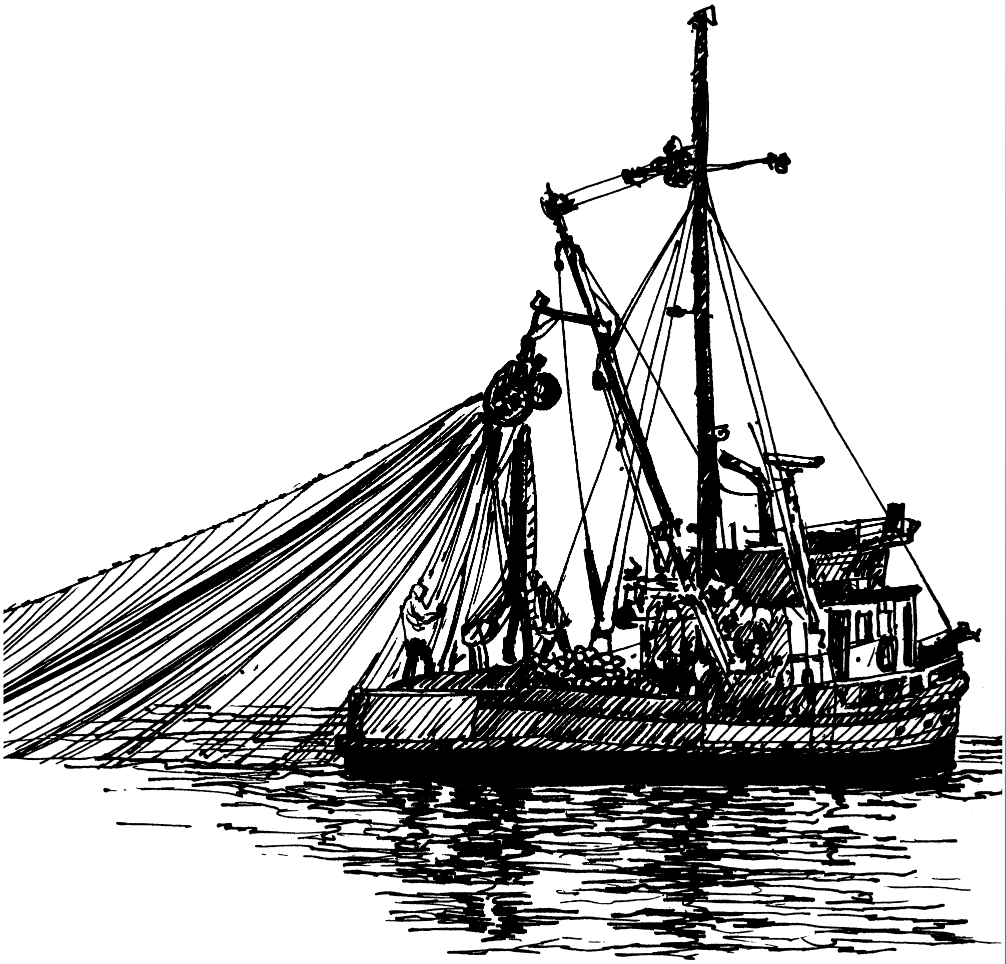
Puget Sound Chinook Harvest Resource Management Plan

Final Environmental Impact Statement

National Marine Fisheries Service
Northwest Region
with Assistance from the Puget Sound Treaty Tribes
and Washington Department of Fish and Wildlife

December 2004



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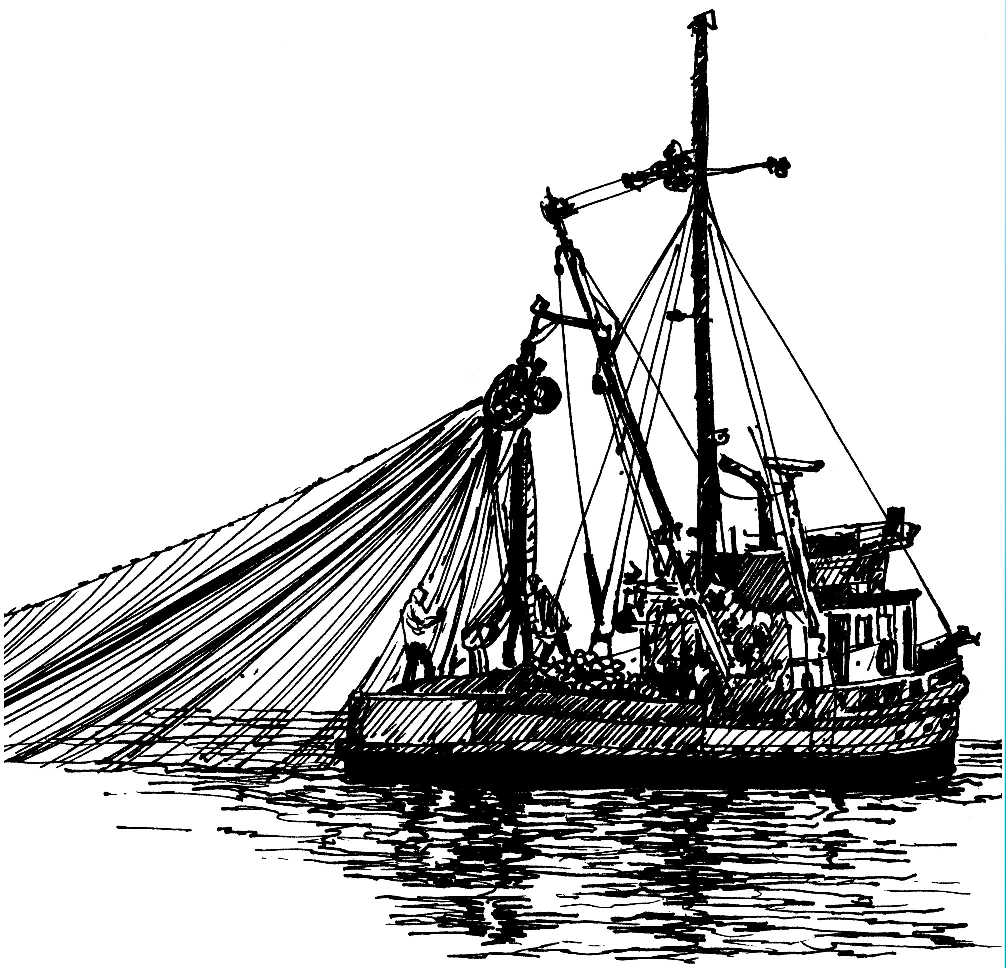

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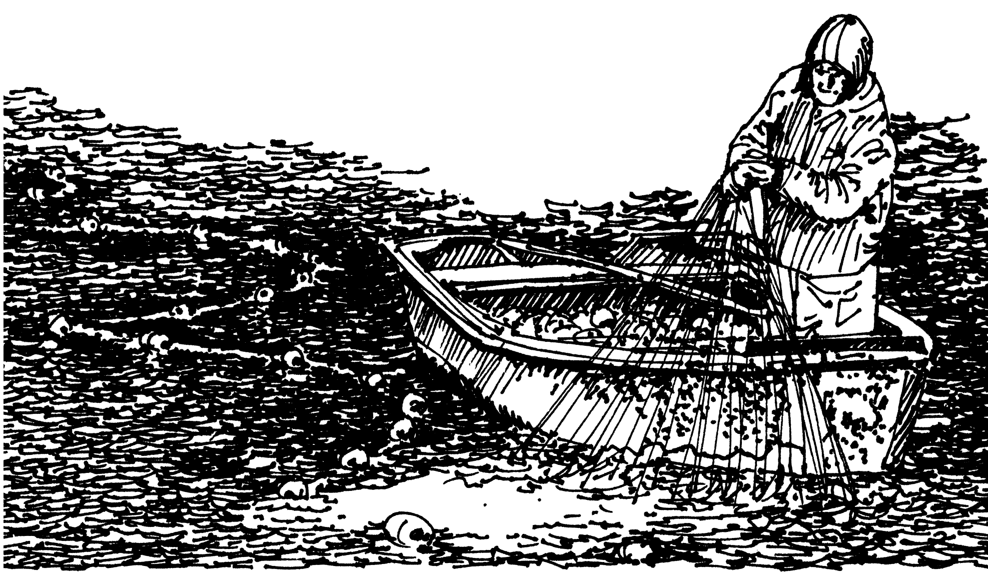

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1.0 INTRODUCTION

The Puget Sound Chinook Harvest Resource Management Plan Draft Environmental Impact Statement (DEIS) was made available for a 45-day public comment period on April 16, 2004 (69 FR 20609). The comment period was extended for one month to July 1, 2004 (69 FR 32547) in direct response to a request from the public. This resulted in a total comment period of 78 days. In addition to the Federal Register announcement, comments were also solicited via: 1) an announcement on the National Marine Fisheries Service (NMFS) Northwest Region web site; 2) an email notification to western Washington news agencies and various federal, state, tribal, and local jurisdictions; 3) postcards and letters mailed directly to individuals and organizations included on a public notification mailing list. Several other agencies and organizations, such as, Shared Strategy, and the Washington Department of Fish & Wildlife (WDFW), also provided notification through their web sites and newsletters.

This Final Environmental Impact Statement (FEIS) was generated in response to updated information and public comments received by NMFS pertaining to the public review draft of the Puget Sound Chinook Harvest Resource Management Plan DEIS, dated April 2004. The FEIS consists of two volumes.

Volume 1:

Section 1.0 Introduction

Section 2.0 Overview of Public Comments Received

Section 3.0 Public Comments and NMFS' Responses

Final EIS Volume 2 is the revised Draft EIS as modified in response to public comments or updated information.

Overview of Public Comments Received

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2.0 OVERVIEW OF PUBLIC COMMENTS RECEIVED

This section provides an overview of the public comments that were submitted following the public comment period, held May 1 to July 1, 2004.

2.1 Number of Comments Received

A total of five letters of comment were received by NMFS pertaining to the DEIS and Resource Management Plan (RMP): one from a government agency, three from public organizations, and one from an individual citizen. Several of the comments and suggestions were incorporated into the DEIS (FEIS Volume 2). This volume of the FEIS (Volume 1) contains copies of the letters of comment, followed by NMFS' responses to the comments.

2.2 Process for Responding to Comments

The comments received ranged from detailed scientific comments, to expressions of opinion on various issues, to comments that were essentially expressions of preference for different alternatives. Specific comments were identified and read by the appropriate resource specialists and NMFS, who prepared individual detailed responses. These comments and their associated responses are provided in Section 3 of FEIS Volume 1. Suggestions that were incorporated into the DEIS are indicated in the response to comments. The revisions are provided in FEIS Volume 2, Revised Draft EIS. Revisions were made by striking out old text and underlining updated or new text (unless otherwise noted).

The letters of comment are listed by page number in the FEIS Volume 1 Table of Contents. Each comment letter is followed by the response to comments in that letter. To see how comments were addressed, refer first to the letter of interest, and then to the numbers in the margins of the comment letter. The margin numbers direct the reader to the associated response with the same number.

2.3 Range of Comments

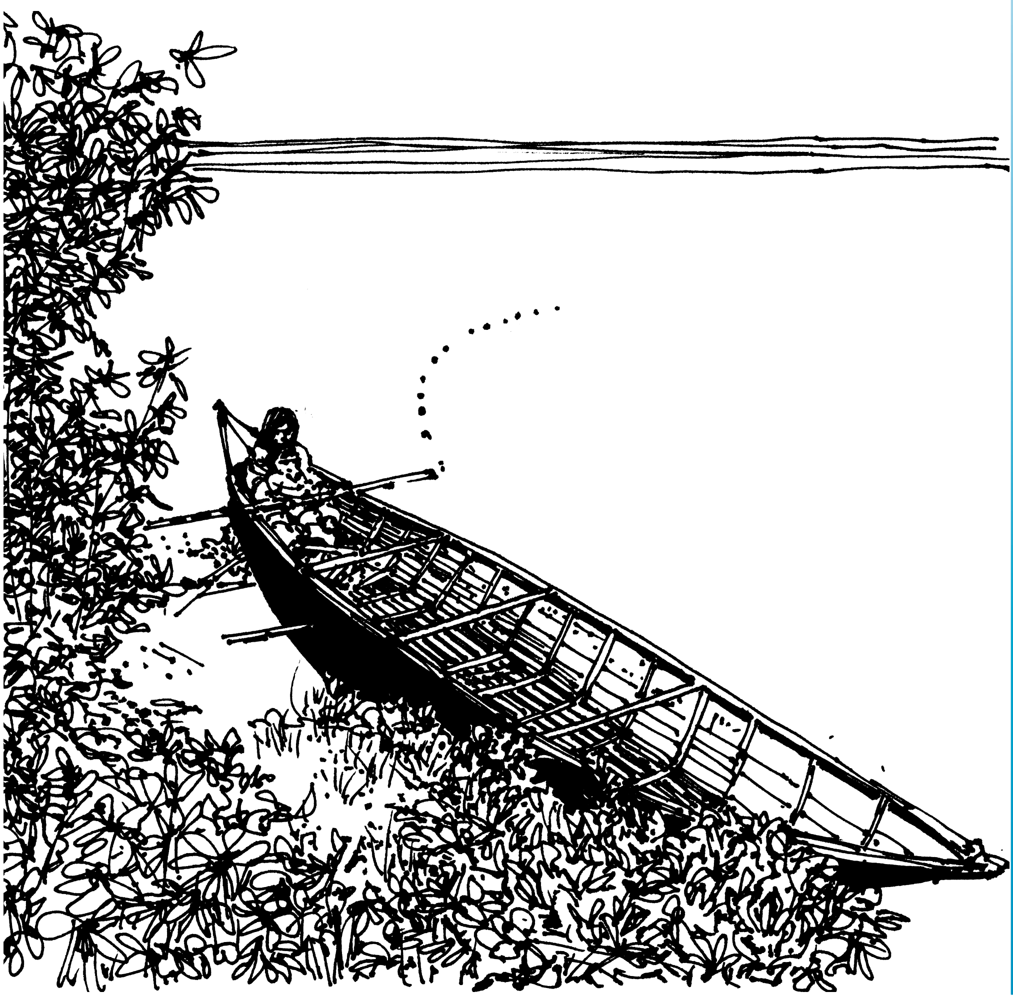
Although relatively few letters of comment were received, comments ranged from general suggestions for additional alternatives to detailed technical comments. Following is a general summary of the comments received:

1. Concern that the range of alternatives evaluated in the DEIS was too narrow and suggestions for additional alternatives:
    - More liberal harvest regime
    - Tribal-only fisheries regime
    - Tribal-only pre-terminal and tribal/non-tribal terminal fisheries regime
    - Fixed escapement goals with incidental-only levels below goal regime

- Fisheries regime similar to that used for Oregon Coast coho
- Changes in hatchery production, including no hatchery augmentation
- Reduced harvest, including specifically in Canadian fisheries
- Use of selective gear.

2. Request for discussion of different methods and locations for tribal harvest.
3. Request to broaden the scope of the Purpose and Need for the Proposed Action.
4. Request for discussion of methods and techniques to limit mortalities in sport and mixed-stock fisheries in order to reduce overall mortality on Puget Sound chinook salmon.
5. Disagreement with derivation of harvest management objectives and standards.
6. Detailed technical comments about the data or assumptions used to evaluate alternatives or to derive harvest management objectives or standards.
7. Disagreement with the range of abundances and Canadian/Alaskan fisheries in the scenarios used to evaluate the alternatives.
8. Concern regarding the treatment of management precision either in the alternatives evaluated or in suggested additional alternatives.
9. Disagreement with the bases for which the tribal-only and no hatchery augmentation alternatives suggested during public scoping were eliminated.
10. Support for the analysis in the DEIS and the choice of the Preferred Alternative.
11. Request for estimation of costs associated from any delay in delisting under the ESA from implementation of the Preferred Alternative.
12. Request for estimation of benefits and costs associated with alternative uses of human and financial resources resulting from adoption of harvest regimes that are less resource-intensive than the Preferred Alternative.
13. Request for economic analysis associated with non-use of the fish resource or costs associated with production of fish harvested (hatchery production), or fisheries management.
14. Request for exploration of objectives and processes that change the hatchery reliance practices.
15. Request for greater discussion of habitat effects in Puget Sound, integration of habitat and hatchery actions, and the influence of habitat on the derivation of harvest management objectives and standards.
16. Concern that the Proposed Action does not meet the stated purpose because it does not conserve the productivity, abundance, and diversity of some populations of Puget Sound chinook salmon in the ESU.
17. Suggest revision to the DEIS to reflect application to the 2005 to 2009 fishing seasons rather than the 2004 to 2009 fishing seasons because of delay in completing the EIS.
18. Disagreement with the identification of Alternative 1 (the Proposed Action) as the No Action Alternative.
19. Suggest that the alternatives do not need to meet all the elements of the Purpose and Need.
20. Concern over the choice of Alternative 1 rather than the Environmentally Preferable Alternative as the Preferred Alternative.

Public Comments and Response to Public Comments



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3.0 PUBLIC COMMENTS AND RESPONSE TO PUBLIC COMMENTS

This section contains the letters of comment received on the Draft EIS, and the response to comments. One element of the response to comments was to revise the DEIS circulated for public comment in April 2004, to add clarifications warranted by the comments, and/or to provide additional updated information. Changes made to the Draft EIS are summarized in Subsection 3.1. The letters of comment and response to comments are reproduced in full in Subsection 3.2.

3.1 Summary of Changes Made to the Draft Environmental Impact Statement

Table 3-1 summarizes key changes that were made to the Draft Environmental Impact Statement (DEIS) in response to public comment or as a result of updated information. The table summary does not identify all changes made; it describes changes in wording that affect content, intent, and explanations of commitments contained in the DEIS or in response to specific public comment. The most extensive changes were related to the discussion of Fish (Subsections 3.3 and 4.3) and Wildlife (3.8). Changes were also made for editorial reasons for purposes of clarification; these are not included in Table 3-1. The location of text modifications is denoted by subsection where the text appeared in the DEIS distributed for public comment (April 2004).

Table 3-1. Major changes made in Final EIS volume 2 in response to public comments received on the Draft EIS: *Puget Sound Chinook Harvest Resource Management Plan (NMFS, April 2004).*

DEIS Section	Page[1]	Response to Comment	Summary of Changes Made to the DEIS
1.1	1-1	EPA-13A	Change duration of Proposed Action from 2004–2009 to 2005–2009.
1.2	1-3	EPA-13A	Change duration of Proposed Action from 2004–2009 to 2005–2009.
1.4	1-4	EPA-13A	Include language explaining that an ESA Section 7 Biological Opinion had been conducted on the 2004 fishing season.
1.4	1-4	EPA-1	Clarify importance of Limit 6 criteria to the Purpose and Need for the Proposed Action.
1.4	1-4	EPA-13A	Revise language to note the revision of the settlement agreement between Washington Trout and NMFS to reflect the Section 7 consultation on the 2004 fishing season.
1.6 Recreational Fisheries	1-23	SW-28	Correct recreational chinook salmon catch numbers in text to correspond with Figure 1.6-4.
1.8.2	1-27	EPA-13A	Change duration of Proposed Action from 2004–2009 to 2005–2009.
1.9	1-27	EPA-13A	Change duration of Proposed Action from 2004–2009 to 2005–2009.
1.12	1-33	EPA-13A	Change duration of Proposed Action from 2004–2009 to 2005–2009.
2.1	2-1	EPA-13A	Change duration of Proposed Action from 2004–2009 to 2005–2009.
2.2	2-2	EPA-13A	Change duration of Proposed Action from 2004–2009 to 2005–2009.
2.2.2	2-3	EPA-13A	Change duration of Proposed Action from 2004–2009 to 2005–2009.
2.3.1	2-6	EPA-10	Revise language to clarify that the Proposed Action would manage mixed-stock fisheries for the harvest management objective of the weakest management unit in the fishery.
2.3.1	2-6	EPA-13A	Change duration of Proposed Action from 2004–2009 to 2005–2009.
3.1	3-1	Workgroup	Clarify that document also addressed SEPA issues of relevance.
3.3.1.1	3-15	EPA-8	Provide a broader overview of habitat activities affecting listed salmon in Puget Sound.
3.3.5	3-81	Workgroup	Update information on derelict fishing gear removal in Puget Sound.
3.3.6	3-82	Workgroup	Update references and add more discussion on terrestrial effects.
3.7.3	3-155	EPA-13A	Change duration of Proposed Action from 2004–2009 to 2005–2009.
3.7.5	3-156	EPA-16	Correct calculation of minority representation by county in Table 3.7-2.
3.8.1	3-160	Workgroup	Update text.
4.2.2	4-4	EPA-13A	Change duration of Proposed Action from 2004–2009 to 2005–2009.
4.2.3	4-5	EPA-13A	Change duration of Proposed Action from 2004–2009 to 2005–2009.
4.2.3.1	4-5	EPA-13A	Change duration of Proposed Action from 2004–2009 to 2005–2009.
4.2.3.2	4-6	EPA-6	Delete language referencing Appendix B for details on Canadian fishing regimes and the basis of the maximum northern fisheries scenario. This information is included in Subsections 1.6 and 4.2 of the DEIS.
4.2.3.2	4-6	EPA-13A	Change duration of Proposed Action from 2004–2009 to 2005–2009.

[1] Page number found in public review draft of the EIS, dated April 2004.

DEIS Section	Page[1]	Response to Comment	Summary of Changes Made to the DEIS
4.3.1.1 Impacts to Hood Canal and Strait of Juan de Fuca Summer Chum	4-9	Workgroup	Correct escapement figures in text and Tables 4.3-7a through 4.3-7d.
4.3.1.2 Impacts to Hood Canal and Strait of Juan de Fuca Summer Chum	4-21	Workgroup	Correct comparison of Alternative 2 to Alternative (Scenario B) corrected in text and Tables 4.3-8a through 4.3-8d.
4.3.1.3	4-24	Workgroup	Catch figures corrected in text and Tables 4.3-9a through 4.3-9d.
4.3.1.3	4-24	Workgroup	Correct Alternative 3 comparison to Alternative (Scenario B) in text and Tables 4.3-9a through 4.3-9d.
4.3.1.4	4-27	Workgroup	Correct catch figures corrected in text and Tables 4.3-10a through 4.3-10d.
4.3.6	4-76	EPA-13A	Change duration of Proposed Action from 2004–2009 to 2005–2009.
4.3.6.1	4-77	EPA-13A	Change duration of Proposed Action from 2004–2009 to 2005–2009.
4.3.6.2	4-81	EPA-13A	Change duration of Proposed Action from 2004–2009 to 2005–2009.
4.3.6.3	4-83	EPA-13A	Change duration of Proposed Action from 2004–2009 to 2005–2009.
4.3.7.1	4-84	EPA-13A	Change duration of Proposed Action from 2004–2009 to 2005–2009.
4.3.8.1	4-100	EPA-13A	Change duration of Proposed Action from 2004–2009 to 2005–2009.
4.3.8.1	4-100	SW-15, 16, 32, WT-32	Expand discussion to provide more detail on the robustness of the different alternatives to management error.
4.6	4-131	SW-7	Information is insufficient to assess economic effects of potential delay in recovery of some Puget Sound Chinook populations.
4.6	4-131	NFS-12	Information is insufficient to assess the potential effects of implementing the different alternatives on non-use values.
4.8.1	4-182	Workgroup	Expand description on effects of derelict fishing gear.
4.8.2.2	4-189	Workgroup	Update text.
4.8.3	4-190	Workgroup	Expand description on effects of derelict fishing gear.
4.8.4.1	4-193	Workgroup	Add reference to biological opinions and incidental take permits for marbled murrelets for Puget Sound salmon fisheries.
4.8.5	4-194	Workgroup	Identify several terrestrial wildlife species with strong consistent links to salmon as prey species.
4.9	4-206	EPA-13A	Change duration of Proposed Action from 2004–2009 to 2005–2009.
5.1	5-2	EPA-13A	Change duration of Proposed Action from 2004–2009 to 2005–2009.
5.2.2	5-10	EPA-13A	Change duration of Proposed Action from 2004–2009 to 2005–2009.
Appendix C2	C-5	EPA-8	Add explanation for how harvest standards change with changing environmental conditions.
Appendix C3	C-15	EPA-13A	Change duration of Proposed Action from 2004–2009 to 2005–2009.

[1] Page number found in public review draft of the EIS, dated April 2004.

3.2 Letters of Comment and Responses

NMFS received five letters of comment on the Puget Sound Chinook Harvest Resource Management Plan Draft EIS (April 2004): one from a government agency, three from public organizations, and one from an individual.

Each letter of comment and attachments (if any) are reproduced in this subsection, along with responses prepared by NMFS and/or appropriate resource specialists. For clarity in associating responses with specific comments, numbers have been applied in the margins of each letter of comment, delineating the paragraph or portion of a paragraph for which a response was prepared. All responses follow each letter of comment, numbered to correspond to these margin numbers.

Sam Wright (SW)

Letter of Comment

To: **Susan Bishop, Fisheries Management Branch, Northwest Region - Sustainable Fisheries Division, NOAA's National Marine Fisheries Service, 7600 Sand Point Way NE, Seattle, WA, 98115-0070**

From: Sam Wright

Subject: **Response to: Draft Environmental Impact Statement (DEIS), Puget Sound Chinook Harvest Resource Management Plan, April 2004.**

The only logical way for me to respond to the DEIS and its Appendices is by developing and describing a new viable alternative, herein called **Alternative 1A**, which falls between Alternatives 1 and 2 in the DEIS. It is my understanding that a new approach can be given serious consideration as long as it falls *within* the range of alternatives presented in the DEIS. Alternatives 2, 3, and 4 were clearly unacceptable before they were even analyzed. Alternative 1A has a fundamental difference from all of the alternatives in the DEIS in that active management attention would be directed toward each brood year or cohort of each 1A
chinook population beginning at age two - when significant fishing-related mortality begins (See No. 10). The affirmation of treaty Indian fishing rights for salmon and steelhead in 1974 required fisheries managers to quantify basis for their decisions. This initially led to improved resource stewardship when meeting spawning ground escapement objectives was accorded highest priority. However, failure followed, beginning in the early 1980s, for salmon resources as providing fisheries replaced attainment of escapement goals as a fisheries management planning priority. In the case of Puget Sound chinook, this change in priority played a huge role in creating a basis for listing under the Endangered Species Act (ESA). Alternative 1 continues with this same misplaced priority and relies on very suspect theoretical models to justify a pre-conceived desired suite of fisheries. It is well known within the fisheries profession that the types of models involved require too many tenuous assumptions to be of any real value and thus can be easily manipulated to "justify" almost anything. In the current DEIS, it is repeatedly shown that it does not matter in the long term whether thousands of salmon are caught or allowed to escape to the spawning grounds. Logic is completely missing. In addition, the chinook spawning escapements observed in many areas in 2003 were unique in that returning 3- and 4-year-old hatchery fish were adipose marked for the first time. In many key areas, the percentages of hatchery fish were much higher than had been estimated by anyone in the past. Thus, critical assumptions in your planning effort about both abundance and productivity 2
of wild fish are now simply obsolete, including many of the adult-to-adult spawner-recruit relationships for natural spawners. For example, 70% of the female chinook returning to the new fish passage facilities on the Cedar river in 2003 were marked hatchery fish. When the Habitat Conservation Plan (HCP) was developed for the Cedar River, the possible presence of significant numbers of hatchery fish was not even raised as an issue (the DEIS also assumes wild fish only). No 2003 escapement information for any area is 3
even presented or considered in the document. Alternative 1A is based upon a foundation of sound fisheries management principles that have a proven track record of success when applied correctly in the past and current management of Pacific Coast salmon populations. In contrast, Alternative 1 evolves from a foundation of "policy" (i.e., political) decisions The two primary principles that form the cornerstone of Alternative 1A are as follows:

Incidental Puget Sound Chinook Catch Principle

The take of listed Puget Sound chinook pursuant to the targeted harvesting of surplus production from other salmonid resources will have a net benefit (chinook bycatch plus other species) that will significantly exceed the future benefits that would be derived if the same listed chinook were allowed to escape and spawn naturally. Valid incidental catches would include listed Puget Sound chinook taken as non-catch mortality associated with harvesting adipose-marked unlisted Puget Sound chinook. 1B

Curtailment of Directed Puget Sound Chinook Harvest Principle

If listed chinook needed to meet a valid spawning escapement objective (generally defined as the "upper thresholds" in state-tribal planning) are allowed to escape and spawn naturally, the net benefits 4
derived from their progeny will, on average, be significantly greater than if the same fish had been immediately harvested.

In Alternative 1A, both of these principles would be applied consistently to *management unit* 1C
escapement objectives, not objectives for individual populations (when they differ). The only two possible fisheries management responses to these two principles would be as follows for each defined population: (1) 1D
If listed Puget Sound chinook are predicted to exist in U.S. waters to meet a specific spawning escapement objective, then all fisheries would be managed to meet or exceed that objective; or (2) if listed Puget Sound chinook are not predicted to exist in U.S. waters to meet a specific objective, then all fisheries would be managed for only incidental, non-targeted impacts. These would include needs for valid test fisheries and critical ceremonial, subsistence and research (test fishing) uses.

The basic approach under Alternative 1A would be similar to that described in the WDFW Wild Salmonid Policy FEIS. However, instead of a fixed 10% limitation on incidental catches in Washington 1E
fisheries, the allowance would be the total from valid incidental catches. This eliminates potential problems when the total incidental catch needs might be slightly above or below 10% (including differences during odd-year pink salmon runs). In the absence of a specific percentage limitation, there will be more potential for abuse of the incidental catch principle. Each proposed incidental catch need will require close scrutiny to insure its validity.

Differences Between Alternative 1 and Alternative 1A

The primary difference between the two alternatives is that Alternative 1 would allow planned, deliberate overfishing of listed Puget Sound chinook in clearly targeted fisheries. These are defined by the 5
co-managers as any chinook fisheries where less than 50% of the total catch comes from listed populations with no harvestable surpluses (or, alternatively, where a certain estimated exploitation rate is not exceeded). Alternative 1A would not allow these particular types of fisheries or anything close to it.. There can be no question that Alternative 1 would at best *delay* and at worst *prevent* chinook populations from ever reaching 6
Viable Population Escapements - in spite of what "models" in the DEIS claim to show. There would be a difference if thousands of additional chinook are allowed to be caught. This would, in turn, significantly delay or prevent the de-listing of Puget Sound chinook, a supposed (stated) primary objective of NOAA Fisheries. 7
Since the ESA listing has significantly increased the costs of doing business for both private businesses and public agencies, a deliberate delay will cause tremendous economic losses to both taxpayers and consumers. These costs will need to be analyzed and presented in the FEIS.

The other major difference between Alternative 1 and Alternative 1A is that the latter does not rely for its success on a number of very tenuous assumptions, many of which are necessary for Alternative 1 to be successful on a sustainable basis. These are as follows:

(1) The "Lower NMFS' Derived Thresholds" or "Critical (Low) Abundance Thresholds" inspire a false sense of security since it is believed that any chinook population will always be able to recover if it is kept at or above these levels. This is one of the reasons that Alternative 1 allows targeted chinook fisheries or planned overfishing when returns are below the Viable Population Escapement levels. 8
The various Critical numbers are consistently portrayed as fully accounting for the possibility of depensatory mortality or depensation. Liermann and Hilborn (1997:1976) give examples such as "predator pits, reduced reproductive success, impaired aggregation, conditioning of the environment, efficiency of food location, and inbreeding."(Liermann, M., and R. Hilborn. 1997. Depensation in fish stocks: a hierarchic Bayesian meta-analysis. Can. J. Fish. Aquat. Sci. 54:1976-1984.) Depensation is also referred to as inverse density-dependence or the Allee effect (Myers et al. 1995) but the latter term is only a sub-part of depensation (Myers, R.A., N.J. Barrowman, J.A. Hutchings, and A.A. Rosenberg. 1995. Population dynamics of exploited fish stocks at low population levels. Science 269:1106-1108.). Mechanisms underlying Alee effects are limited to physiological and behavioral causes (Frank, K.T., and D. Brickman. 2000. Alee effects and compensatory population dynamics within a stock complex. Can. J. Fish. Aquat. Sci. 57:513-517.) The empirical evidence on Pacific salmon populations shows that depensatory mortality can be manifested at population sizes significantly larger than the relatively small Critical numbers 8
currently being used by NOAA Fisheries for Puget Sound chinook (Liermann and Hilborn 1997; Myers et al. 1995. Peterman, R.M. 1977. A simple mechanism that causes collapsing stability regions in exploited salmonid populations. J. Fish. Res. Bd. Can. 34:1130-1142.

Peterman, R.M. 1987. Review of the components of recruitment of Pacific salmon. Am.
Fish. Soc. Symposium 1:417-429. Ricker, W.E. 1973. Two mechanisms that make it 8
impossible to maintain peak-period yields from stocks of Pacific salmon and other fishes. J.
Fish. Res. Bd. Can. 30:1275-1286.). It seems obvious that NOAA Fisheries is, at best, only
accounting for the Allee effects sub-set (with numbers as low as 200) and not all potential
elements of depensation. If these numbers are used, then 3-year-old females should be deleted
from the totals (See No. 8). In addition, any such "critical" numbers should be expressed as
numbers of females four years or older. The "normal" wild fish escapement in the Skagit river 9
is 55% males (excluding jacks) but the 3-year-old component is sizable in rivers with large 1F
numbers of hatchery fish (everywhere except the Skagit) and is composed of about 70% males
(Note: The point is to correct for the anomalous spawning population caused by the presence
of hatchery fish. For example, 200 fish would become 100 females age 4 or older. The above
would be an acceptable variation for Alternative 1A).

(2) The relatively successful use of Alternative 1 in three recent years (2001-2003) was achieved
when the independent variables of freshwater and marine survival were both clearly above
average (egg to smolt and smolt to adult survival rates, respectively). Since each of these two 10
independent variables has the possibility of being above or below average, the current situation
might be expected 25% of the time. Even a poorly conceived system can give the illusion of
success during such a brief period. In addition, there have been several recent years in which
Canadian fisheries have not harvested chinook at levels allowed under the Pacific Salmon
Treaty due to internal Canadian conservation issues. The only long-term data series for egg to
smolt survival rates for Puget Sound chinook comes from the Skagit River (Seiler, D., S.
Neuhauser, and L. Kishimoto. 2002. Annual Report. 2001 Skagit River wild 0+ chinook
production evaluation. Report No. FPA02-11. WDFW, Olympia, WA. and Dave Seiler,
WDFW, personal communication). The egg to smolt survival rate has not been severely
depressed by high flood flows since the 1995 brood year, which had a survival rate of only 3.8
percent. Since then, the survival rates for the next seven brood years (1996 to 2002) have 11
ranged from 10.8 to 16.5%. The Hare et al. (1999) reference is frequently cited to claim that
marine survival of Puget Sound chinook will be above average for an extended period of time.
However, the same reference (Hare et al. 1999:12) concedes that "interannual variability
appears to be more pronounced, in relation to interdecadal variability, in chinook and chum."
Their supposed relationship for Pacific salmon is really a relationship for and driven by data
from pink, sockeye, and coho salmon. Other scientists examining ocean survival have used a
similar data base as Hare et al. (1999) and their published results reflect these same problems.

(3) The "Rebuilding Exploitation Rates" or "Recovery Exploitation Rate Ceilings" that are critical
to the success of Alternative 1 (but not 1A) are generally based on exploitation rates observed 12
in the late 1990's that resulted in stable or increasing spawning escapements. However, as
described in No. 2 above, the late 1990's had a fortuitous combination of above average
freshwater and marine survival rates as well as reduced Canadian fishing pressure.
Computation of these rates also involved many uses of questionable data. All of the CWT data
for Puget Sound chinook come from hatchery fish and these data are used as surrogates for the
expected behavior of wild fish. In a number of cases these hatchery fish are not even from the
same river basin. Non-indigenous Samish River hatchery fish are used to represent the largest
resource in the ESU - Skagit River summer-fall chinook. The former mainly move north
through Georgia Strait after being released while most of the Skagit fish probably migrate out 13
through Juan de Fuca Strait. Stillaguamish hatchery fish are used to represent Snohomish
system summer and fall chinook populations although the latter are the only summer-fall runs
in the ESU with a sizeable component of yearling migrants as well as a higher percentage of 5-
year-old adults (about 25%). Other substitutions involve two Lake Washington populations,
mid-Hood Canal tributaries, and the Puyallup, Nisqually and Elwha rivers (the Hoko River is
used for the latter and is not even in the ESU). Nothing is modeled for the Dungeness River.
The only places in Washington with usable CWT data for wild chinook are the Lewis River
and the Hanford Reach. In each case, both the catch (ocean) distribution and exploitation rate
are significantly different from hatchery fish in the same area (WDFW. 1992. 1992

Washington State salmon and steelhead stock inventory. Appendix Three. Columbia River stocks. WDFW, Olympia, WA.). In addition, most of the CWT data from earlier years had incomplete spawning escapements which artificially inflated the perceived exploitation rates. 14
There have been greater efforts in recent years to get complete escapement data. However, the calculated declines in exploitation rates present an unknown mixture of real declines and false declines caused by incomplete escapement data.

(4) Different fisheries management strategies have been debated for decades and the central points of this debate are described as follows by Frederick and Peterman (1995:301): "Many have discussed the apparent conflict between a constant escapement policy (usually characterized by a high average harvest but also high interannual variability in harvests) and a constant harvest rate policy (usually associated with lower average harvests but also lower harvest variability) (e.g., Ricker 1958; Allen 1973; Gatto and Rinaldi 1976; Hall et al. 1988; Quinn et al. 1999). Although this is an accurate characterization of the two policies for stocks that are optimally managed with perfect information, it does not necessarily apply where there is observation error in stock abundance" (Frederick, S.W., and R.M. Peterman. 1995. Choosing fisheries harvest policies: when does uncertainty matter? Can. J. Fish. and Aquat. Sci. 52:291-306.). In managing Puget Sound salmon fisheries, the "uncertainty" is typically over correct spawning escapement objectives. This is used by some scientists as a basis for exploitation rate management as a "probing" element of the Adaptive Management Concept. Their rationale is that ranges of spawning escapements will eventually produce answers to the questions of correct spawning escapement objectives. They also claim that managing every year for a fixed numerical escapement goal will not produce the needed range of escapements. Three major 15
Puget Sound chinook populations have been managed for fixed escapement goals for the past six years (1997-2002) - Green River (5800 natural spawners), Nisqually River (1100 natural spawners), and Skokomish River (3650 natural spawners). During the six year period, annual spawning escapements ranged from 6170 to 13950 in the Green River, from 340 to 1542 in the Nisqually River, and from 1479 to 10729 in the Skokomish River. This is sufficient range for any conceivable spawner-recruit analysis. It appears that the co-managers definitely favor year-to-year fisheries stability over higher yields but, in this particular ESA-listed case, there are tremendous economic costs associated with the delayed resource recovery which this choice mandates.

(5) The information presented above is also a good example of the tremendous imprecision in the actual fisheries management processes. Only the Green River met the objective of meeting or exceeding the escapement goal despite active terminal area management. This is what you can get in practice when you are managing for specific quantitative objectives, whether it is numbers of fish or desired exploitation rates. The narrative in the DEIS gives the illusion that use of rates gives more management precision but this is for the rates themselves, not the 16
resultant numbers of fish. With this tremendous imprecision in the management processes, you do not want to base your system on quantitative values that have their own high degrees of imprecision. This is one of the best advantages of Alternative 1A over Alternative 1. In Alternative 1A, the only values with a significant degree of present uncertainty are the spawning escapement objective numbers. These will quickly improve as adequate time series of chinook smolt trapping data become available for most major river systems. The eventual success in managing Puget Sound chinook will have to come from an ability to compare 17
numbers and sizes of female spawners with their resultant smolt production. Adult-to-adult relationships will always have too much variability to be of any real value. They cannot separate the independent variables of freshwater and marine survival, the percentages and sizes of females vary from year to year (changing the spawning capabilities and egg totals), and accurate catch statistics specific to each cohort cannot be obtained (as can be done when managing sockeye, chum or steelhead populations that are only harvested in terminal areas). The science of adult spawner-recruit analysis mandates that accurate statistics for both total catch and total escapement must be available for each specific brood year or cohort. It is not acceptable to use averages or estimated fishing rates. Alternative 1 has the same weakness plus two additional weaknesses - the needs for both critical population numbers and rebuilding

exploitation rates. There is simply too much uncertainty to allow a significant degree of planned, deliberate overfishing. Enough will happen by accident from the inherent imprecision of the management planning process.

(6) The same problem with adult-to-adult relationships carries over to all of the attempts to determine current watershed productivity. Computerized theoretical habitat modeling with countless assumptions (Ecosystems Diagnosis Treatment methodology or EDT Method) is a poor substitute when you can get your answers directly and without assumptions from real fish numbers. The Skagit River juvenile production data provide the only accurate basis for determining current watershed productivity. It is the only place in Puget Sound where chinook freshwater survival can be isolated and determined for an extended period of time. The system has produced 5.0 to 6.4 million ocean-type migrants annually from four recent brood years (1998, 2000, 2001, and 2002) with adult escapements ranging from 15.6 to 20.7 thousand. 18
Seven other brood years (1991-94, 1996-97, and 1999) were not seriously impacted by high peak flood flows during egg incubation but production was markedly less - 1.5 to 4.5 million smolts from escapements of 5.4 to 11.7 thousand adults. The only possible conclusions that can be drawn from these data are that (1) the system has a current capability of producing 5 to 6 million out-migrants, and (2) the adult spawning escapements were inadequate for those recent brood years with less smolt production. There is a solid empirical basis for both production capabilities and a spawning escapement objective.

(7) The DEIS mistakenly treats Canadian interceptions of Puget chinook as only a "given" that must be accounted for in the management planning process. In reality, the salmon treaty with Canada reflects results of a conscious, negotiated exchange of U.S. and Canadian origin 19
salmon. Some of the anticipated surplus production from Puget Sound chinook was traded away to secure continued treaty Indian fishing opportunities on salmon originating in Canada. None of this reality is reflected in any of the analyses contained in the DEIS. The existing quantitative population statistics clearly indicate that most or all of the potential surplus production was in fact traded away to Canada for a number of Puget Sound chinook populations. In the case of severely depressed populations, it appears that the U.S. government traded away surplus production that does not even exist. At the heart of this problem is an erroneous assumption that each chinook population has the inherent capability to produce a large increment of surplus production, at least under improved habitat conditions. However, salmon populations that persist over time do not automatically have an inherent ability to produce significant surplus production for harvest, regardless of habitat conditions. Ricker (1973) estimated that about 30% of the original salmon populations were driven to extinction soon after the advent of significant commercial fishing - they had minimal or no ability to produce surplus production for harvest. This original 30% is long gone but habitat degradation has produced a new group of populations with the same predicament (little or no surplus production capabilities). Since the DEIS correctly concedes that average recruits per spawner will likely decline with higher population sizes due to density dependent factors, there 19
is no quick way out of this trap. The "trap" is that there will be no chance to even change Canadian and Alaskan interceptions until at least 2010 and the needed habitat improvements involve a time scale of decades. Alternative 1A, by being more conservative, is clearly superior to Alternative 1 for these particular populations since it limits any U.S. impacts to only incidental catch mortality until there is a chance to modify the treaty with Canada. Alternative 1 is concerned mainly with building a justification for preservation of the entire ESU even if these particular populations are allowed to go extinct.

(8) The DEIS perpetuates the erroneous assumption that there has never been any significant change in size and age structure of Puget Sound chinook populations. However, a century of massive hatchery releases and selective fishing regimes against older fish, females, and larger individual of the same age class have caused important changes that need to be acknowledged. Gilbert (1912:64) reports as follows: "From salt-water in Puget Sound, we have secured immature third-year fish, both males and females, *and also matured third-year males*, taken by purse-seines from the same school, and both feeding voraciously and equally on small sand lance and young herring. There was no difference in size between the mature and immature

individuals, nor could they be externally distinguished, unless by a certain distension of the
abdomen in mature specimens, due to the developed testes. It became evident from our
observations: (1) that a very small proportion of the males of given year develop precociously;
(2) that precocity is apparently not caused by the influence of peculiar external conditions
operating upon the individuals thus affected, but by some unknown factor; (3) that precocious
development does not stunt the growth. *No mature female king salmon less than four years
old have thus far been encountered.*" (emphasis added) (Gilbert, C.H. 1912. Age at maturity
of Pacific coast salmon of the genus *Oncorhynchus*. Bulletin U..S. Fish Commission 32:57-
70.) Doubters may attempt to dismiss this early work with a claim of inadequate sampling but
it is important to note that the same author (Gilbert 1912) documented the presence of
significant numbers of mature 3-year-old female chinook in California and in the Columbia
River system. Major hatchery programs had already been established in both areas prior to the
time of sampling. It does not appear that any reliance should be placed on third-year females
for the recovery of Puget Sound chinook since this particular life history strategy failed to be
successful in centuries of evolution. If the strategy could not be successful under natural
habitat conditions, it is certainly not going to be viable in this era of dramatic increases in both
the frequency and amplitude of flood events. Again, Alternative 1A is superior to Alternative
1 since it represents a much more conservative approach to resource management. Three- 20
year-old females are not currently a significant part of the reproductive element in the Skagit
River (according to your personal communication from Bob Hayman) and this is the only river
basin in Puget Sound where wild fish are not overwhelmed by hatchery fish as both juveniles
and adult spawners. Under Alternative 1A, three-year-old females would not be used in any 1G
calculations, "Critical" numbers or assumptions involving spawning adults (Note: In managing
steelhead, 3-year-old hatchery-origin females are commonly excluded from spawner-recruit
relationships. In addition, I conducted many spawning ground surveys on Washington coastal
rivers without hatcheries in the 1960s and early 1970s. All of our chinook counts were
separated into jacks, adults (4-, 5- and 6-year-olds) and 3-year-old males - that were obviously
smaller than adults but much bigger than jacks. Small 3-year-old females were not seen.)

(9) The DEIS mistakenly describes the chinook populations in the Lake Washington system as not
being of any critical importance since the same life history strategy is found in other South
Puget Sound river systems. This is incorrect since these populations are the only members of 21
the entire ESU that have extended juvenile rearing in lake habitats (Lake Washington and Lake
Sammamish). The large numbers of marked hatchery fish observed in the Cedar River (at the
southern end of Lake Washington) in 2003 suggests that homing fidelity is primarily to the lake
systems rather than to individual tributaries (hatchery chinook are not planted in the Cedar
River). This is clearly a unique life history strategy that needs to be preserved. In addition, the
HCP for the upper Cedar River creates the only large no-logging preserve for chinook salmon
in the entire Puget Sound basin. Alternative 1A would provide greater protection to Lake 22
Washington chinook populations than Alternative 1.

(10) The Skagit River chinook enjoyed a very fortunate string of seven consecutive brood years
(1996-2002) in which incubating eggs were not seriously impacted by high flood flows.
However, this lucky streak came to an end in late October of 2003 when many river systems in
the Puget Sound basin were hit by record or near record floods. Many chinook populations
had their peak of spawning activity prior to this extreme flooding and egg to fry survival rates
can be expected to approach zero (as was the case for the 1990 chinook brood year in the
Skagit River when the egg to migrant survival rate sank to 1.2%). Early 2004 counts of the 23
2003 brood year survivors indicate that the production will only be about 10% of the 5 to 6
million smolts that the river is capable of producing (Dave Seiler, WDFW, personal
communication). In addition, the reduced production will be skewed to progeny from fish that
spawned after the flooding and run timing is an inherited trait. The best the DEIS modeling
did was to evaluate a 30% decline from the above average chinook abundance observed in
2003. Under Alternative 1, fish from the 2003 brood year will be subjected to normal
exploitation rate management procedures and only the mature members of the cohort would be
actively managed. The DEIS discusses a number of "special precautions" that will be taken

with extremely low runs but there is no showing anywhere in the DEIS that poor runs can be
accurately predicted in advance of significant fishing mortality taking place. Most of the
populations have the majority of their females maturing at age four. These fish from the 2003
brood year will not even receive management attention until 2007 under Alternative 1.
However, significant fishing-related mortality on these females will occur in both 2005 and
2006. Under Alternative 1A, needed protection would begin as early as 2005 in more
restrictive management of the Puget Sound recreational salmon fisheries (where immature 2- 1H
year-old fish often provide a majority of the catch). This would also provide additional
protection to those members of the 2002 brood year destined to mature as 5-year-old females
in 2007. Important, usable information on ocean-type smolt production from the 2003 brood
year will be available by the end of 2004. The burden of proof should be on showing that
surplus production exists for harvest before targeted, non-selective chinook fisheries are
allowed. The same fatal flaw described above for Alternative 1 will apply to all brood years
(weak and strong) for all Puget Sound chinook populations managed throughout the tenure of
the EIS.

(11) It is clear from the content of the DEIS that NOAA Fisheries has modified their policy
position with respect to the role of hatchery fish in the Puget Sound chinook ESU. At the time
of listing, hatchery fish were clearly identified as one of the primary causes for listing and a
whole series of detailed adverse impacts from hatchery fish were described in the listing
decision documents. At the same time, five hatchery stocks were also listed and deemed
essential to recovery of the ESU. Until recently, all of the unlisted hatchery stocks were
considered to have all of the same adverse impacts identified at the time of listing. The current 24
DEIS is a marked departure in that all hatchery stocks, listed and unlisted, are now considered
to have significant beneficial elements. The listed North Fork Nooksack hatchery stock is now
considered beneficial when it strays into the South Fork Nooksack even though the latter has a
genetically distinct chinook population. The same situation occurs in the North and South
Forks of the Stillaguamish River, although straying has not been quantified. Unlisted hatchery
chinook stocks are considered to be a distinct benefit when they spawn with wild fish in the
Skykomish River, in northern Lake Washington tributaries, and in mid-Hood Canal tributaries.
Except for the Skagit River, hatchery chinook dominate wild fish in every river system within
the Puget Sound ESU (the hatchery releases are at least two times - Stillaguamish - and as
much as 40 times - Skokomish - the estimated wild smolt production). However, they are
never even mentioned in the DEIS as a possible reason for certain wild populations not
achieving their expected progress toward recovery. NOAA Fisheries may have a new policy
with respect to hatchery fish but it is clearly at odds with the best available science and this
distinction should be spelled out in the FEIS. Under Alternative 1A, the role of hatchery fish
in recovery would remain consistent with that described at the time of listing. In addition, new
evidence on the adverse impacts of hatchery fish would be added. For example, it was recently 25
determined that chinook natural spawners in several Canadian rivers with hatchery fish had
reduce egg sizes and thus reduced reproductive fitness (Heath, D.D., J.W. Heath, C.A.
Bryden, R.M. Johnson, and C.W. Fox. 2003. Rapid evolution of egg size in captive salmon.
Science (299):1738-1740.)

(12) It is also evident in the DEIS that NOAA Fisheries is willing to sacrifice a significant number
of Puget Sound chinook population if necessary to provide continued, planned, deliberate
overfishing. This policy decision could eventually evolve to a point where only one population 26
is deemed essential to perpetuate the ESU. There are currently several listed ESUs with only a
single population and there are no firm guidelines of any type as to the minimum number or
percentage of populations that should be preserved in a multiple population ESU. Alternative
1A would give equal high priority to all Category 1 and 2 populations - a significant number of 1I
populations have already been lost. I hate to think what will happen to the resource if
development interests (the people who legally challenge your ESA listings) stumble upon the
NOAA Fisheries new policy decisions spelled out in the DEIS.

(13) A basic assumption in the DEIS is that marine survival is the primary influence on overall 27
survival (See Executive Summary, page iv). This is simply incorrect. In 14 years of record,

the egg to smolt survival rate in the Skagit River ranged from 1.2 to 16.7%, which is nearly a
14 fold difference. There is nothing to indicate that marine survival can vary by over 14 times.
This erroneous assumption led to evaluating impacts of Alternatives on chinook abundance
that ranged from the 2003 abundance level (clearly well above average) to a 30% reduction in
that abundance (probably slightly above average to average). We now know that most of the 28
eggs deposited by the 2003 brood year chinook spawners were either blown out of the gravel
or smothered by silt during record to near record floods that occurred in late October 2003.
The entire analysis in the DEIS has already become obsolete for the 6-year period in question.

(14) There are a number of key technical errors in the DEIS that cast doubt on the entire body of
quantitative analysis work. For example, Table 1.6-1 on page 1-22 shows an "incidental"
chinook catch of 29,592 fish taken in 1997. Catches in six other adjacent years (1995-96,
1998-2001) only ranged from 3 to 5,321. It is well known that a major directed fishery for
chinook occurred in 1997. If this huge number is part of your data base as an incidental catch,
any analysis results will be distorted. The "less than 5,000 chinook" sport catch cited on page
1-23 does not mesh with the scale in Figure 1-24 (less than 50,000). Bigler et al. (1996)
determined that 45 of 47 salmon "populations" examined decreased in average body size (see
page 3-90) but both of their exceptions were with chinook. One was the British Columbia troll 29
fishery , the primary interceptor of Puget Sound chinook. The apparent size increase appeared
to be an artifact of increasing the minimum size limit from 26 to 28 inches during the time
series examined. Four of the five chinook populations examined outside of Alaska were the
commercial troll fisheries of California, Oregon, Washington and British Columbia. These
were all poor choices for analysis due to changes in regulations and timing of the fisheries.
The attempt by Myers et al. (1998) to estimate Puget Sound chinook production at the
beginning of the 20th Century is supported by the DEIS despite the inclusion of a large
increment of Canadian fish and a failure to pay any attention to the two important mechanisms
described by Ricker (1973).

(15) The narrative of the DEIS contains many contradictions. For example, the narrative on pages
2-9 and 2-10 seems to indicate that some key elements of Alternatives 1 and 1A are identical.
However, this DEIS narrative is in direct contradiction to a stated principle that chinook
fisheries may be allowed whenever less than 50% of the population being impacted is from
listed populations that are not expected to be able to meet their spawning escapement 30
objectives. It is also stated that targeted chinook fisheries can be allowed if the Rebuilding
Exploitation Rates (RERs) are not exceeded. These are three very different management
standards and, in addition, the various numbers associated with each standard often change
with each new management report. There are also "critical" numbers and the different
management standards associated with them. These also change frequently with each new
report. For example, the Dosewallips River was a defined population in the previous report 31
but it has now been combined with the Duckabush and Hamma Hamma rivers. The large
number of hatchery fish returning to the Hamma Hamma have conveniently "solved" a former
critical numbers problem with the Dosewallips alone. Part of the confusion comes from a
complicated mixture of specific management standards versus stated co-manager intents. The
co-managers will be under intense pressure from fishermen to provide the maximum amount of
fishing opportunity that the FEIS allows. You will be doing them (and the resource) a favor by 32
stating firm, unambiguous fisheries management standards such as described in Alternative 1A.
It is unrealistic to expect that five subsequent annual fishing plans will be decidedly more
conservative than allowed in the FEIS. Alternative 1 has far too many loopholes that will be
exploited. Your analysis of the 6-year outcome is simply unrealistic.

(16) In summary, Alternative 1 is a classic example of what is called "forcing". Since the DEIS
admits that Alternative 1 is a mixture of "policy" and science, the beginning point or given in
the planning process must have been a list of "sacred cow" directed chinook fisheries that
needed to be provided every year. A very complex management framework was then designed
to give *the illusion* of adequately protecting the resource while still allowing these same 33
fisheries to continue. It is obvious that no one really checked on actual data availability before
this elaborate system was selected. This was followed by a great deal of "scrambling around"

in an attempt to fill in the extensive data requirements of the chosen system. In some cases, appropriate data were available but the norm was simply forcing numbers to be created. Only a few examples were mentioned in my prior comments - such as using Samish hatchery fish to simulate Skagit summer-fall wild fish - but there are literally hundreds of forced numbers employed in Alternative 1. The DEIS even concedes that the "data base" needed is far from complete and that much more forcing needs to be done. In the absence of the initial list of required fisheries, the management system that evolved would probably have been very similar to Alternative 1A, which is essentially the management framework described in the FEIS for the WDFW Wild Salmonid Policy. No forcing would have ever been required.

RESPONSE TO COMMENTS RECEIVED FROM SAM WRIGHT (SW)

SW-1A-1I.

The commentor proposed to present a new alternative, "Alternative 1A", for comparison to DEIS Alternative 1. However, the commentor did not provide the detailed information necessary to analyze the new alternative, such as: 1) a description of Alternative 1A; or 2) a list of the features (objectives, implementation steps, criteria, etc.) of Alternative 1A. He has, however, provided some description of general components of Alternative 1A throughout his letter of comment. NMFS has identified these comments as components to the suggested alternative, and provided responses here for ease of understanding. Given the following information, NMFS concludes that the suggested alternative (Alternative 1A) is not technically feasible to evaluate or implement within the available time of the Proposed Action.

SW-1A

The primary fishery impact assessment tool used for Puget Sound Chinook is the Fishery Regulation Assessment Model (FRAM). The FRAM estimates fishery-related mortality on two-year-old to five-year-old fish in a single fishing year (May – April) associated with coastal Washington and Puget Sound marine and freshwater fisheries, and fisheries in Alaska and British Columbia. FRAM assesses the fishing mortality on several age classes in a single fishing year. Brood year or cohort-based models generally account for fishing mortality on a single-year class over four or five fishing years. FRAM is designed to inform annual pre-season harvest management planning. Brood-year models are usually used for post-season assessment of fishing mortality on a specific cohort. The fishery assessment model used by the Chinook Technical Committee (CTC) of the Pacific Salmon Commission has the ability to estimate exploitation rates on either a fishing-year or brood-year basis. Results from this model have shown that annual exploitation rates calculated from the fishing year model will be approximately equal to brood-year exploitation rates when averaged over the appropriate period. Modifying FRAM to calculate brood-year-based exploitation rates would benefit post-season analysis, but could easily take three or more years to complete the extensive rewriting of programming code, debugging and model-run trials needed. Therefore, the necessary modifications to the management tools probably would not be completed in time for implementation during the period of the Proposed Action (2005–2009). In addition, use of a brood-year-based FRAM in pre-season fishery assessment is limited because of the nature of the annual management process.

During the pre-season management process, forecasts for the abundance of age three- to five-year-old chinook salmon are developed as inputs to the FRAM. For some Puget Sound stocks such as Skagit summer/fall chinook, these forecasts are age specific, for others they are based on an average assuming that maturing fish are all four years old. Age specific forecasts are preferred, and are generally used when historical data is adequate to do so. The age-specific forecasts can incorporate any abnormally high or low production years. FRAM estimates fisheries mortality and escapement for the proposed fisheries on each age class, from age 2 "jacks" to age three- to five-year-old adults. The number of age three- to five-year adults projected to escape to the spawning grounds establishes the status of each stock in a given fishery management year. If annual forecasts detect weak brood years, and, over time, brood-year exploitation rates approximate fishing-year rates, and post season analysis can identify and track weak brood years, there does not appear to be a clear benefit to moving to brood-year management for annual planning, given the added management complexity and technical resources required by such an approach.

SW-1B

The commentor provides no guidance regarding what an acceptable level of valid incidental catch would be against which to evaluate the different alternatives (40 CFR 1503.3), or to assess whether it would be consistent with the Purpose and Need for the Proposed Action. The magnitude of catch could vary greatly from year to year, and may or may not be consistent with levels of harvest compatible with the resource needs of individual Puget Sound Chinook populations.

SW-1C

Comment noted.

SW-1D

Comment noted. NMFS observes that the definition of valid incidental catches identified in this comment differs from the definition under SW-1B, and there is no definition for what would constitute a "valid test fishery" or "critical ceremonial, subsistence and research (test fishing) uses." Also see the response to SW-1B.

SW-1E

See response to comment SW-1B. It is explicitly stated in this comment that the commentor's proposed alternative does not define the limit of valid incidental catch, but that the limit would be whatever had been determined to be the total of valid incidental catches for that year.

SW-1F

Since the sex ratio and the number of eggs per female (fecundity) differ by fish size and age, the number of eggs in the gravel will differ depending on the age structure of the escapement. In Columbia

River wild chinook populations, females comprise about 10 to 15 percent of the three-year-old mature run. Puget Sound wild Chinook probably have a similar low female contribution as maturing three year olds. Historical spawning ground age composition and sex ratio information is lacking in many areas and minimal in others. For many areas, it would be very speculative to convert historical spawning ground estimates to numbers of fish by age and sex. Abnormally high or low survival years for any of the age three- to five-year-old classes will influence the population status for that year, and to a degree, the number of eggs laid. For example, poor production/survival for the 2003 brood year would begin to influence the adult returns expected in the 2006 management year as three-year-old fish. However, if three-year-old maturing adults were ignored in the spawning escapement estimate because of their low female/egg contribution, then an abnormally low production year like 2003 would not be considered in the stock status and fisheries assessment for 2006. (Also see comment and response to comment SW-1A requesting brood-year-based management.) Of course, the converse could occur with a favorable production year for returning three-year-old age-class. For a typical Puget Sound chinook salmon population, the influence on the total adult return would likely be largest in 2007 as four-year-olds. The modeling tools that have been developed, such as FRAM, and the management criteria that have been established are dependent on the quality and resolution of the historical information. For annual pre-season fisheries management, using estimates from FRAM of age three- to five-year-olds as a measure of spawning escapement and stock status represents a compromise between the available historical information and our understanding of Puget Sound chinook life histories and genetic diversity.

Also see responses to comments SW-9 and SW-18.

SW-1G

See response to comment SW-1F.

SW-1H

See response to comments SW-1A and SW-1F.

SW-1I

There is not enough detail provided in these comments to determine whether the implementation of Alternative 1A (recommended by the commentor) would give equally-high priority or protection to all Category 1 and 2 populations. Also see responses to comments SW-1B and SW-19.

Regardless of what criteria are used to measure stock status in any particular year, it is likely that at least one Puget Sound chinook stock will not achieve its management unit escapement objectives during the period of the Proposed Action (2005–2009). Under the Proposed Action (Alternative 1), impacts to stocks in poorest or critical status are more constrained by managing for a critical exploitation rate ceiling (CERC). The CERC was developed from modeling a minimum fishery regime that represents the "minimum level of fishing that allows some exercise of those [treaty] rights, and demonstrates their commitment to contribute… to the recovery of Puget Sound chinook salmon to levels that would satisfy their treaty rights" and the allowance for some reasonable harvest of non-listed salmon by Treaty Indian and non-Indian fishers (WDFW and PSIT 2004). The general approach in the Proposed Action is to establish exploitation rates ceilings that correspond to varying stock status levels, and allow the pre-season management process to determine the structure of the fisheries.

SW-2

The 2003 hatchery contribution data for the Cedar River escapement was unavailable at the time the DEIS was written, and NMFS believes that a single year of data is insufficient on which to base modeling assumptions. However, as more information is available, all the alternatives include adaptive management provisions that would require revision of key parameters based on new information. The lack of hatchery contribution to natural spawning estimates is still the case for the majority of Puget Sound chinook salmon populations. Where sufficient information on abundance and productivity was available to develop harvest standards (i.e., Nooksack early, Snohomish, Green River, Skagit and Stillaguamish), NMFS used these standards to evaluate the environmental consequences of the alternatives.

SW-3

The 2003 escapement information for Puget Sound chinook salmon was not available at the time the DEIS was written. Table 3-2 summarizes Puget Sound chinook salmon escapement by population and year, which includes the 2003 escapement information. Inclusion of the observed 2003 escapement data would have changed the trends in two of the 22 populations in the Puget Sound chinook salmon ESU for which data are available. Estimates of natural-origin escapement in 2003 are not yet available for the Skykomish or Snoqualmie chinook salmon populations. Recent abundance trends for the Upper Sauk spring and South Fork Stillaguamish populations would have changed from stable to decreasing since March 1999 when the Puget Sound Chinook Evolutionary Significant Unit (ESU) was listed. Abundance and exploitation rate data for 2003 is unavailable at this time to determine why 2003 escapements were lower in several areas than in recent years. It could be due to lower abundance than in years previous or higher harvest in Canadian or southern U.S. fisheries than expected, or a combination of several factors. The 2003 escapement information, however, would not have changed the Environmental Consequences analysis in the DEIS, which was based on other data sources.

Table 3-2. Natural-origin or natural escapement for Puget Sound chinook salmon populations, 1990 to 2003.

Management Unit	Population	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Nooksack	Natural-Origin Spawner:	142	444	403	444	113	421	353	223	128	255	442	517	503	414
	North Fork Nooksack	6	87	345	285	26	175	210	121	39	91	159	250	221	210
	South Fork Nooksack	136	357	58	159	87	246	143	102	89	164	283	267	282	204
Skagit	Natural Spawners:	16,792	5,824	7,348	5,801	5,549	6,877	10,613	4,872	14,609	4,924	16,930	13,793	19,591	9,489
Summer/Fall	Upper Skagit River [1]	11,793	3,656	5,548	4,654	4,565	5,948	7,989	4,168	11,761	3,586	13,092	10,084	13,815	7,107
	Lower Sauk River [1]	1,294	658	469	205	100	263	1,103	295	460	295	576	1,103	910	1,493
	Lower Skagit River [1]	3,705	1,510	1,331	942	884	666	1,521	409	2,388	1,043	3,262	2,606	4,866	889
Skagit	Natural Spawners:	1,511	1,346	986	783	470	855	1,051	1,041	1,086	471	906	1,856	1,065	786
Spring	Upper Sauk River [1]	557	747	580	323	130	190	408	305	290	180	273	543	460	178
	Suiattle River [1]	685	464	201	292	167	440	435	428	473	208	360	688	265	353
	Upper Cascade River [1]	269	135	205	168	173	225	208	308	323	83	273	625	340	255
Stillaguamish	Natural-Origin Spawners:	701	1,279	716	725	743	654	935	839	863	767	1,127	936	1,090	
	N.F. Stillaguamish River	434	978	422	380	456	431	684	613	615	514	884	653	737	
	S.F. Stillaguamish River	267	301	294	345	287	223	251	226	248	253	243	283	353	
Snohomish	Natural-Origin Spawners:	3,662	2,447	2,242	3,190	2,039	1,252	2,379	3,517	2,919	2,430	2,900	5,869	4,544	
	Skykomish River	2,551	1,951	1,642	942	1,478	1,144	1,719	1,696	1,500	1,382	1,773	3,052	2,264	
	Snoqualmie River	1,111	496	600	2,248	561	108	660	1,821	1,419	1,048	1,127	2,817	2,280	
Lake Washington	Natural Spawners:	787	661	790	245	888	930	336	294	697	778	347	1,269	637	774
	Cedar River [1, 2]	469	508	525	156	452	681	303	227	432	241	120	810	369	562
	Sammamish River [3]	318	153	265	89	436	249	33	67	265	537	227	459	268	212
Green River	Natural Spawners:														
	Duwamish-Green River	7,035	10,548	5,267	2,476	4,078	7,939	6,026	9,967	7,300 [6]	9,100 [6]	6,170	7,975	13,950	10,405

Management Unit	Population	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
White River	Natural Spawners:														
	White River	275	194	406	409	392	605	628	402	316	553	1,523	2,002	803	1,434
Puyallup	Natural Spawners:														
	Puyallup River [4]	3,515	1,702	3,034	1,999	1,328	2,344	2,111	1,110	1,711	1,988	1,193	1,915	1,590	1,173
	S. Prairie Creek Index Area [4]	-	-		-	798	1,408	1,268	667	1,028	1,430	695	1,154	840	
Nisqually	Natural Spawners:														
	Nisqually River	994	953	106	1,655	1,730	817	606	340	834	1,399	1,253	1,079	1,542	627
Skokomish	Natural Spawners:														
	Skokomish River	642	1,719	825	960	657	1,398	995	452	1,177 [6]	1,692 [6]	926 [6]	1,913 [6]	1,479	1,125
Mid-Hood Canal	Natural Spawners														
	Mid-Hood Canal Tributaries:	-	86	96	112	384	103	-	-	287	762	438	322	95	194
Dungeness	Natural Spawners:														
	Dungeness River	310	163	158	43	65	163	183	50	110	75	218	453	633	640
Elwha	Natural Spawners:														
	Elwha River [6,]	2,956	3,361	1,222	1,562	1,216	1,150	1,608	2,517	2,358	1,602	1,851	2,208	2,376	2,305
ESU Total		39,964	29,240	26,284	19,457	20,887	25,610	27,773	26,380	36,238	27,326	36,087	43,341	52,744	

[1] The majority are natural-origin spawner.
[2] The escapement estimates for the Cedar River are based on an expansion of a live count of fish. However, Cedar River redd counts suggests that this expansion of the live count may be a conservative estimate of the total escapement (P. Hage, Muckleshoot Tribe, e-mail to S. Bishop, NMFS, February 10, 2004).
[3] Does not include escapement into the Upper Cottage Lake Creek, which has been surveyed since 1998. Surveys of the Upper Cottage Lake Creek have exceeded 100 fish (S. Foley, WDFW, pers. com., to K. Schultz, NMFS, February 19, 2004). Escapement counts also do not include spawners in Issaquah Creek, which are believed to be primarily Issaquah Hatchery returns (N. Sands, NMFS, e-mail to S. Bishop, NMFS, February 26, 2004). Therefore, escapement information presented is a conservative estimate of the total Sammamish River population's escapement.
[4] The area surveyed for the South Prairie Creek index increased from 1.5 to 12.5 stream miles in 1994.
[5] Escapement is considered in-river gross escapement plus hatchery voluntary escapement minus pre-spawning mortality.

SW-4

NMFS understands that this is a principle of the commentor's alternative; i.e., it is a key assumption of the commentor's alternative that if listed chinook needed to meet a valid spawning escapement objective are allowed to escape and spawn naturally, the net benefits derived from their progeny will, on average, be significantly greater than if the same fish had been immediately harvested. However, NMFS would need to be certain that this was a realistic assumption if the alternative was determined to be reasonable to analyze. The meaning of this comment is not clear as to whether the commentor is referring to economic, social, or biological benefits, and no information is provided to support the statement that the net benefits would be significantly better. NMFS also notes that the commentor does not propose that all listed chinook salmon below the spawning escapement objective be allowed to escape and spawn naturally (see comments SW-1B and SW-1E).

The goal of the Proposed Action is to exceed the upper threshold 80 percent of the time (more if productivity improves). Fisheries directed on naturally-produced chinook salmon are not expected to occur during implementation of the Proposed Action, because the abundance is not expected to be sufficient as defined under the terms of the Proposed Action except in a few areas expected to have large hatchery returns. The commentor has indicated he does not object to the harvest of hatchery-produced chinook salmon (see comments SW-1B, SW-9, SW-11). Therefore, the total benefits from the harvest of chinook occur primarily from the harvest of salmon species other than chinook salmon during which chinook are caught incidentally. In this context of benefits, it is not true to say that the future net benefits from not harvesting any component of the chinook return would be greater than the present benefits of harvest, because those present benefits are from the harvest of other species, not Chinook salmon. As shown by the evaluation of Alternatives 2 and 3 which use a fixed-escapement goal approach, these approaches would be expected to preclude most Puget Sound salmon fisheries given the range of abundances reasonably expected through 2009, providing very little net economic or social benefit from the additional escapement (see DEIS Subsection 4.6).

Under the biological interpretation of benefits, assuming a population is below the escapement associated with Maximum Sustained Yield (MSY)(the upper threshold referred in the comment), and that its spawner-recruit relationship is defined by a Beverton-Holt curve, then NMFS agrees that forgoing harvest now will allow the population to reach its upper threshold (as defined by MSY) in a shorter time period; however, it may not generate significantly greater benefits than would occur with some level of harvest. For this EIS, the only populations that were expected to achieve their viable escapement thresholds without fishing (Alternative 4), but not achieve their viable thresholds under the

Proposed Action were the Skokomish; the South Fork Stillaguamish and Upper Skagit summer run under the low abundance scenarios; and the Lower Sauk summer run under the high abundance scenarios (DEIS Table 4.3-5). Of these, the difference in expected Skokomish escapement between the Proposed Action and its viable threshold (1,250) was 11 to 39 spawning adults. The difference in expected South Fork Stillaguamish escapement between the Proposed Action and its viable threshold (300) was <1 to 7 spawning adults. The difference in expected Upper Skagit escapement between the Proposed Action and its viable threshold (7,454) was 700 to 1,100 spawning adults. The difference in expected Lower Sauk escapement between the Proposed Action and its viable threshold (681) was 61 to 93 spawning adults (DEIS Tables 4.3.7a through 4.3.10d). The South Fork Stillaguamish, Upper Skagit and Lower Sauk populations have associated NMFS-derived RERs that NMFS uses as harvest standards to evaluate the impact of proposed harvest actions on the Puget Sound Chinook ESU. One of the RER criteria is that escapement exceed the viable threshold at least 80 percent of the time at the end of 25 years. Both the South Fork Stillaguamish and the Upper Skagit summer run populations are anticipated to meet their RERs under all scenarios for both the Proposed Action and the no-fishing alternative. The same is true of the Lower Sauk population (except Scenario B, when abundance and northern fisheries are at high levels). The differences in escapement between the Proposed Action and the commentor's suggested Alternative 1A would be even less, or perhaps none, because the commentor also proposes some level of harvest below the upper escapement threshold to accommodate "valid incidental catch."

SW-5

Alternative 1A is not well-enough defined for NMFS to comment on its prospective performance relative to Alternative 1 (Proposed Action)(see responses to comments SW 1A-1H). However, by compiling statements scattered throughout Mr. Wright's comments, it appears that both Alternatives 1 and 1A have the same basic management strategy (i.e., incidental impacts only, unless the escapement level of the target run is projected to exceed an upper threshold), with the following differences:

a) Alternative 1A has no ceiling on incidental catches; whereas, under Alternative 1, incidental catches cannot exceed a ceiling exploitation rate

b) Alternative 1A variously defines "incidental" catch as that taken in only "valid" test, research, and ceremonial and subsistence fisheries; in fisheries targeting marked hatchery adults; or as the "surplus production from other salmonid resources."

Alternative 1 defines "incidental" as any fishery in which catches of harvestable fish predominate. Directed fisheries are those where encounters with listed chinook exceed encounters with unlisted chinook salmon. Directed fisheries, with the exception of fisheries for ceremonial and subsistence or research purposes, are not allowed under the Proposed Action unless the number of spawners from listed Chinook salmon populations consistently exceeds the Upper Management Threshold and exploitation rates are consistently less than the Rebuilding Exploitation Rate (RER) ceilings (Section 5 of WDFW and PSIT 2004). In actual application, almost all fisheries that have been conducted under Alternative 1-type management have been composed overwhelmingly of harvestable fish, and might therefore also qualify as "incidental" under Alternative 1A depending on which definition of valid incidental catch was used. So the only practical difference between these definitions might be that Alternative 1A could potentially allow fisheries in circumstances where Alternative 1 would not (e.g., chinook populations without harvestable surplus make up more than 50% of the impacts).

c) Escapement objectives under Alternative 1A would apply only to management units; there would be no escapement criteria applied to separate populations; and

d) Alternative 1A lacks Low Abundance Thresholds, which, under Alternative 1, are lower escapement thresholds, applied to both management units and populations, below which the exploitation rate ceilings in southern U.S. fisheries are further reduced.

e) Alternative 1 uses a mixture of escapement goal and exploitation rate management objectives.

Thus, it appears that the management strategies are similar, although Alternative 1A could be less restrictive, and potentially allow more aggressive fishing, than under Alternative 1, depending on how incidental catch levels were defined.

NMFS has preliminarily found that the implementation of fisheries under the Proposed Action, some of which would result in some populations not achieving their Upper Management Threshold within the duration of the Proposed Action (2005–2009), can be conducted without jeopardizing the Puget Sound Chinook ESU. Furthermore, in some well-documented cases; e.g., Nooksack early and Stillaguamish summer chinook salmon, further reduction in exploitation rate has resulted in no or very limited increases in natural production because of limitations in the freshwater and marine environments. Recovery of the ESU will require both increases in productivity as well as numbers of spawners.

SW-6

See responses to comments SW-4 and SW-30. In addition, the DEIS acknowledges that the Proposed Action might reduce the probability of achieving the viable escapement threshold for some populations in the Puget Sound Chinook ESU. However, while NMFS evaluates the effects of proposed harvest actions on individual populations, it must make its determination on the risk to the ESU in total. This determination accepts that not all populations in the Puget Sound Chinook ESU will share the same level of risk. In selecting its Preferred Alternative, NMFS must give consideration to economic, technical, and other factors, as well as environmental factors (CEQ Forty Most Asked Questions 4a).

NMFS accepts that the commentor does not agree with using the model results in reaching his conclusions. However, NMFS must use the best available science in reaching its conclusion, and the model results currently represent the best available science.

SW-7

NMFS acknowledges that the listing and recovery of species under the ESA imposes costs on taxpayers and consumers. As described in an economic study of Snake River salmon recovery (Huppert and Fluharty 1995), these costs include not only budgetary costs of the public agencies involved in recovery efforts, but also the opportunities costs (i.e., value foregone) associated with restrictions on land use activities such as mining, irrigated agriculture, and recreation and on other productive activities (e.g., hydropower generation).

As presented in the DEIS Fish section (Tables 4.3-7 through 4.3-10), implementing Alternative 1 (Proposed Action) could delay the recovery of some listed chinook salmon populations in Puget Sound when compared with a no-harvest baseline. However, the effect that implementing Alternative 1 would have on the recovery period affecting the de-listing of the Puget Sound Chinook ESU cannot be determined with any reasonable degree of certainty. The harvest of Puget Sound chinook salmon is only one of many factors that affect recovery, and the incremental effect of harvest cannot be accurately isolated. Consequently, the extent to which the period of recovery is delayed cannot be determined, nor can it be determined whether the delay in the recovery of several populations within the multi-population Puget Sound Chinook ESU would affect the time in which the ESU would be de-listed. NMFS has indicated that not all populations within the ESU would need to be at equally low risk in order to determine that the ESU was sufficiently recovered to be de-listed, and that there are probably multiple recovery scenarios.

To acknowledge that implementing Alternative 1 might extend the period of recovery for Puget Sound chinook and potentially impose additional costs to taxpayers and consumers, the Environmental Consequences section, *Economic Activity and Value* (Subsection 4.6) has been modified (see FEIS Volume 2, Revised Draft EIS). NMFS considers this acknowledgement to be a conservative position.

SW-8

The best available information has been used to develop the escapement thresholds and account for demographic and genetic concerns. For some populations, low abundance thresholds are equal to or greater than the historic spawner numbers from which the population produced greater than one-return-per-spawner. In that sense, the empirical evidence shows that the populations in question rebounded from these levels. Derivation of the Low Abundance Thresholds in the Proposed Action is detailed in Appendix A of the Proposed Action (produced in DEIS Appendix A). They are intended to define escapement thresholds well above the point of population instability precisely because of the uncertainties. Derivation of the critical and viable escapement thresholds used by NMFS in its evaluation of the alternatives is described in DEIS Appendix C2.

The commentor's remarks argue for the minimum threshold to be determined on a population-by-population basis, and considering the life history strategies and local conditions that would contribute to depensation. NMFS agrees. Determination of the population size at which depensatory mortality manifests is highly specific to each population and its habitat. NMFS also agrees that depensatory effects can be manifested at population sizes larger than some of the critical escapement thresholds used by NMFS (DEIS Subsection 4.3.1, *Threatened and Endangered Fish Species*). That is why NMFS has used population-specific information on demographic and genetic effects where available, and guidance from the scientific literature where it is unavailable, in deriving its critical thresholds. NMFS has also incorporated error in its derivations to account for uncertainties in the data around these effects. NMFS' critical escapement thresholds range from 200 to 1,650, and the viable escapement thresholds from 300 to 7,454 reflecting the differences among Puget Sound chinook salmon populations in size, habitat conditions and life history strategies. Re-examination of abundance thresholds would occur through "adaptive management" under any of the alternatives.

Without intervention, populations may not be able to recover from very low abundances, or may lose genetic integrity. The critical escapement threshold represents the point below which the possibility of rebuilding declines significantly, and is therefore informative to managers in evaluating the status of populations and the robustness of proposed management approaches (Feiberg 2004; McElhaney *et al.* 2000). Most of the low abundance thresholds in the Proposed Action are above the critical escapement thresholds defined by NMFS in order to minimize the chance that escapements would approach critical levels. The simulation models that NMFS uses to derive the RER standards used to evaluate of the Proposed Action allow extinction to occur at very low abundance levels in order to simulate potential real-world outcomes. The RER is the exploitation rate that is associated with a low probability of a specific population falling below its critical escapement threshold ($\leq$5%) and a high probability (80%) of exceeding its viable escapement threshold based on the model simulations. The RER is determined by the most constraining of these two criteria, not solely on remaining above the critical escapement threshold. In most cases, it is the probability of exceeding the viable escapement threshold that determines the RER, not the critical escapement criterion. Escapement thresholds and the RERs would be revised as additional information becomes available and provide a better view of how populations actually respond at low abundances.

As explained in response to comment SW-5, directed fisheries, with the exception of fisheries for ceremonial and subsistence or research purposes, are not allowed under the Proposed Action unless the number of spawners from listed chinook salmon populations consistently exceeds the Upper Management Threshold <u>and</u> exploitation rates are consistently less than the Rebuilding Exploitation Rate (RER) ceilings (Section 5 of the Proposed Action found in DEIS Appendix A, and DEIS Subsection 2.3.1).

Also see response to comment SW-4.

SW-9

It is true that three-year-old females are not a large part of the spawning population, but they do contribute. Available information indicates that three-year-old spawners comprise, on average, a minor proportion of Puget Sound natural-origin spawning populations in each year (8 to 20%) (PSTRT 2003a, PSTRT 2003b; PSTRT 2003c; PSTRT 2003d; PSTRTe; PSTRT 2003f; PSTRT 2003g). However, the proportion of three-year-old spawners can vary substantially from year to year, comprising up to 42 percent of the spawning population (PSTRT 2003e) in any year, depending on the survival of each of the brood years contributing to that years' escapement. (Chinook salmon return to spawn at multiple ages, so escapement in any year is usually comprised of 3, 4, and 5 year old spawners.) In 10 years of broodstock collections in the Upper Skagit, during which 386 female spawners have been collected, 13 were age-three females (slightly more than 1 per year, or 3.4% of the total). The mean fecundity of these females was 5,300 (range 2,700 to 7,400), and their length range was 64 centimeters to 85 centimeters, of which only two were less than 75 centimeters, and eight were in the 82 centimeter to 85 centimeter range. In five years of broodstock collections in the Lower Skagit, during which we've collected 144 female spawners, 13 were age-three females (12 of these were collected in 2003), or 9 percent of the total. Their mean fecundity was 5,500 (range 3,300 to 7,100), and their mean length was 85 centimeters (range 80 centimeters to 105 centimeters) (personal communication with Bob Hayman, Skagit Systems Cooperation, Salmon Recovery Planner, August 6, 2004). The fact that three-year-old female spawners continue to consistently contribute to spawning populations, although in low percentages, together with their substantial size and fecundity, suggests that they are an important segment of diversity expressed by the species and at certain times, when environmental conditions change suddenly, may be essential to maintaining the viability of the population.

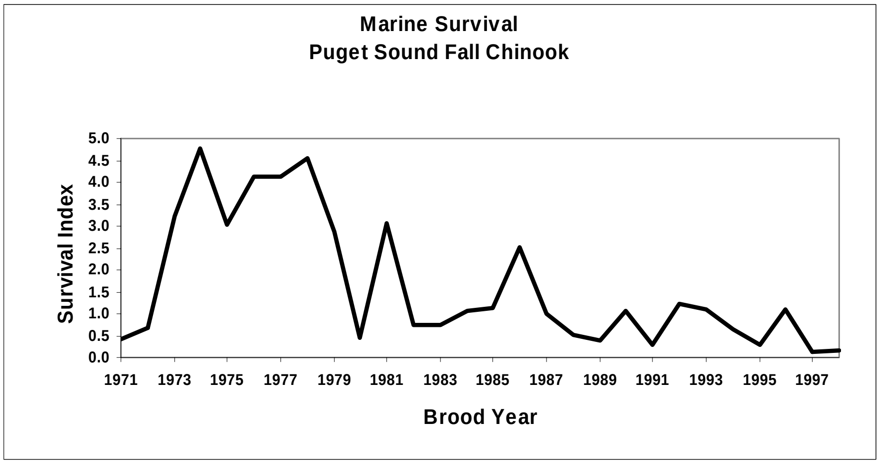
For these reasons, NMFS sees no reason to exclude three-year-old females from its development of population harvest standards; evaluation of the performance of the alternatives in the DEIS, or assessment of fishing regime performance in the future. As additional information becomes available on age contribution, sex ratio and other biological characteristics, all the alternatives evaluated in the DEIS would use this information to revise key parameters, assumptions, and harvest objectives through the use of adaptive management.

Also see responses to comments SW-1A, SW-1F and SW-20.

SW-10

All alternatives in the DEIS were evaluated under the same conditions because each was evaluated against the same assumptions of abundance and the same environmental variables that influenced that abundance. Therefore, the results from the comparison of alternatives in the DEIS were the result of the management approach represented by the alternative and not the environmental conditions. Trends in escapement are the result of change in both environmental conditions and management. The DEIS acknowledged that there is a possibility that abundances could change during implementation of the Proposed Action from those observed in recent years due to changes in marine or freshwater environmental conditions (see DEIS Subsection 4.2.3, *Scenarios for Alternatives*). In response, NMFS evaluated a reduced abundance scenario based on observations of the period 1990 through 1999, for which average, aggregate abundance of all Puget Sound chinook salmon stocks was approximately 30 percent lower than that of 2003 (DEIS Appendix C3). It should be noted that data on marine survival for Puget Sound chinook populations indicate marine survival has not increased for these populations as has been observed for some Columbia River chinook salmon populations (see Figure 3-1) (brood year 1998 includes adult chinook returning through 2003) (personal communication with Dell Simmons, NMFS, 2003). The evaluation also examined scenarios where Canadian fisheries were managed near the limits of the current chinook annex of the Pacific Salmon Treaty (see DEIS Subsection 4.2, *Basis for Comparison of Alternatives and Approach to Alternatives Analysis*).

Figure 3-1. Marine survival of Puget Sound fall chinook salmon: Brood Years 1971–98.



The modeling on which NMFS based its harvest standards (RERs) and many of the exploitation rate objectives in Alternative 1 included times of both poor and good freshwater and marine survival. In fact, the average marine survivals in the model simulations were equal to the average observed in a recent period that had the lowest marine survivals in the database. Given that, escapements should be even better if the average marine survival over the next 25 years reverts to the long-term average that included times of better marine conditions (Figure 3-1).

The proposed resource management plan provided to NMFS by the co-managers indicates the harvest management objectives in Alternative 1 (Proposed Action) were designed to maintain Puget Sound chinook salmon populations so that they will be able to withstand the poor freshwater and marine survival conditions that occur, and also be able to respond rapidly to improved conditions. For example, the requirement of many of the RERs to meet or exceed the upper threshold means that, on average, escapements will be above that threshold at the end of the rebuilding period. By allocating more fish to escapement, as opposed to harvest, the stocks have a better chance to be as strong as possible if the offspring of large escapements, like those seen in recent years for some populations, are faced with poor freshwater and marine conditions. So returns in future times of poor marine survival should be greater than they would have been if such an approach was not in place in times of good marine survival.

See also responses to comments SW-1A (second paragraph regarding pre-season forecast ability to detect strength of brood years), and SW-27.

SW-11

Seiler *et al*. (2002a and 2003a) have shown strong correlation between egg-to-smolt survival and flow. Major flood events provide the extremes, but it is not only the 100-year floods that depress survival. For example, the limiting effects of degraded or lost habitat on estuarine survival have been particularly well-documented in the Skagit (Beamer et al. 2003a and b). Until the causes for scouring flows in the Skagit can be identified and mitigated, each year has about an equal probability of suffering disastrous egg-to-migrant survival. Skagit flows during the last 8 years (1996–2004) have actually been average, when compared to flows since 1940. Marine survival rates may be less influential on overall survival in those instances, but depending on whether marine survival is lower or higher than average, can exacerbate or mitigate poor freshwater survival conditions in the number of subsequent adult spawners that return. This would not be accounted for by reliance on smolt trap data alone to predict survival. Both marine and freshwater survival are important to consider in forecasting abundance and in evaluating the robustness of Puget Sound chinook salmon populations to changes in their environment. The relative influence of the two varies among populations and over time. Both are explicitly considered in the derivation of the Skagit RERs (see DEIS Appendix C2, and Appendix A in the RMP). For example, the derivation of RERs for the Upper Sauk and Suiattle spring chinook salmon populations indicated that marine survival was not influential in the relationship between spawners and recruits for the Suiattle population, but did influence the relationship for the Upper Sauk population (Skagit RER Workgroup 2003).

Moreover, the objectives in Alternative 1 were not determined by assuming only recent-year environmental conditions as assumed by the commentor. To establish the Skagit objectives, flows back to 1972 were incorporated in the modeling (Skagit Management Unit Profile, in DEIS Appendix A) – this time period included flows with a 31-year recurrence interval (1975), two 16-year recurrence intervals (1979 and 1980), a 70-year recurrence interval (1990), and a 47-year recurrence interval (1995); i.e., a wide range of flow levels. Marine survival was modeled to vary cyclically, according to the variation observed across 13 brood years for summer/fall runs, and across 17 brood years for Skagit spring runs (personal communication with Bob Hayman, Skagit Systems Cooperative, Salmon Recovery Planner, August 6, 2004). Thus, the possibility that floods like those of 1990 and 1995 would occur occasionally (such as occurred in 2003), or that marine survival might decrease, was accounted for in the development of the objectives in the Proposed Action and in the choice of abundance scenarios against which to evaluate the alternatives in the DEIS.

Research (Mantua *et al.*1997) also supports the importance of marine survival effects on Pacific salmonids. Because of our inability to forecast marine survival and the large effect it may have, we have assumed low marine survival conditions in developing the RERs used by NMFS to evaluate the performance of the alternatives in the DEIS. In recognition of interannual variability in marine survival, NMFS incorporated error in these parameters into its derivation of RERs (NMFS 2000). Clearly, this is a conservative approach, providing additional escapement in good marine-survival years.

Also see responses to comments SW-8 and SW-27.

SW-12

The commentor stated that the RERs are "generally based on exploitation rates observed in the late 1990s." That is only true for those populations where data were unavailable or inadequate to derive exploitation rate management objectives based on spawner-recruit relationships. Where data were adequate, RERs were derived from spawner-recruit relationships that used data on exploitation rates as far back as the early 1980s.

See also responses to comments SW-10, SW-11, and SW-23.

SW-13

A cornerstone of chinook and coho salmon management along the entire Pacific coast is the reliance of coded-wire-tagged (CWT) hatchery production to represent the behavior, migration, and vulnerability to harvest of associated wild salmon production. There are no on-going wild stock CWT programs on Puget Sound chinook. Initial efforts at tagging wild Puget Sound chinook stocks resulted in few recoveries and high tagging mortality rates, because wild chinook salmon juveniles emigrate at such a small size. Analysis of long-term exploitation and productivity trends must use existing CWT hatchery programs to represent the diversity of life histories of Puget Sound wild chinook. For the near term, CWT data from hatchery fish will have to suffice for much of the analysis and assessment of fishery impacts. For the long term, other stock identification methods may need to be developed to fill in data gaps and provide a better measure of wild stock impact assessment.

There is also some support for the use of hatchery surrogates to represent associated wild production and to represent unrelated populations. While Puget Sound summer and fall chinook salmon CWT hatchery stocks may have very different terminal harvest rates, and some differences in marine distribution, their total pre-terminal exploitation rates are very close to each other, and it is therefore believed that their mean is an acceptable approximation of the pre-terminal exploitation rate on other Puget Sound summer and fall chinook salmon populations that do not have associated CWT hatchery production, including Skagit summer/fall runs (personal communication with Jim Scott, WDFW, Senior Research Scientist, 2000). The spawner-recruit parameters generated from the CWT hatchery stock data track very closely to those estimated independently from Skagit-specific habitat analyses (personal communication with Bob Hayman, Skagit Systems Cooperative, Salmon Recovery Planner, August 6 2004). This independent assessment provides support for the validity of these estimates.

In the development of some population-specific RERs, the co-managers (and NMFS) have used other types of information to estimate fishery-related mortality on populations that do not have an associated coded-wire-tagged hatchery indicator stock, if they judged that this information could better represent the population of interest. For example, recognition of the differences in terminal fishery patterns between chinook salmon returning to the Stillaguamish and Snohomish Rivers led the co-managers to estimate exploitation rates for the Snohomish chinook population based on a terminal area run reconstruction of catch and escapement of Snohomish chinook salmon rather than the Stillaguamish chinook hatchery indicator stock (Snohomish RER Workgroup 2003). However, this method may not be appropriate to other areas. Absent this type of information, the use of indicator stocks is the best available information.

One correction needs to be made in the commentor's information. Skagit summer/fall chinook salmon <u>exploitation rates</u> are not computed from Samish data; however, confusion is understandable. Skagit summer/fall chinook salmon <u>marine survival indices</u> are computed from Samish chinook data. However, the distribution data for Skagit summer/fall chinook salmon used for annual harvest planning and post-fishing season review is derived from limited tagging of Skagit hatchery and wild stocks that was done in the late 1970s.

SW-14

Enumeration of natural spawners can be improved in a few areas of Puget Sound, and the co-managers are pursuing those improvements (see RMP Appendix E in DEIS Appendix A). These enumeration problems have been consistent through time. Spawning escapement estimates upon which current impacts assessments rely have not improved enough in the past 15 years such that calculated exploitation rates would be biased. Some work has been done to verify assumptions in current methods, but alternative methods, which in some cases have produced higher estimates of escapement, are not yet accepted for management use.

Historical fisheries exploitation rate histories are calculated from CWT data from "indicator stocks" (indicate the distribution, status and mortality of associated wild stocks) that are selected for accuracy standards, including the ability to completely account for escapement of tagged fish and all fishery impacts. The PSC Chinook Technical Committee examines these data carefully for sampling errors, and if flaws are identified for these indicator CWT groups, then the time series is reduced to ensure comparability of the data. If CWT data are found to be biased, those indicator CWT groups are not used to estimate exploitation rates. See the Pacific Salmon Commission's Chinook Technical Committee report TCChinook 93-2 for a description of methods used in calculating and comparing exploitation rates.

SW-15

The commentor's description of management for the Nisqually and Skokomish Chinook salmon populations is incorrect. For the Skokomish River population, the 3,650 and the 10,529 figures include combined river and hatchery escapement. The Nisqually and Skokomish populations have been managed to achieve natural escapement as a primary management objective only since 2000. The DEIS acknowledges the possibility of escapements exceeding (or falling below) the escapement goal in some years due to management imprecision, although this is not the intent of a fixed-goal harvest management approach (DEIS Subsection 2.3.2, *Alternative 2 – Escapement Goal Management*). However, the degree to which escapement deviates from the threshold varies from year to year depending on the management decisions and error in forecasted abundance. Therefore, for the purposes of the DEIS analyses, populations that were managed for escapement thresholds were treated the same across alternatives with fisheries modeled to harvest all chinook salmon in excess of the escapement goals (DEIS Subsection 2.3.1-3, *Alternative 1 – Proposed Action/Status Quo*).

The co-managers have not implemented an exploitation rate approach to management under the Proposed Action for the purpose implied by the author. A major objective of the Puget Sound Resource Management Plan is to pass "additional" spawners to the spawning grounds in high-abundance years – something that would not occur under fixed-escapement goal management (personal communication with Teresa Scott, WDFW, Natural Resource Policy Analyst, and Will Beattie, NWIFC, Conservation Planning Coordinator, July 30, 2004). These additional spawners can take advantage of newly-restored and expanded habitat provided through recovery actions in the other "H" sectors and favorable environmental conditions. Because the Proposed Action provides for additional spawners, over the long term, the managers' Rebuilding Exploitation Rate ceilings provide a natural rebuilding potential as habitat conditions and capacity improve (see responses to comments SW-10 and EPA-8)[2]. Additionally, exploitation rates are advantageous for management applications where forecast abundance has a high degree of uncertainty (Feiberg 2004, and FEIS Volume 2, Subsection 4.3.8.1, *Indirect Effects*).

Exploitation rates used in managing Puget Sound fisheries have another important advantage over the alternative fixed-escapement goal approach. Exploitation rates are used to define fishing limits and management goals in northern fisheries managed under the Pacific Salmon Treaty (PST), therefore providing needed compatibility among the coastwide management jurisdiction.

SW-16

NMFS' RERs are designed to achieve a high probability of exceeding an upper escapement threshold and a low probability of declining below the critical escapement threshold within a specified time period; i.e., the resultant numbers of fish referred to by the commentor. The derivation of RERs incorporates many conservative assumptions (lower than current marine survival, robust to management error, no consideration of the conservative effect of the response to critical status) to achieve precision in both the RER and the desired achievement of the escapement thresholds (DEIS Appendix C2; NMFS 2000; Nooksack RER Workgroup 2003; Skagit RER Workgroup 2003). FEIS Volume 2, Subsection 4.3.8 (*Indirect and Cumulative Effects)* compares in more detail exploitation rate and escapement goal approaches.

SW-17

There is uncertainty about MSY escapement levels for Puget Sound chinook salmon, as for many other fish species. Indeed, these levels change with conditions of marine survival, and habitat and population productivity. For management units that are managed for RERs under the Proposed Action, spawner-recruit functions have been estimated as accurately and conservatively as possible given the best available information. No one method, neither adult spawner-to-migrant nor adult spawner-to-adult spawner relationships, can be relied upon solely to define population performance (productivity), or to precisely define management objectives. It is not clear what the advantage of Alternative 1A over Alternative 1 would be, given that, according to the commentor, they appear to share the same key uncertainty (spawner escapement goal under Alternative 1A, upper abundance threshold under

[2] Given the short duration of the Proposed Action (2005–2009), favorable freshwater and marine environmental conditions will be more influential in increasing subsequent production from higher escapements than habitat improvements from implementation of the Proposed Action. The effects of habitat restoration are expected to be realized over a period of decades.

Alternative 1). Either method would "quickly improve as information becomes available." The contrast with management of sockeye and chum is inappropriate because both species are harvested both in pre-terminal and terminal fisheries – the accuracy of catch statistics is the same regardless of species.

Evaluation of management imprecision among the different alternatives is only one of the biological factors on which NMFS relied in choosing its Preferred Alternatives. All alternatives were also evaluated in terms of the resulting exploitation rates, escapements and achievement of population harvest standards. Management error is not incorporated in modeling any of the alternatives, including the Proposed Action. In this way, the alternatives are treated exactly the same in the DEIS analyses. Also see response to comment WT-33.

SW-18

The commentor reported that juvenile research on the Skagit indicates that the current chinook salmon smolt capacity of the Skagit River appears to be five to six million freshwater smolts, which have been produced by adult escapements ranging from 15,600 to 20,700, while lower escapements (5,400 to 11,700) have produced fewer smolts (1.5 to 4 million). Indeed, the Skagit summer/fall viable escapement thresholds proposed in Alternative 1 are consistent with these capacity numbers (VET = 14,500 for summer/falls, and VET = 2,000 for springs; total is 16,500, which is within the range between 15,600 to 20,700). However, these threshold numbers are buffered for management error, and are actually significantly greater than the levels that would maximize harvestable surplus if management precision was perfect. The commentor may be unaware that, while the Skagit River has been able to produce up to six million total fingerling chinook smolts, it has only been able to produce about 2 to 2.5 million parr migrant chinook smolts, and this parr migrant capacity has been achieved with lower escapements, in the 8,000 to 12,000 range. Because parr migrants are the only chinook salmon life history type that has thus far been documented in the adult returns, it might be concluded that, under current conditions and perfect management precision, the adult chinook salmon capacity of the Skagit River can be achieved with spawning escapements in the 8,000 to 12,000 range. Moreover, juvenile chinook salmon rearing capacity in the tidal delta habitat (further downstream from where the freshwater smolts are estimated) appears to approach capacity at a density of about 12,000 smolts/hectare blind channel, which has also been achieved with escapements in the 8,000 to 12,000 range (personal communication with Bob Hayman, Skagit Systems Cooperative, Salmon Recovery Planner, August 6, 2004). Research is continuing, particularly in pocket estuary habitat (which may have potential for fry migrants), but the results to-date indicate that the viable escapement thresholds proposed for Skagit River management units in Alternative 1 are indeed conservative, precautionary, standards.

SW-19

The commentor is correct that the DEIS treats Canadian interceptions as though they are a "given" that must be accounted for in the U.S. domestic fisheries management planning process. That is a necessary assumption until a different arrangement is negotiated with Canada. However, the commentor oversimplifies the relationship of the two countries' interceptions and as to how the balance is arrived, by essentially implying that the number and species of each party's interceptions are merely currency that can be readily exchanged between the two countries by decision of their respective federal governments, and that the "exchange" begins with neither party intercepting fish originating in the other country. The realities are different. Both countries have depressed stocks of concern, and it is a given that each would prefer that the other country intercept fewer of them. However, both countries also have long-established fisheries that involve interceptions. A party's desire to reduce the other country's interceptions does not in itself lead to a mandate by either of the parties' federal governments to "trade away" fish that are intercepted in that country's other domestic fisheries. In fact, the ability of both countries to effectuate such trade-offs is constrained by the terms of the Pacific Salmon Treaty, their respective internal decision making processes (e.g., on the U.S. side, by the Pacific Salmon Treaty Act), and by their respective interests in protecting their own existing fisheries. Nonetheless, it is quite possible that, when the terms of the existing fishing arrangements under the Pacific Salmon Treaty expire after 2008 and 2010, the parties' priorities will have changed. Their respective resource needs and other priorities may change relative to those that existed in 1999, which are reflected in the current arrangements, thus leading them to develop different provisions that, in turn, will have to be reflected in their respective domestic management processes. That is why the duration of the Proposed Action in the DEIS coincides with the negotiation of a new Pacific Salmon Treaty agreement in 2009. Until then, the DEIS must take into account the terms of the existing Pacific Salmon Treaty Agreement when evaluating alternatives within the scope of the Proposed Action; i.e., steelhead net and salmon fisheries within Puget Sound.

In the final statement in this comment, the commentor suggests that Alternative 1 is concerned only with preservation of the ESU. The Puget Sound Chinook ESU, not the component, individual populations, is the primary focus of NMFS' evaluation of the impacts of the Proposed Action and its alternatives under the ESA. The determination that NMFS must make under Limit 6 of the ESA 4(d) Rule is that the proposed action will not "…appreciably reduce the survival or recovery of the affected threatened ESUs…." (65 FR 42422). However, in doing so, NMFS considers the status and distribution of the populations within the ESU. In conducting this evaluation, NMFS takes into account the recommendations of the Puget Sound TRT, which is charged with identifying the biological characteristics of a recovered ESU as part of developing delisting and recovery criteria. The TRT's preliminary recommendation is that any ESU-wide recovery scenario should include at least two to four viable chinook salmon populations in each of five geographic regions within Puget Sound, depending on the historical life history and biological characteristics of populations in each region. NMFS has evaluated the co-managers plan using the best available information regarding the expectation of conditions over the proposed duration of the plan (2005–2009), and evaluated the outcome against NMFS' standards for listed Puget Sound chinook salmon and the TRT's. NMFS' has concluded in its 4(d) evaluation and in a biological opinion under section 7 of the ESA that the 2005–2009 co-managers' Puget Sound Chinook Harvest Resource Management Plan would not pose jeopardy to the Puget Sound Chinook ESU guidance (NMFS 2004a; NMFS 2004b).

SW-20

See response to comments SW-1A, SW-1F and SW-9.

SW-21

The Puget Sound Technical Recovery Team has preliminarily delineated 22 chinook salmon populations that are currently extant within Puget Sound (PSTRT 2004). It is expected that as an outcome of the recovery planning process, a subset of the 22 extant populations will be managed for recovery to viable, self-sustaining levels. Included among the 22 delineated populations are the two chinook salmon populations originating from the Cedar River and from the North Lake Washington tributaries. Both of the populations identified in the Lake Washington watershed are fall-run fish that are similar in genetic characteristics (Marshall *et al.* 1995), adult return and spawn timing (SaSI 2003), and juvenile out-migrant size and timing (Seiler *et al.* 2003b) to other fall chinook salmon populations within the mid- and south Puget Sound sub-regions, including the Green River. Like other fall-run chinook salmon populations in the region, the two Lake Washington watershed chinook populations have an ocean-rearing life history strategy, emigrating seaward as 0+ age fish. Similar to fall-run populations in the Skagit, Duwamish-Green, and Deschutes Rivers (Seiler *et al* 2001; Seiler *et al* 2002a; Seiler *et al* 2002b; Fuss 2003), the annual emigration timing for the Lake Washington populations is bimodal, with an early peak for fry emigrants and a later peak for smolt emigrants (Seiler *et al*. 2003). Fry emigrants leaving the rivers and streams January through March rear in Lake Washington and Lake Sammamish to a size where survival in seawater is possible. They then emigrate seaward as smolts in May through July, similar in emigration timing to other fall-run chinook smolt populations in Puget Sound. The extent of use of the lakes for rearing by the emigrating smolt component from the Cedar River and North Lake Washington tributaries is unknown, but June-July chinook smolt emigration peak at the Ballard Locks suggests that rearing is not prolonged. The proportions of fry and smolts in the total migration into the lake varies between years and streams as a function of several variables, including flow and stream gradient. In the higher-gradient Cedar River, most juvenile chinook emigrate as fry, with flow at the time of emergence having a strong positive effect on the fry emigration. WDFW biologists studying chinook juvenile emigration behavior in the Cedar River believe that fry collected in downstream migrant traps are not really migrating, but are being flushed downstream in years when flows are spiking during fry emergence. There is a therefore the potential that, rather than reflecting a genetic predisposition and a unique population trait, lake rearing may be a happenstance response to adverse environmental conditions in the Cedar River. It is highly likely that emerging fry are being involuntarily flushed out of the Cedar River, arriving in Lake Washington where they may rear to smolt size prior to emigrating seaward, like other fall-run chinook salmon sub-yearling populations in the early summer.

An additional consideration is that data collected in 2003 show that a substantial proportion of the total adult chinook escapements into Lake Washington tributaries, including the Cedar River and North Lake Washington tributaries, were stray Green River lineage hatchery fish (Burton *et al.*, 2004). This last year was the first in which most four-year-old hatchery-origin fall chinook adults returning to spawn in the area were mass-marked with an adipose fin clip, allowing for determinations of the natural population abundance “masking” effect attendant with hatchery fish straying. Given long-standing hatchery fall chinook production in the watershed (Issaquah Hatchery has operated since 1937), non-native hatchery fall chinook straying within the watershed has likely occurred for decades.

The Puget Sound TRT has provided initial guidelines for recovery for the number and distribution of populations within the listed Puget Sound Chinook ESU (PSTRT 2002a). NMFS has used that guidance in its assessment of the effects of the Proposed Action on the recovery of the ESU as the best available information on this subject. That guidance includes the Cedar River and Lake Washington populations in a group of five late-type populations in the South Puget Sound region of the Puget Sound ESU, and suggests that two to four viable populations within each region representing the range of life-history types is necessary for a recovered ESU. While NMFS evaluates the effects of proposed harvest actions on individual populations, it must make its determination on the risk to the ESU in total. The DEIS recognizes the documented and likely similarities between the Cedar River and North Lake

Washington, and other mid- and south Sound region fall-run chinook salmon populations when considering ESU-wide ramifications of the proposed harvest management framework. However, it was not an intention to subordinate preservation and recovery needs for the individual Lake Washington watershed chinook salmon populations through the evaluation. Instead, the intent was to factor risks to the ESU if abundances of those populations were adversely affected by the proposed harvest actions. The DEIS concludes that the risk of extinction to the Puget Sound Chinook ESU is not increased by the potential for harvest impacts to the Lake Washington watershed chinook salmon populations over the plan’s five-year duration when those populations are near their critical thresholds. NMFS believes that implementation of the Resource Management Plan will not preclude management options for recovery of the Lake Washington chinook salmon populations that could be adopted as an outcome of the recovery planning process.

SW-22

Comment noted; however, no analysis or data is provided to support this conclusion.

SW-23

The commentor states that “Skagit River chinook enjoyed a very fortunate string of seven consecutive brood years (1996-2002) in which incubating eggs were not seriously impacted by high flood flows.” In actuality, flows in the Skagit River since 1996 have not been unusual or particularly “fortuitous.” Since 1940, the median peak daily flow at Mount Vernon during chinook incubation has been 61,000 cubic feet per second. In the 8 years since 1996, four years have had lower peak flows, and four years have had higher peak flows. In other words, flows have been average; thus, the success the commentor noted for Alternative 1 (SW-10) during recent years occurred under average flow conditions.

Of an estimated 45.3 million eggs deposited in 1990, only about 500,000 smolts survived to migrate from the Skagit River, a survival rate of about 1.2 percent. Ironically, the 1990 brood resulted from a recent record chinook spawning escapement of more than 18,000. The 1995 brood egg deposition was estimated at 19.6 million, yet only 3.8 percent, or 700,000, survived to migrate. These survivals contrast with an average (non-flood-year) egg-to-migrant survival of about 13 percent. The fact that we have smolt estimates for the Skagit River that reflect disastrous freshwater survival is clear evidence that we have the capability to predict low abundance in advance of significant fishing mortality. The 30 percent reduction in abundance scenarios are based on years that include the significant flood events of 1990 and 1995, specifically in recognition that abundance might differ from that seen in recent years. A preliminary analysis of the projected abundance from the 2003 brood year indicates it should be within the 30 percent reduction scenario analyzed in the DEIS (see response to comment SW-27). NMFS recognized that in this modeling, exercise conservative assumptions were made and there was always the possibility that in any individual year the results could be different than the range of possibilities considered. If impacts under the implementation of the Proposed Action are greater then expected, NMFS can withdraw the ESA 4(d) Rule determination or ask the co-managers to adjust fisheries to reduce impacts.

It is incorrect to say that immature fish would not be "managed" under the Proposed Action, since management under the Proposed Action does consider the age of fish harvested in each fishery. Indeed, fishing periods for fisheries targeting sub-adult chinook salmon have varied each year since 2001, showing that managers are consciously examining the sub-adult impacts during that period. It is true to say that mature fish from the 2003 brood will be managed in 2007; it is not valid to assume that management in 2005 and 2006 will not be responsive to the 2003 brood. The complexity of implementing brood management, even if the required data and models were available, makes it impractical in the context of annual fishery season setting. A comparison of exploitation rates on brood-year and calendar bases indicate that there is not an appreciable difference in management outcome over the long term. Also see responses to comments SW-1A and SW-1F.

Regarding the statement requesting that surplus production for harvest be shown to exist before directed, non-selective fisheries are allowed – directed fisheries are not anticipated through the duration of the Proposed Action except for a few populations where large returns of hatchery adults are expected. Also see response to comment SW-8 and SW-30.

Finally, many of the commentor's points provide evidence that habitat condition, not spawner abundance, is the primary limiting factor in the Skagit River. It is also possible that "weak brood" management, as suggested by the comment, would likely result in consistent overescapement and increased compensatory mortality, particularly in systems that are clearly shown to be habitat-limited.

SW-24

When the Puget Sound Chinook ESU was listed as threatened in 1999, habitat loss, degradation, and blockage, and past over-exploitation in fisheries were identified as the primary factors for decline of regional populations (64 FR 14308, March 24, 1999). The concerns identified in association with hatchery effects in the NMFS final listing determination document for the ESU were widespread production of hatchery chinook salmon and the inability to differentiate hatchery and natural-origin chinook salmon in natural spawning areas. The abundance of unmarked hatchery fish masked the status of natural populations, complicating assessment of natural population abundance, survival and productivity. It is correct that five hatchery populations were determined to be essential for recovery of the ESU and protected under ESA provisions with natural-origin populations. It is incorrect that all hatchery populations, listed and unlisted, are now uniformly considered to have significant beneficial effects on ESU recovery. NMFS has proposed in its updated status review for the ESU that hatchery chinook populations located in chinook salmon watersheds that are no more than moderately divergent from natural chinook populations within the ESU also be ESA-listed and protected (69 FR 33102, June 14, 2004). These additional hatchery populations were considered in the updated status review for their contribution to the conservation of the ESU in extinction risk assessments. These hatchery populations, and other hatchery stocks not proposed for ESA listing, were also evaluated for potential risks to the viability of natural chinook salmon populations. Listed and non-listed hatchery chinook salmon straying into other watersheds is not considered a beneficial effect by NMFS, and hatchery operational measures are being implemented by the co-managers to lessen straying levels (WDFW and PSTT 2004). These and other adjustments in hatchery practices within the ESU will be evaluated in other, on-going ESA and NEPA review processes administered by NMFS. Included in these evaluations will be effects of hatchery programs on recovery of the listed chinook salmon ESU. Explanations regarding the scientific rationale for NMFS' proposed Hatchery Listing Policy and the updated salmon population status review findings based on application of the Policy are outside the scope of the DEIS. Information regarding the scientific basis for these documents may be found through the NMFS Northwest region web-site at http://www.nwr.noaa.gov/AlseaResponse /20040528 /index.html.

The potential beneficial and adverse effects of artificial programs are described in DEIS Subsection 3.3.8.1, *Hatchery-Related Fishery Effects on Salmon: Straying and Overfishing*. The fishery-related effects are evaluated in Subsection 4.3.7, *Effects of Hatchery-Origin Chinook on Natural-Spawning Chinook Salmon*. Specifically, the DEIS states on page 4-90, "…to the extent that increases in the contribution of hatchery-origin adults on the natural spawning grounds increase risks such as predation on naturally-produced salmon, or competition with naturally-produced salmon for food, and rearing and spawning areas, a reduction in the contribution of hatchery-origin adults on the natural spawning grounds would be considered a beneficial effect. Information is not currently available to determine with certainty what levels of hatchery contribution to naturally-spawning Chinook salmon populations in Puget Sound result in what levels of risk or benefit….for the purpose of this analysis, a reduction in hatchery contribution will be considered a benefit…"

SW-25

NMFS declines to include the reference offered in this comment in its evaluation. The findings are probably not applicable to nearly all hatchery chinook populations in Puget Sound (Dungeness was the lone captive brood program). Reduced adult size, egg size and spawning fitness have been indicated in other studies for captive brood fish (usually farmed salmon) (personal communication with Tim Tynan, NMFS, Fisheries Biologist, July 26, 2004). Captive brood fish have the highest level of intervention of any “hatchery”" produced fish (since they are held in captivity for their entire lives). They would, therefore, be expected to exhibit the highest domestication effects. About 95 percent of chinook salmon reared in Puget Sound hatcheries are released as sub-yearlings. Captivity in the hatchery environment for these fish amounts to about 5 percent of their life cycle, assuming adults return primarily as four year olds.

The patterns in the study are primarily driven by some years in the early 1990s, where egg size and fecundity decreased. These were years when ocean productivity conditions were very low, and affected coho and chinook salmon size and survival. The patterns of decreased egg size may in fact be real, but it is not clear that hatchery practices are the cause or that it would be applicable to Puget Sound chinook salmon populations. The potential effects of hatchery practices on the fecundity, egg size, and reproductive fitness are outside the scope of this Proposed Action, but will be examined in an EIS that NMFS is conducting on the effects of proposed Puget Sound hatchery programs on listed Puget Sound chinook salmon.

SW-26

The Puget Sound TRT has provided initial guidelines for recovery for the number and distribution of populations within the Puget Sound Chinook ESU (PSTRT 2002a). NMFS has used that guidance in its assessment of the effects of the Proposed Action on the recovery of the ESU as the best available information on this subject. The guidance recognizes the diversity of the chinook salmon populations in the Puget Sound Chinook ESU. The guidance defines five geographical regions within the ESU and the need to protect two to four populations within each region, representing the range of life history types in each region. Application of the TRT guidance would not result in protection of only a single chinook salmon population within the Puget Sound Chinook ESU.

SW-27

The commentor states that the 2003 flood event, which likely had impacts comparable to those of the 1990 flood event, could cause a 14-fold reduction in smolt abundance in a particular year, and that, because the DEIS only analyzed a 30 percent reduction in abundance from 2003 levels, “the entire analysis in the DEIS has already become obsolete for the 6-year period in question." The source of the 30 percent reduction is the calculation that overall <u>average</u> abundance in the early-to-mid-1990s, during which Puget Sound chinook experienced both low marine survival and two major flood events, was approximately 30 percent less than the average forecasted abundance during 2001–2003 (DEIS Subsection 4.2.3.1, *Abundance*). The 30 percent reduction is therefore applicable to the average adult abundance over a 5-year period, not to the reduction in abundance possible for smolts in one single year. In terms of the effect that the 2003 flood might have on average adult abundance over the five-year period of the plan, if it is assumed that the 2003 brood year has the same survival rate as the 1990 brood year, and that all other brood survival rates vary randomly according to those observed from 1987–2001, the median expected spawning escapement of Skagit summer/fall chinook salmon over the 5-year time period would be 16,000 adults, and the median terminal run size would be 17,200 adults (personal communication with Bob Hayman, Skagit Systems Cooperative, May 10, 2004). In contrast, if it is assumed that the brood year 2003 return rate also varies randomly (i.e., ignore the flood), the median escapement would be 17,000 adults, and the median terminal run size would be 18,400 adults. Thus, the expected affect of the 2003 flood would be a reduction in average abundance of only 6.5 percent (personal communication with Bob Hayman, Skagit Systems Cooperative, Salmon Recovery Planner, August 6, 2004). This is well within the 30 percent reduction in average abundance analyzed in the DEIS.

Moreover, if return rates are not varied, and it is assumed that mean return rates apply for every brood except that of 2003 (for which the 1990 rates would apply), the calculated mean escapement, 21,284, is only an 8 percent reduction from the mean escapement that would be projected if mean return rates were used for every year (personal communication with Bob Hayman, Skagit Systems Cooperative, May 10, 2004), which is also well within the 30 percent reduction analyzed in the DEIS.

This is not to belittle the effects of the 2003 flood on individual years; however, it also should not be forgotten that chinook salmon mature at multiple ages, and that strong returns from adjacent broods can mitigate to some extent the impact on a single brood. If we assume 1990 return rates for brood year 2003, and mean return rates for all other broods, and that 2003 FRAM exploitation rates apply in odd years and 2004 rates apply in even years, then the expected Skagit summer/fall chinook salmon escapement in fishing year 2007 would be about 12,000 adults (personal communication with Bob Hayman, Skagit Systems Cooperative, May 10, 2004). This is considerably lower than the numbers projected for the other years, but is considerably higher than a 14-fold decrease.

Research supports the importance of cycles of marine survival on Pacific salmonids (Mantua *et al.*1997). Because of our inability to forecast marine survival and the large effect it may have, low marine survival conditions have been assumed in developing the RERs used by NMFS to evaluate the performance of the alternatives in the DEIS. In recognition of interannual variability in marine survival, NMFS incorporated error in these parameters into its derivation of RERs (NMFS 2000). This is a conservative approach, providing additional escapement in good marine-survival years.

SW-28

NMFS, in cooperation with the co-managers, has modeled the anticipated impacts of implementation of the Proposed Action and its alternatives. The 2003 forecasted abundance and a 30 percent reduction from that level for all populations were modeled as the range of Puget Sound chinook salmon abundance likely to occur over the duration of the Proposed Action (2005–2009). The reduced abundance condition was based on observations of the period 1990 through 1999 (DEIS Appendix C3) that included years with significant flood events; e.g., 1990, 1995, similar to that of 2003 (Seiler *et al*. 2000). This range of modeled abundance is considered conservative. Given the general trend of stable to increasing abundance, it is likely that if the actual abundance in the next five years falls outside this range, the actual abundance would most likely be greater.

NMFS recognized that in this modeling exercise, conservative assumptions were made, and that there was always the possibility that in any individual year the results could be different then the range of possibilities considered. If impacts under implementation of the Proposed Action are greater then expected, NMFS can withdraw the ESA 4(d) Rule determination or ask the co-managers to adjust fisheries to reduce impacts.

See responses to comments SW-23 and SW-27.

SW-29

The commentor is correct that 1997 incidental chinook catch in the Marine Catch Area 7/7A sockeye fishery was anomalous, but incorrect in assuming it was intentional or “directed.” Table 1.6-1 also indicates that there were more than 3 million sockeye and pink salmon caught in 1997 along with the 29,592 chinook salmon. In other words, the catch of all salmon species was greater in 1997 with chinook comprising less than 1 percent of the catch. Over 70 percent of the coded-wire tags recovered from chinook salmon caught in Areas 7 and 7A during the pink and sockeye fisheries were of Canadian origin, and the year class of three-year-old Fraser River chinook was stronger than average. Despite the larger than usual incidental catch of chinook salmon in the sockeye and pink fisheries, the exploitation rates in pre-terminal fisheries were generally lower for Puget Sound chinook stocks than in previous years. There may have been unusually high local abundance or availability; i.e., more abundance of Canadian stocks, in areas where U.S. commercial pink and sockeye fisheries occurred in 1997, or just a greater overall abundance of salmon, but there were no commercial fisheries in these areas intentionally targeting chinook salmon. It is not clear what 'analysis' is referred to by the commentor, but the Environmental Consequences analysis (DEIS Section 4) compared alternatives to the 2003 pre-season 'baseline,' not historical average catch, so the 1997 anomaly does not pose any analytical risk.

The commentor has pointed out a typographic error on page 1-23 in the DEIS – the figure "50,000" was intended. Marine sport catch ranged from 26,000 to 41,000 in 1998-2002 with an average of about 31,000. This correction has been made in FEIS Volume 2 (also on page 1-23).

The citation of Bigler *et a*l. was used as general reference to illustrate that there are a variety of cause and effect relationships that might result in the same pattern of trends in size; i.e., competition for food or fishery selection. This can be true regardless of salmon species. It was not intended to be specific to Puget Sound chinook salmon. In pointing out the difficulties inherent in the use of some of the fisheries by Bigler <u>et al</u>., the commentor underscores a primary point of DEIS Subsection 3.3.7, *Selectivity on Biological Characteristics of Salmon*, which is the difficulty in establishing a clear causal link between changes in size and/or age in chinook salmon populations and the fisheries that intercept them. The commentor is referred to the revision to Subsection 3.3.7 in FEIS Volume 2 that includes additional language on size-at-age analyses specific to Puget Sound chinook salmon populations described in the DEIS but completed subsequent to its publication.

Finally, NMFS recognizes the limitations to the estimates of early twentieth century abundance provided in Myers *et al*. (1998), but it is the best available information on abundance of that time, and is used primarily to offer a relative comparison of abundances at that time with those of recent decades.

SW-30

The commentor's confusion that "these are three very different management standards" exists because it may be assumed that only one standard could apply at a time, rather than that all standards must apply simultaneously. The Proposed Action contains multiple constraints that must <u>all</u> be achieved simultaneously, rather than as a system under which fisheries can be conducted whenever <u>any</u> <u>one</u> of the constraints is met. In actuality, as described in Section 5 of the Proposed Action (DEIS Appendix A), and DEIS Subsection 2.3.1 (*Alternative 1 – Proposed Action/Status Quo*), a fishery may be conducted <u>only if</u> more than 50 percent of the impacts are from harvestable runs, <u>and</u> the aggregate of fisheries impacts does not exceed the Rebuilding Exploitation Rate (RER) ceilings, and the aggregate impacts of southern U.S. fisheries does not exceed Pacific Salmon Treaty guidelines. Directed chinook salmon fisheries might be conducted only if the projected escapements exceed the upper thresholds and the aggregate of fisheries impacts does not exceed the RER ceilings. Each fishery must be agreed to by the co-managers as part of an overall regime, and additional constraints on the exploitation rate ceiling apply when the abundance of any management unit or population is critical. Aside from some ceremonial and subsistence, and research fisheries (which would also occur under Alternative 1A), this situation is not anticipated to be encountered except perhaps in the Green, Nisqually and Skokomish Rivers during implementation of the Proposed Action. Fisheries are restricted to incidental-only harvest of chinook salmon whenever more than 50 percent of the resulting fishery-related mortality will accrue to management units and species without harvestable surpluses. In most cases over the last five years (1999–2004), the exploitation rates for the adopted fishing regime have been considerably less than the "maximum amount" allowed in the DEIS.

See responses to comments SW-5 and SW-31.

SW-31

NMFS must evaluate the Resource Management Plan that is provided by the co-managers. If NMFS finds that the Proposed Action meets the criteria of Limit 6 of the 4(d) Rule and will not appreciably reduce the likelihood of survival and recovery, then it must issue that finding and does not have the authority to require changes to the Proposed Action. The use of critical numbers is an element of the Limit 6 criteria (50 CFR 223.203[b][6][i]) to demonstrate that the RMP is consistent with the concept of viable and critical thresholds in the Viable Salmonid Population document (McElhaney *et al.* 2000).

NMFS would expect that the information would change as management reports are updated with new and better information. The change in the status of the Dosewallips is a good example. The Puget Sound Technical Recovery Team (TRT), the group charged by NMFS to define the population structure of the listed ESUs in Puget Sound and to provide technical assistance for recovery planning, revised its earlier assessment of the structure of the mid-Hood Canal chinook populations in January, 2004 (PSTRT 2004). The TRT had concluded in an earlier report (PSTRT 2002b) that the Hood Canal region of the ESU comprised two populations: the Skokomish and the Dosewallips Rivers. In its latest report, the TRT has revised its assessment and now concludes the Dosewallips is part of a larger population comprised of the Dosewallips, Hamma Hamma and Duckabush Rivers (PSTRT 2004). The co-managers revised their RMP to reflect this new, best available, information. NMFS has also incorporated the new information into its evaluation of the RMP, as it is tasked with using the best available information in its assessments.

Lastly, management standards are not provided in the commentor's description of Alternative 1A. See responses to comments SW-1B, SW-1D, SW-1E.

SW-32

NMFS must evaluate the Resource Management Plan that is provided by the co-managers. In its Proposed Evaluation and Pending Recommendation, NMFS has evaluated the co-managers plan using the best available information regarding the expectation of conditions over the proposed duration of the plan (2005–2009), and evaluated the outcome against NMFS' standards for listed Puget Sound chinook salmon. If NMFS finds that the Proposed Action meets the criteria of Limit 6 of the 4(d) Rule and will not appreciably reduce the likelihood of survival and recovery, then it must issue that finding and does not have the authority to require changes to the Proposed Action. NMFS' Proposed Evaluation and Pending Determination of the co-managers' Puget Sound Chinook Harvest Resource Management Plan, as proposed to be implemented during the 2005–2009 fishing seasons, is that it is consistent with the criteria of Limit 6 and would not pose jeopardy to the Puget Sound Chinook ESU.

SW-33

Development of data with which to manage Puget Sound chinook salmon has been an ongoing endeavor since the rulings of U.S. v. Washington. Work toward a comprehensive approach to Puget Sound chinook salmon harvest began in the late 1980s, when data began to be available with which to evaluate harvest impacts. When it became apparent that stocks were not faring well, the co-managers began development of a new management framework, represented by earlier versions of the Puget Sound Comprehensive Chinook Management Plan's Harvest Management Component, in spite of a lack of complete data in some cases. The co-managers' decision to change to exploitation rate management was carefully considered, after assessment of risks and benefits of different management approaches (personal communication with Teresa Scott, WDFW, Salmon Resource Policy Analyst, and Will Beattie, NWIFC, Salmon Recovery Coordinator, July 30, 2004). This includes consideration of economic, social and cultural impacts as well as biological factors.

A comprehensive chinook salmon management plan was implemented initially in 1997. Subsequent Puget Sound chinook salmon escapements indicate that the reduced exploitation rates and other harvest management actions resulting from implementation of that Plan has contributed to the stabilization and increase in Puget Sound chinook escapements (NMFS 2004a; NMFS 2004b). Revisions to the management framework have been made in subsequent years as new information became available. The most recent version of the management framework is the Proposed Action for the 2005–2009 fishing seasons, evaluated in the DEIS. Also see responses to comments SW-1A, SW-1F, SW-4, SW-8, SW-10, SW-11, SW-13, SW-14, SW-17 and SW-27.

CEQ's Forty Most Asked Questions 6a acknowledges that "NEPA does not require that an agency adopt the most environmentally preferable alternative but that the impacts are disclosed in a full and fair manner" (CEQ Regulations §1502.9 and 15002.16), and that the agency provides a clear record of the basis of its decision "including consideration of economic and technical considerations and agency statutory missions"(CEQ Regulations §1505.2[b]).

Also see response to comment SW-32.

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Native Fish Society (NFS)

Letter of Comment

NATIVE FISH SOCIETY

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May 21, 2004

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Re: Puget Sound Chinook Harvest Resource Management Plan Draft Environmental Impact Statement

This letter is to provide comments on the referenced Draft EIS.

1 1. The range of alternatives is very unrealistic and by their choice appears to have forced the
selection of the "status quo" alternative as the preferred alternative. Including the unimaginative
alternative for "no harvest." This alternative does not provide a decision-maker with realistic
information about harvest management possibilities. It is a worthwhile exercise to generate 2
information for such a strategy, but it should have been a side-analysis rather than an assessed
alternative.

2. It is our position harvests should be managed to sustain wild populations, based on weak
stock management. Each river reach should have spawner escapement goals and harvest
3 management regimes should be designed to deliver those escapement goals. These goals would
be specific to each stock to achieve the standards under the Viable Salmonid Population (VSP)
policy annually.

The status quo objectives for managing on a "management unit" basis will not provide
sufficient protection or rebuilding of specific populations of concern. The Oregon Coastal
Natural coho (OCN) harvest management approach for testing environmental conditions facing 4
broodstocks has shown to be workable and it could be extended to the Puget Sound Chinook
stocks. The alternatives for escapement goal management "with no fisheries restriction" and
"with terminal fisheries only" are akin to the OCN management approach, but when properly
implemented through <u>restricted</u> fisheries are more acceptable preferred alternatives. Alternative 5
2 especially could have been better characterized so as to have integrated harvest management
similar to Alternative 1, but with population level escapement goals. The Draft EIS design for
both Alternative 2 and 3 seemed to have a predisposed purpose for showing drastic fisheries
reductions so as to avoid further consideration.

3. There is too much emphasis on only meeting minimum protection requirements for the ESA
listed stocks. Much more can be done for a harvest management regime that is in conjunction 6
with habitat improvement plans. The Draft EIS attempts to separate the two efforts, which will

mean each cause of mortality will assume the other has a workable solution. A mortality profile for each stock must be determined including harvest impacts. There must be an overriding understanding that has mutual dependence and triggers for action when both efforts are out of balance. An annual report on ESA-listed chinook taken in the fishery must be provided to the agencies and public each year to track harvest impact. This numerical harvest accounting would be in several forms. One would be an overall numerical take, take by ESU, and take by 7
each distinct population in the ESU. Only by doing this numerical accounting can the NMFS, agencies and the public understand the effect of harvest on rebuilding and recovery of chinook.

4. The Draft EIS fails to include the flexibility and influence on Alaskan and Canadian fisheries allowed through impact sharing arrangements annually determined by the Pacific Salmon Commission (PSC). Methods in the Draft EIS simply assume 2003 fisheries conditions or higher 8
impacts without setting objectives and outlining procedures for improved implementation of impact sharing arrangements. The myopic view for only regulating harvest within Puget Sound ignores the coordinated management approach built into agreements for ocean fisheries. It is much more difficult to outline objectives and processes for improving on coordinated management than just assuming "that is the way things are." In fact, the North Pacific Fishery Management Council (NPFMC), Pacific Fishery Management Council (PFMC), and the PSC were specifically instituted to handle such arrangements.

5. The reliance on hatcheries to compensate for degraded habitat means harvests are pushed to terminal areas to minimize impacts on wild origin populations. Objectives and processes should have been explored and assessed that change the hatchery reliance practices. Furthermore, the 9
EIS should document, using the scientific literature, the assumption that hatcheries can compensate for habitat degradation. Since the purpose of the ESA is to recover native wild salmonids in their natural habitat, the use of hatcheries to compensate for habitat degradation has to be placed in context for each ESA-listed population.

6. Up to three-quarters of harvest mortality for Puget Sound origin Chinook occurs incidentally outside of Puget Sound. This can mean that Indian treaty rights for harvestable fish can be allocated geographically and need not rely on post-ocean migration fisheries for the harvests. There may be creative opportunities for other area harvesting when fish condition is better 10
suited for markets that would bring higher value to the Indian fishing industry. The procedures for such arrangements should have been explored and economically assessed.

7. It appears a significant portion of the Indian harvests are only for the purpose of selling eggs and fish carcass disposition practices were not described. There is no assessment of new regulations that might be needed to protect water quality or have better utility of the carcasses. 11
Their utility for stream nutrient augmentation in streams should specifically be addressed. The EIS must consider the Clean Water Act requirements in disposing of carcasses.

8. The discussion for alternatives' consequences is remarkably devoid of economic discussion. Numbers abound for measurements of net economic value and regional economic impacts, but there are no measurements or even qualitative discussion of societal economic worth given to 12
non-use of this fish resource. The Draft EIS does not meet standards as called for in NMFS guidelines for preparing economic analysis, let alone a host of federal executive orders, acts, regulations, and instructions to include these types of discussions. Even if data is sparse and

budgets are short for modeling non-use impacts, magnitudes and distribution effects can be explained and assessed in non-numerical ways.

The Draft EIS should not be considered complete until these issues are fully examined and discussions included in a re-issue of a new draft.

Thank you for the opportunity to comment and we look forward to the agency's full compliance with the court decisions and mandated requirements for EIS preparation.

Sincerely,

Bill M. Bakke

Bill M. Bakke, Director

RESPONSE TO COMMENTS RECEIVED FROM NATIVE FISH SOCIETY (NFS)

NFS-1

The range of alternatives considered by NMFS was in part mandated in a settlement agreement (Washington Trout v. Lohn) that challenged the adequacy of NMFS' NEPA analysis on an earlier 4(d) determination for a Puget Sound chinook salmon harvest plan. NMFS was therefore required to include them in its range of alternatives. Other alternatives that were considered but eliminated from detailed study are discussed in DEIS Section 2, *Alternatives Including the Proposed Action*.

NFS-2

Comment noted.

NFS-3

Data is currently insufficient to establish escapement goals for each river reach. In addition, such an approach might not be practical or desirable to implement. Environmental and habitat conditions are highly variable from year to year, and spawning adults seek out the best habitat as defined by the conditions in that year. NMFS agrees that harvest management plans should be consistent with the concepts in the Viable Salmonid Population (VSP) document regarding abundance, productivity, diversity and spatial structure, and this is a requirement of any resource management plan provided to NMFS under the 4(d) Rule. NMFS' evaluation of how the RMP is consistent with the VSP criteria can be found in its Proposed Evaluation and Pending Recommendation (NMFS 2004).

DEIS Alternative 3 evaluates the implementation of a fixed-escapement goal approach to harvest management with escapement goals at the individual population level. Although Alternative 3 also mandates terminal fisheries only, removing the geographical restriction on the fisheries would not change the results because the anticipated abundances for many populations would preclude mixed-stock fisheries under the fixed-escapement goal approach represented by Alternative 3. The Proposed Action (Alternative 1) also uses a weak-stock management approach, although harvest management objectives are specific to management units. The twenty-two Puget Sound chinook populations identified by the Puget Sound Technical Recovery Team (PSTRT 2004) are divided into 14 management units, eleven of which are explicitly managed for the weakest population in the management unit. Therefore, the range of alternatives evaluated in the DEIS is inclusive of the approach suggested by the commentor.

NFS-4

The harvest management approach used to manage Oregon Coast Natural coho (OCN) is a matrix of parent and grandparent escapement measured against a marine survival index to yield a ceiling exploitation rate for an annual adult abundance forecast. For Puget Sound chinook salmon, parent and grandparent escapement estimates are available. A marine survival index for chinook salmon is more difficult to determine than for coho, because chinook are in marine waters for several years and each age class will experience different environmental conditions and survival rate factors, particularly early marine survival conditions. The marine survival index used for OCN coho is the "jack" (age 2) return to the spawning areas as an indication of the return of adult age 3 coho the next year. Using jack coho as an indicator of adult survival rate is much more reliable for coho than it is for chinook salmon where the "jack" (age 2) maturation rate is very low compared to the number of fish returning as age three- to five-year-olds. For example, two-year-old Skagit summer and fall chinook salmon comprised 2 percent of the mature run for the 1987–1991 brood years (personal communication with Rebecca Bernard, Swinomish Tribe, Fisheries Biologist, February 4, 2004).

Accounting for jack chinook salmon in Puget Sound terminal fisheries and in escapement is difficult and highly variable between river systems (see Appendix E of DEIS Appendix A, the Resource Management Plan). Because of their small size, jack chinook salmon are not caught in significant numbers in net fisheries, and are difficult to enumerate accurately during spawning ground surveys. For most systems in Puget Sound, terminal area age data necessary for estimating a marine survival index is not available until after the pre-season forecasting period for the upcoming management year.

Finally, the OCN matrix system is designed to work across a wider range of escapement, ocean survival and abundances than what is expected for Puget Sound chinook salmon across the duration of the Proposed Action (2005–2009). With the Proposed Action only covering the next five fishing seasons, it is likely that abundance and survival conditions will be similar to those in recent years. The Proposed Action is in a sense similar to the OCN matrix approach where its tiered exploitation rates (e.g., RER, CERC) approach depends on critical, low, or normal abundance status.

NFS-5

Insufficient detail is provided in this comment for use in analyzing the suggested approach. It is unclear how the commentor defines "restricted" fisheries or what the magnitude of the fisheries would be. The commentor characterizes the fixed-escapement-goal alternatives in the DEIS (Alternatives 2 and 3) as similar to the OCN approach, however, the OCN approach is exploitation-rate based, not escapement goal based. The OCN approach uses escapement thresholds of parent and grandparent escapements, in combination with predictions of marine survival, to determine what exploitation rate is appropriate in a given year. This approach is similar to that of the Proposed Action, which uses escapement thresholds to determine which level of exploitation rate is appropriate in a given year. CEQ Regulations specify that "Comments on an environmental impact statement…shall be as specific as possible…"(§1503.3[a]), and "When a commenting agency criticizes a lead agency's predictive methodology, the commenting agency should describe the alternative methodology which it prefers…"(§1503.3[b]). Also see response to NFS-3.

NFS-6

The integration of habitat, hatchery and harvest actions is the subject of a recovery planning process currently underway in Puget Sound through a forum called the Shared Strategy (see DEIS Subsection 1.10.4, *Puget Sound Recovery Planning*), and is outside the scope of the Proposed Action. Completion of the recovery plan and decisions regarding the form and timing of recovery efforts described in the recovery plan will dictate the kinds of harvest actions that may be necessary and appropriate in the future. However, NMFS has integrated an assessment of current habitat conditions in the development of standards used to evaluate the DEIS alternatives. NMFS has done this to ensure that its standards are consistent with the productivity and capacity of the habitat for specific Puget Sound chinook populations where that information is available (see DEIS Subsection 4.3.1, *Threatened and Endangered Fish Species*, page 4-10).

Aspects of the integration between habitat actions and the proposed harvest management action are discussed as cumulative effects in DEIS Subsections 4.3.8 (*Indirect and Cumulative Effects*), and 4.8.6 (*Cumulative Effects on Wildlife*).

NFS-7

The Proposed Action includes annual reports provided to NMFS that report numerical harvest accounting by fishery, adult spawner escapement estimates, and estimates of exploitation rate on each Puget Sound chinook salmon management unit and population. Initial estimates of commercial harvest provided in annual reports are preliminary, and are finalized in subsequent years. Catch estimates can be reported immediately post-season for a few recreational fisheries for which creel surveys estimate recreational catch in-season, but actual post-season catch estimates for most recreational fisheries are not available until one to two years after the fishery occurs.

Population- and management-unit-specific exploitation rate information used to measure performance of the Resource Management Plan become available two to four years after fisheries are completed.

Post-season Fishery Regulation Assessment Model (FRAM) assessments are used to report this information by management unit or population when data become available. The Proposed Action suggests FRAM be updated to incorporate this new information every five years.

NFS-8

The assumptions used in the DEIS modeling were based on the terms of the Pacific Salmon Treaty Chinook Annex and information exchanged with Canadian harvest managers that occurs through the Pacific Salmon Commission and the annual implementation of the terms of the Annex. The objectives and procedures for improved implementation of impact sharing arrangements is the subject of the terms of the Pacific Salmon Treaty Chinook Annex negotiated in 1999 between Canada and the U.S. That agreement is not part of the Proposed Action, although it influences the shaping of annual fishing regimes in Puget Sound. Therefore, it is outside the scope of the Proposed Action, but impacts on Puget Sound chinook salmon in Canadian fisheries must be taken into account when evaluating the alternatives in the DEIS. NMFS cannot assume that Canada will manage it fisheries in a different manner than specified in the terms of the Annex. Therefore, NMFS attempted to define a reasonable range of outcomes consistent with that agreement (CEQ Regulations 1502.14 and CEQ Forty Most Asked Questions 1b), and describes the rationale behind these choices.

Also see response to comment SW-18.

NFS-9

In actuality, chinook salmon harvests that target hatchery-origin fish occur throughout marine and freshwater (pre-terminal and terminal) areas of Puget Sound. Harvests in all Puget Sound areas where chinook salmon may be affected are managed to protect the weakest management unit. Alternatives that explore the effects of decreases and increases in the hatchery production of juvenile chinook salmon will be included in a separate, ongoing EIS for Puget Sound region hatchery programs. Evaluations of these alternatives within the hatchery EIS will consider effects on fisheries harvests, fishery economic value, and natural and hatchery-origin chinook salmon population abundances.

In addition to the need to avoid duplication of issues that will be more appropriately addressed in the hatchery EIS, NMFS did not consider hatchery program adjustment effects in this EIS because any changes in hatchery practices would have little practical effect on the Puget Sound Chinook harvest management framework under consideration. The Proposed Action has a five-year duration. Considering that chinook salmon recruit to fisheries primarily as four-year-olds, the effect of any hatchery adjustments implemented now on harvests would be experienced overwhelmingly in the final two years of the five-year plan (2008 and 2009). To the extent that changes in hatchery practices would be reflected in earlier age classes, this would be taken into account in annual pre-season fishery planning. Integration of habitat, hatchery, and harvest actions to effectuate recovery of the listed Puget Sound Chinook ESU is the subject of on on-going recovery planning process but outside the scope of the action evaluated in this EIS. Also see responses to comments SW-19, SW-22 and NFS-6.

It is unclear from this comment in what context the EIS should document the assumption that hatcheries can compensate for habitat degradation. Such additional documentation needs to be connected with a specific alternative to be evaluated or a specific assumption made in the EIS analysis. Without this information, it is unclear what specific information is missing from the EIS. The potential beneficial and adverse effects of hatchery programs have been summarized in numerous scientific publications and literature reviews (for example, Lichatowich and McIntyre 1987; Hard et al. 1992; Witty et al. 1995; Busack and Currens 1995; Waples 1999), and discussed in DEIS Subsection 3.3.8, *Hatchery-Related Fishery Effects on Salmon*. One beneficial effect of hatcheries identified in all of these documents is their enhanced ability to bolster the abundance of adult salmon relative to naturally-spawning fish due to increased egg-to-smolt survival rates afforded by the hatchery environment. Given extensive habitat degradation that has occurred within the Puget Sound region (WDNR 1998), hatchery production has been necessary to at least partially off-set natural chinook salmon production that has been lost.

NFS-10

Tribal fisheries are limited in geography by treaty and through court order (see DEIS Subsection 3.4, *Tribal Treaty Rights and Trust Responsibilities*, U.S. v. Washington: 384 F. Supp. 312). In addition, tribal fishing is as much a cultural activity as an economic one, so “higher economic value” is not the only value considered when planning fisheries. Indian treaties signed by the federal government guaranteed continued access to fisheries for future generations. The Treaty of Medicine Creek includes a provision typical of that found in treaties with many Northwest tribes:

> “The right of taking fish, at all usual and accustomed grounds and stations, is further secured to said Indians, in common with all citizens of the Territory,..” (Treaty of Medicine Creek , Article III, 10 Statute 1132. *See also*, Treaty of Point Elliott, 12 Statute 927; Treaty of Point-No-Point, 12 Statute 933; Treaty of Neah Bay, 12 Statute 939; and Treaty of Olympia, 12 Statute 971, which are generally known as the “Stevens Treaties”.)

Provision of fishing opportunity in all usual and accustomed fishing grounds is therefore an essential objective of the Resource Management Plan, and is central to fulfilling NMFS’ trust responsibility. It would be inconsistent with the Purpose and Need for the Proposed Action to examine re-location of tribal fisheries.

NFS-11

Presence of salmon carcasses in streams is a natural component of stream ecology. Nevertheless, the Clean Water Act specifically prohibits the placement of "biological materials"" unless an environmental review is done indicating no significant adverse environmental effect. WDFW completed a State Environmental Policy Act process, and issued a Declaration of Non-Significance on May 21, 1997 prior to implementing its carcass dispersal activities.

In some fisheries, for both treaty Indian and non-treaty fishers, sales of eggs can be more lucrative than sales of the whole fish. This is primarily true for pink and chum salmon – chinook salmon eggs are a relatively small proportion of total egg sales. Egged carcasses associated with commercial harvest are not used for stream fertilization because of logistical constraints. The infrastructure required to collect and distribute egged carcasses from commercial fisheries is not in place, and would be much more complicated than that required for hatcheries. Hatcheries act as central collection facilities because large numbers of fish in a region return there. The fishermen and commercial buyers are dispersed throughout Puget Sound when fisheries are open and their location changes depending on factors such as the pattern of catch, price paid, and weather. A significant number of carcasses are sold along with the eggs and processed (e.g., smoked, used for bait, fishmeal), or taken home as subsistence catch by the fishermen. Generally, disposition of carcasses into fresh or marine waters by fishermen is not known to cause any significant water quality problems. However, mass disposal of salmon carcasses into marine waters has been identified as a specific problem in some local areas of Puget Sound. In areas where disposal of salmon carcasses has been identified as a problem, the co-managers are developing new markets for carcasses otherwise discarded and encouraging buyers to retain the carcasses to facilitate proper disposal. In addition, WDFW and the Puget Sound tribes work cooperatively with a number of volunteer groups who help to distribute carcasses from hatcheries into streams. Applications to WDFW for carcass distribution are reviewed within WDFW for consistency with fish health and carcass distribution guidelines (Michael, Jr. 1997).

It is an open question whether the nutrient load from salmon carcasses is significantly different now than it was historically, when all the natural runs were healthy.

NFS-12

NMFS acknowledges that protecting, restoring, and enhancing salmon and other aquatic resources affected by the Proposed Action generate non-use values. Non-use values associated with protecting salmon resources in the State of Washington have been the focus of several studies in recent years (Olsen et al., 1991; Loomis, 1996b; and Layton et al., 1999).

NMFS' guidelines for preparing economic analysis were developed for the purposes of analyzing regulatory actions in Regulatory Impact Reviews and Regulatory Flexibility Analyses. These guidelines, primarily structured around a benefit-cost analytical framework, allow for considering non-use values in evaluating regulatory actions. The Proposed Action is not considered a regulation requiring the co-managers to comply with specific regulations; instead, the EIS states that if the fisheries are conducted consistent with the Plan, then the co-managers of the fisheries will be exempt from take regulations. Fisheries also could occur in other ways and not be in violation of the ESA. Consequently, strict adherence to the guidelines in preparing the economic analysis, including evaluating non-use values, is not mandated. In addition, the guidelines' primary focus on determining the "expected direction in net benefits to the nation" of the Proposed Action is considered to be an analytical objective beyond the scope of the EIS.

In recognition of the relevance of non-use values pertaining to fishery resources, particularly listed species, the Affected Environment section, *Economic Activity and Value* (Section 3.6) has been modified to include a brief description of non-use values and how they relate to the Proposed Action and alternatives. Because the effects of the alternatives on the recovery of listed species cannot be determined with sufficient certainty to reliably estimate non-use values associated with recovery, potential effects of implementing the alternatives on non-use values are not evaluated in the Environmental Consequences section.

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Washington Trout (WT)

Letter of Comment

W A S H I N G T O N   T R O U T

Comments Regarding:

Puget Sound Chinook Harvest Resource Management Plan; Draft Environmental Impact Statement

National Marine Fisheries Service, April 2004

Submitted July 1, 2004

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WASHINGTON TROUT

Part 1. Comments Regarding:
Puget Sound Chinook Harvest Resource Management Plan; Draft Environmental Impact Statement
National Marine Fisheries Service, April 2004

Washington Trout, July 1, 2004

INTRODUCTION
Washington Trout has reviewed the *Puget Sound Chinook Harvest Resource Management Plan; Draft Environmental Impact Statement* (DEIS) and relevant accompanying documentation. We have also reviewed the relevant RMP, the *Puget Sound Comprehensive Chinook Management Plan: Harvest Management Component*, submitted to NOAA by the Puget Sound Treaty Tribes and Washington Department of Fish and Wildlife (co-managers). We have also reviewed relevant fisheries-management records and scientific literature pertinent to a review of both the RMP and the DEIS.

We find that the DEIS is inadequate in several fundamental respects. NEPA requires a thorough and fair analysis of the potential environmental impacts of the “Proposed Action” as well as alternatives to the Proposed Action. The dismissals of several potential alternatives to the Proposed Action that were proposed in scoping appear to be arbitrary. In the discussion that does occur regarding alternatives to the Proposed Action, the DEIS fails to consider and analyze the alternatives to the Preferred Alternative in sufficient detail and without bias. The analysis of the Preferred Alternative fails to adequately consider or evaluate its full environmental impacts, particularly the impacts of the RMP on Threatened Puget Sound chinook. The economic analyses and the evaluation of the affected environments in the DEIS fail to include any evaluation of the full economic, social, and environmental costs of chinook harvest under each of the Alternatives. Of particular importance in the economic analyses is the absence of any consideration of opportunity costs associated with the Preferred Alternative and of benefits to chinook harvest and chinook conservation that might reasonably be made available by the adoption of one or another alternative to the Preferred Alternative.

In view of the considerable deficiencies in these regards we believe that the DEIS is unacceptable and should be withdrawn and revised to remedy these basic failures.

KEY ISSUES
I. Inadequacy of Alternatives Analyses
<u>I-1. *Inappropriateness of the Adopted Environmental Baseline:*</u> NOAA Fisheries attempts to
make transparent the connection between the DEIS – including several of its particulars – and
NOAA's July 2002 Settlement Agreement with Washington Trout re *Washington Trout v. Lohn.*
The basis for Washington Trout's challenge of NOAA's determination on the 2001 RMP in
Washington Trout v. Lohn was NOAA's clear failure to comply with NEPA requirements to 1
perform a full Environmental Impact Statement before finalizing its ESA take-authorization
processes. But now, NOAA proposes to use as a "baseline against which the environmental,
social, and economic consequences of the [proposed] action are compared," the "harvest
management practices and baseline environmental conditions" that have existed *since* NOAA's
inappropriate determination to grant take-authorization for the RMP in 2001. Had NOAA
undertaken to comply with NEPA in 2001 it could not have employed the yet-to-be-initiated 2
RMP as the environmental baseline against which to evaluate the changes likely to occur if the
RMP were adopted. NOAA proposes to reward itself for failing to comply with NEPA in 2001
by using the conditions resulting from that failure to imply that the new proposed action "most
closely approximates" current environmental conditions, suggesting the least impacts. It is
inappropriate and unfairly biased in favor of the RMP for NMFS to now use that same RMP
harvest regime as the appropriate baseline for the DEIS.

The 2001 RMP-determination was the first take-authorization NOAA had awarded for harvest-
related impacts to PS chinook since the ESU had been listed as Threatened in 1999, representing
and suggesting significant reevaluation and modification of then-current "harvest management
practices and baseline environmental conditions." Using the baseline proposed in the DEIS
leaves still-unexamined the potentially significant changes in environmental impacts that resulted
from NOAA's inappropriate 2001 determination. The harvest regime proposed by the RMP is a 3
matter of controversy, especially as regards the conservation and recovery of PS chinook; it is at
best premature to employ it as a baseline to argue the Preferred Alternative would effect no
change in the environmental status quo. Besides leaving the actual relevant changes in
environmental impacts unexamined, this places an unfair burden on any other alternative by
characterizing such an alternative as one that would endeavor to *alter* the status quo.

The language and tone of the DEIS overall suggest an attempt to justify the co-managers' RMP
for chinook harvest, rather than present a clear and balanced overview of several alternative
approaches to the management of harvest-related impacts on the ESA-listed Puget Sound
chinook salmon ESU and its component populations. For example, page-i of the Executive
Summary states "The Resource Management Plan also includes implementation, monitoring, and 4
evaluation procedures designed to ensure that fisheries are consistent with the objectives of the
Resource Management Plan for conservation and use." Such statements are inappropriately
presumptive and favorable to the Preferred Alternative. Moreover, this statement is unsupported
by a fair and critical review of the harvest RMP, which will be discussed below.

<u>I-2. *Failure to Justify the Several Purposes and Needs; Failure to Consider Potential Inherent*</u>
<u>*Incompatibilities among Some Purposes and Needs:*</u> Pages i and ii of the Executive Summary list
eight (8) constraints that the proposed action must satisfy. No justification for this suite of 5

constraints is provided, yet this assertion (viz., that all of these constraints must be satisfied) is crucial to the argument in support of the Preferred Alternative.

In addition, it is simply assumed that all eight constraints are mutually compatible, an assumption that is far from obvious. For example, among the constraints are the following: “Provides equitable sharing of harvest opportunity among tribes, and among treaty and non-treaty fishers pursuant to U.S. v Washington and U.S. v. Oregon; “Manages risk associated with abundance estimation, population dynamics, and management implementation”; and “Optimizes 5 harvest of abundant Puget Sound salmon … while protecting weaker commingled chinook stocks”. Some argument is required to even make plausible the claim that management of the risks mentioned and protection of “weaker commingled chinook stocks” in mixed stock (including mixed species) fisheries is possible in conjunction with optimal harvest of other salmon stocks and with complying with the sharing of opportunity required under U.S. v Washington and U.S. v. Oregon. (It is certainly not clearly supported that the RMP successfully reconciles this difficult and contradictory standard.)

Further, it is not at all obvious that such constraints have equal weight when devising a harvest management regime capable of satisfying ESA concerns. Clearly, any such list is likely to require some degree of prioritization among the components of the list. If the DEIS asserts such 6 a list of constraints it should also prioritize them. The DEIS is remiss in failing to do this.

The DEIS attempts to argue that among the Alternatives considered, *only* the Preferred Alternative satisfies the purpose and need as characterized by the eight conditions. If true, this 7 would seem to be inappropriate. Is the assertion of the DEIS that ONLY the preferred alternative, of all other imaginable alternatives, is capable of meeting the purported purpose and need? There are none more expensive, more complicated, less efficient? Surely, the purpose and “need” must be capable of being characterized more generally and the Alternatves described in such a way that they can be understood (and subsequently evaluated) as different ways in which and different degrees to which the basic purpose can be fulfilled. Hence, we argue that the DEIS 8 has failed to provide a properly unbiased description of the purpose and need for the contemplated harvest action and has therefore failed to provide an appropriate context in which the Alternatives can be fairly considered and evaluated.

I-3. *Biased Consideration and Arbitrary Dismissal of Alternatives Proposed in Scoping:* In its specification of “criteria applied in narrowing the range of alternatives included”(page 2-2), the DEIS employs the description of the program purpose and need -- characterized by the eight constraining conditions described in Section I above – to arbitrarily dismiss reasonable alternatives presented during scoping.

A tribal-only fisheries alternative was presented during scoping. This alternative would “provide the 4(d) Rule take limitation on harvest activities only for treaty tribal fishing, would estimate the level of tribal fisheries required to satisfy federal trust responsibilities to the Puget Sound treaty tribes, and would configure those fisheries for all salmon species” (p. 2-2). 9

Such an alternative would clearly satisfy NMFS trust responsibilities to Puget Sound Treaty Tribes and would generally be expected to result in both a reduced overall level of harvest-

impacts to Puget Sound populations of the listed chinook ESU and to a reduction in some of the
impacts arising from mixed stock fisheries in marine waters. It would also require a detailed 9
estimation of the level and distribution of hatchery production necessary to satisfy such a fishery.

The DEIS appears to place a great deal of weight on NOAA's trust responsibilities as a
constraint on acceptable alternatives while at the same time arguing that the additional levels of
fishing impacts permitted under the Preferred Alternative are consistent with the conservation
and recovery of the listed chinook ESU. Describing and evaluating a tribal-only alternative in
detail would appear to be a useful exercise that would provide a valuable contrast with the 10
Preferred Alternative. This would enable the public to clearly understand the level of fishing that
NMFS believes is required to satisfy trust responsibilities and to understand the additional levels
of harvest and additional levels of impact that arise from satisfying the other features of the
alleged purpose and need that require non-tribal harvest. The DEIS steadfastly refuses to do this,
resorting to an arbitrary dismissal of the suggested alternative.

> This alternative is not consistent with the purpose and need of the Proposed Action. Since
> the purpose is to put in place a resource management plan under Limit 6 of the 4(d) Rule
> (i.e., a joint state-tribal plan), it would not be reasonable to expect that the Washington
> Department of Fish and Wildlife and the Puget Sound tribes would put forward a joint
> plan under Limit 6 that would include no provision for non-tribal fishing. A fishery plan
> involving tribal-only fisheries would reasonably be expected to be provided to NMFS for
> evaluation under the Tribal 4(d) Rule. (2-2) 11

This line of reasoning is entirely unconvincing, arbitrary and capricious. NOAA should act on its responsibilities under the ESA and NEPA to thoroughly analyze and influence the technical and biological elements of resource-management proposals that could potentially impact the status and recovery of PS chinook. Instead, the DEIS attempts to employ rhetorical and legalistic acrobatics to suggest that NOAA has met some bare-minimum interpretation of its responsibility. The dismissal of this alternative is also not compelling on its face.

There is no organic reason why the Washington Department of Fish and Wildlife (WDFW)
cannot or would not participate in developing such a plan on behalf of the co-managers (and thus
submit it under Limit 6) in order to discharge its over-arching (Washington-State) constitutional
responsibility to manage the fish and wildlife resources of the state for the posterity of the 12
citizens of the state. There is no reason for believing *a priori* that a tribal-only fisheries plan
might not be the preferred alternative on the part of a reasonably-responsible WDFW when
balancing conservation, legal, and equity concerns with respect to the treaty tribes.

The DEIS appears to suggest that WDFW represents only one narrow interest group of
consumptive users of the fishery resource – non-tribal commercial and sport anglers – and uses 13
that unsupported suggestion to label WDFW participation in such a plan "unreasonable. " Even
if it were true that WDFW represented only harvest-fishers, the department still would certainly
consider participating in a tribal-only RMP if for no other reason than to reconcile potential 14
forgone-opportunity issues that have been matters of controversy between the co-managers in the
past. But this is an entirely inappropriate view of WDFW and of its legal responsibilities with
regard to the fishery and aquatic resources of the Washington.

More importantly perhaps, NOAA Fisheries surely has equal if not greater obligations, and there
is no reason that NMFS might not recognize that a treaty-only fishery is required and even may 15
be the most equitable under circumstances in which ESA-listing of Puget Sound salmon ESUs
was warranted. It is neither at all clear to this review that NOAA has any particular obligation to
accept or reject alternatives proposed in scoping only as a matter of whole cloth. It seems
reasonable to assume that NOAA Fisheries retains some discretion in deleting or adding
elements to scoping proposals in order to shape and analyze reasonable and potentially valuable
alternatives. It would not seem a huge leap for NOAA to have fashioned some variation of this 16
alternative that might have appeared to it more plausible, even under its torturously rigid
interpretation of the 4(d) Rule. For instance, an alternative that considered tribal only mixed-
stock fisheries combined with terminal-area tribal and recreational non-tribal fisheries would
certainly appear to satisfy the standards for Purposes and Needs at least as well as the Preferred
Alternative, would likely provide valuable contextual information for evaluating the relative
environmental impacts of the Preferred Alternative, and would appear to *require* joint-
participation of the co-managers in applying for take authorization.

In its discussion of Alternative 4, NOAA argues that before considering the implementation of
an alternative precluding tribal fishing, it is constrained by several standards related to its Trust
Responsibilities, including that “reasonable regulation of non-Indian activities” has not been 17
considered first. This would appear to argue *for* an evaluation of some form of tribal-only or
nontribal-restricted fishery as a more reasonable alternative to the proposed action, but NOAA
games the 4(d) Rule to avoid having to make even that analysis. Finally, it should be noted that
the likely desires or inclinations of take-authorization applicants may not be entirely relevant in
this context, certainly not controlling. The co-managers appear to be disinclined to consider any
alternative significantly different from the RMP, and it’s unlikely they would jointly submit a 18
significantly different plan. Doesn’t that make analyses of Alternatives 2 and 3 as
“unreasonable” as an alternative similar to the tribal-only alternative proposed in scoping?

A No Hatchery Augmentation alternative was also suggested during public comment. This is
dismissed out of hand by the authors of the DEIS for reasons that are both arbitrary and
confused. The DEIS argues the following:

> A no-hatchery augmentation alternative would assume that hatchery augmentation
> programs and the fish produced from those programs do not exist. It has been excluded
> from further detailed analysis because it is not reasonable or practical. Even if the
> hatchery programs were discontinued in 2004, substantial numbers of hatchery fish from 19
> previous hatchery releases will return to Puget Sound in 2004 and over the next several
> years. It is not reasonable to expect that the co-managers would develop a resource
> management plan that did not provide for harvest of these hatchery fish, particularly since
> many of these fish were produced specifically for harvest. This alternative is also
> technically infeasible to assess with current tools and available data, since it is not yet
> possible to distinguish returning hatchery adults from wild adults for many Puget Sound
> chinook salmon populations. (2-3)

It is clearly uncharitable in the extreme to interpret a no-hatchery augmentation alternative as assuming or requiring the magical, instantaneous elimination of all hatchery fish of all ages and stages of development from the waters of Puget Sound and the Pacific Coast. It is incumbent 19
upon NMFS under NEPA to provide a realistic and charitable interpretation of an otherwise reasonable alternative proposed by the public, not create a strawman caricature that is then ridiculed.

Absent such a principle of charity there is no reasonable way for the interested general public to 20
propose alternatives for serious consideration. Nor does such a lack of charity further the aims and purposes of NEPA that a consideration of environmental impacts provide a reasonable spectrum of alternative ways that *might* succeed in meeting the broad purposes of a proposed action while minimizing or eliminating undesirable collateral impacts. A range of alternatives should be fully and fairly assessed – even if those alternatives only partially meet the purpose and need – in order to provide a useful evaluation of the relative environmental impact from 21
meeting the need, and determine not only the best balance between environmental conservation and meeting the need, but the relative value of meeting the need as now conceived. An examination of the relative impacts of alternatives that partially meet the need will be valuable in identifying the cost society at large or even proponents are willing to incur to meet particular, often subjective, "needs."

Certainly, a reasonable description can be provided for the elimination of chinook hatchery production in Puget Sound and Hood Canal and for the attendant development of a transitional fishery regime that would direct harvest at the remaining returning hatchery adults. It would seem that NOAA is required under NEPA to provide such a description.

NOAA proceeds to assert that the alternative is technically infeasible to assess due to the imperfect ability to distinguish returning adult hatchery chinook from natural-origin chinook. The statement is a *non sequiteur*. If hatchery fish are not produced (the case under the proposed alternative here at issue) there is no issue as to whether hatchery fish can or cannot be distinguished. Under a charitable reading of the proposal in which a transitional harvest regime would be established to harvest the remaining returning cohorts of hatchery chinook, NOAA's assertion is patently false in as much as all returning adult Puget Sound and Hood Canal hatchery 22
chinook beginning with the current year (2004) are expected to be 100% marked so as to be entirely distinguishable from natural-origin adults.

Consequently, the authors of the DEIS here simply fail to establish the claim that such an alternative "is not reasonable or practicable".

The passage from page 2-3 quoted above continues as follows:

> Finally, most of the reasons suggested for including this alternative (broodstock take, prey competition, loss of genetic fitness, and migration barriers) are not affected by fishery activities. An analysis of harvest activities will only provide information about the change in 23
> escapement, catch and exploitation rate, and would not provide the information necessary to address the reasons given for the request. These issues would be more appropriately addressed in a National Environmental Policy Act analysis of proposed hatchery operations,

> if necessary. A pending National Environmental Policy Act review is currently under development for the Puget Sound salmon hatchery program. Fishery-related hatchery issues, such as straying and possible over-fishing, are addressed in the alternatives evaluated in this Environmental Impact Statement. Therefore, it is not necessary to develop and analyze an additional alternative in order to evaluate them. (2-3).

It is simply false that harvest activities do not affect either broodstock take or genetic fitness of hatchery or wild chinook populations. For example, the Independent Science Advisory Board -- an independent scientific panel that is advisory to NMFS and to the Northwest Power and Conservation Council for fishery management issues in the Columbia River Basin – in its extensive review of hatchery supplementation (“Review of Salmon and Steelhead 23
Supplementation”, ISAB 2003-03; June 4, 2003) presented and discussed at length a population model for integrated hatchery-natural-spawning populations that evaluates the fitness impacts on wild populations of hatchery operations that involve different levels of spawning of hatchery fish in the wild and incorporation of natural-origin spawners into the hatchery broodstock. Among the factors that affect the impact of hatchery operations on the fitness of naturally-spawning populations are the harvest rates on the natural-origin fish as a fraction of the harvest rate on the hatchery-produced fish. (ISAB 2003-03, Section 4, pp. 40 – 46. See also, Goodman 2003 and Goodman 2004, in review for a more extended and technical presentation of the model).

In addition, the distribution of harvest mortality not only affects escapement but, in the case of chinook salmon, can also affect the age-composition of the escapement. The age composition of spawning adults is an extremely important feature of chinook populations that is directly relevant to the survival and recovery of listed chinook that can be directly affected by harvest. Harvest 24
impacts on the number and the age composition of spawning chinook and on the proportion of naturally spawning fish that are of direct hatchery origin (F1 hatchery fish) are directly relevant to genetic fitness issues and are direct impacts of hatchery production for harvest augmentation. Analysis of harvest actions are, for this reason alone, directly relevant to the evaluation of the proposed no-hatchery augmentation alternative.

In the remainder of the quoted passage under discussion the DEIS implausibly asserts that the kinds of concerns that might motivate (and justify) consideration of the no-hatchery alternative are not appropriate concerns for a harvest EIS but rather for a review of “proposed hatchery operations, if necessary.” This makes little sense in view of NMFS admission in this very same passage that “many of these fish were produced specifically for harvest.” As we note below in 25
our discussion of the Economic Impacts Analysis, hatchery production in Puget Sound and Hood Canal is nearly entirely for the subsidization (augmentation) of harvest. It is principally harvest directed at hatchery stocks of chum, coho, and non-listed chinook in Puget Sound and Hood Canal that have direct impacts on the listed chinook populations for which Limit 6 take exemptions are being sought by the Preferred Alternative that has occasioned this DEIS. Put simply, hatchery production *is* a “fishery activity.”

Consideration of hatchery practices and their impacts on populations of the listed chinook ESU are directly relevant to the determination of the appropriate kind of harvest management plan, if any, that is compatible with the preservation and recovery of the ESU. Several scientific reviews 26
and independent review panels have made this point and have urged NMFS to consider

integrated recovery measures that consider both hatchery and harvest practices in conjunction
with habitat protection and restoration. In particular, the Salmon Recovery Science Review Panel
– an independent review expert body organized by the US National Academy of Sciences at
NMFS request to oversee the quality of the science employed by the regional Technical 26
Recovery Teams (TRT), including the Puget Sound TRT – has explicitly recommended this to
the Puget Sound TRT and NMFS, state, and tribal harvest managers (RSRP 2001).

Further, NOAA attempts to use assertions about the effects and impacts of various Puget Sound
hatchery programs to justify conclusions drawn in its Proposed Evaluation and Determination of
the RMP (the Proposed Action), even though, as the DEIS correctly notes, NOAA has not
completed either its NEPA or ESA evaluation of those programs. NOAA’s Sustainable Fisheries 27
Division cannot have it both ways; it cannot assert determinations regarding hatchery impacts it
considers supportive of its arguments and then reject responsibility for evaluating the ecological,
social, and economic impacts of those hatchery programs. Consequently, the casual dismissal of
the suggested no-hatchery augmentation alternative is unconvincing as well as arbitrary and
capricious.

<u>I-4. *Inadequate Range of Alternatives Considered in Detail:*</u> The DEIS considers four (4)
alternatives in some detail (DEIS Section 2). These include the co-managers’ RMP (the Preferred
Alternative), two escapement goal management alternatives, and a complete no-chinook harvest
alternative. This fails to provide an appropriate contrast among the considered alternatives with
regard to the maximum harvest impacts that a harvest management regime might embrace.
Clearly, many of the purely harvest-oriented elements of the purpose and need as it is 28
characterized by the DEIS (e.g., “optimization of harvest of abundant Puget Sound salmon
stocks”, “equitable sharing of harvest opportunity among tribes, and among treaty and non-treaty
fishers pursuant to <u>U.S. v Washington</u> and <u>U.S. v. Oregon</u>”) could be satisfied by even greater
levels of harvest than would generally be provided by the RMP. It is important to consider one or
more such alternatives, if for no other reason than to clearly delineate where – in the opinion of
the authors of the DEIS – the line is crossed with regard to satisfying ESA concerns for listed
Puget Sound chinook.

It is at the least somewhat odd that the Preferred Alternative is the most harvest-intensive of the
alternatives considered and the most risk-prone with respect to impacts on the survival and
recovery of the listed ESU and its component populations. This certainly suggest that the
Preferred Alternative provides no middle ground with respect to the kinds of risks and benefits 29
that are associated with mixed stock fisheries harvest regimes affecting ESA-listed stocks.

The DEIS frankly admits that the Preferred Alternative (take-authorization of the 2004 RMP) is
not the “Environmentally Preferable Alternative.” However, NOAA justifies its choice by
identifying Alternative 4 (no harvest) as the Environmentally Preferable Alternative and
dismissing it as incompatible with the Purposes and Needs, and describes at some length the
discretion is reserves for choosing a Preferred Alternative at odds with the most Environmentally 30
Preferable Alternative. Leave aside for the moment that the DEIS makes no very compelling
case that the Preferred Alternative meets all the standards of Purpose and Need significantly
more successfully that the Environmentally Preferable Alternative. Based on the standards that
would identify Alternative 4 as the Environmentally Preferable Alternative, *all* the alternatives

analyzed in the DEIS would be environmentally preferable to the Preferred Alternative. Some
discussion would seem warranted on the discretion available to NOAA in choosing a Preferred 30
Alternative that is the *least* environmentally preferable of every alternative analyzed.

I-5. <u>*Inadequate Consideration of the Preferred Alternative's Environmental Impacts:*</u> The
analysis of the Preferred Alternative fails to adequately consider or evaluate its full
environmental impacts, particularly the impacts of the RMP on Threatened Puget Sound
chinook. The description of the harvest regime proposed in the RMP is often confusing and
misleading. Some of these issues are addressed in the discussions of other key issues evaluated in
this review. Washington Trout has already submitted substantive comments to NOAA Fisheries
detailing our concerns regarding NOAA Fisheries' *Proposed Evaluation and Pending* 31
Determination on a Resource Management Plan (RMP), Pursuant to the Salmon and Steelhead
4(d) Rule (PEPD), the technical "Proposed Action" being evaluated in the DEIS at issue. That
review, *COMMENTS ON NOAA FISHERIES; SUSTAINABLE FISHERIES DIVISION Proposed*
Evaluation of and Pending Determination on a Resource Management Plan (RMP), Pursuant to
the Salmon and Steelhead 4(d) Rule (May 17 2004, Washington Trout), is attached as an
Appendix to these Comments and are herein incorporated by reference and should be evaluated
as part of Washington Trout's submitted comments on the DEIS.

I-6. <u>*Inadequate Description of the Alternatives:*</u> Alternative 2 is inadequately characterized in
such a way as to bias its evaluation. It is inappropriate, for example, to fail to employ estimation
of management imprecision in modeling projected escapements under all of the Alternatives
except Alternative 4, the No Harvest alternative. While there are good theoretical reasons for
adopting escapement-goal-based harvest management regimes under assumptions of perfect
management in which no escapement in excess of escapement goals would occur (pure threshold
harvesting) or in which only a specific proportion of the excess of potential escapement would be
harvest (proportional threshold harvesting) (cf., Lande et al. 1995 and 1997), in practice such
perfect implementation is not expected to occur. Consequently, harvest management regimes
must be adopted after taking into account the expectation that harvest regimes in any particular
year/season will not be perfectly implemented so as to achieve exactly the preseason estimate of
total escapement. Consideration of such imprecision affects both the choice of nominal 32
escapement target levels and modeled projections of the range and distribution of escapements
likely to be achieved over a period during which a particular management plan is to be
implemented.

By choosing to ignore these real-world complications by making the "simplifying" assumption that harvest management perfectly achieves the escapement targets in all years when population abundance is expected to exceed the escapement target, the contrast between Alternatives 2 and 3 on the one hand and the Preferred Alternative on the other with respect to conservation of populations of the listed ESU is considerably weakened. This further biases the presentation of Alternatives in favor of the Preferred Alternative.

The discussion of Alternative 2 (Escapement goal management at the management unit level
with no restriction on where fisheries may take place) is further unfairly simplified by the
assumption that under the six-year period of implementation considered in the DEIS projected 33
abundances are expected to be such as to permit principally terminal area (freshwater) fisheries

with only limited fisheries in mixed stock marine areas. The DEIS fails to consider the development and employment of modified or alternative fishing gears – such as “tangle nets” 34 and reduced set times or net lengths for purse seines – that may selectively harvest target species and stocks and non-lethally release non-targeted chinook stocks.

Failure to consider selective fishing gears also biases the description of Alternative 3 (Escapement goal management at the individual population level with terminal fisheries only), since in order for fisheries to take place under this alternative in estuaries and lower mainstem rivers that have multiple local populations of listed chinook (such as the Skagit and Snohomish 35 Rivers), selective fishing gears would have to be employed. In fact, the motivation for this alternative is the fact that this is the only approach that permits risk-averse escapement goal management to be implemented in the absence of the employment of selective fishing gears.

The descriptions and analyses of Alternatives 2, 3, and 4 are also deficient in failing to adequately describe and evaluate alternative uses of resources that might be expected to result from the adoption of a harvest management regime that is less resource intensive than the Preferred Alternative and in failing to estimate the benefits resulting from these alternative uses. 36 For example, monitoring and enforcement activities would be shifted and/or reduced under each of these alternatives in comparison to the Preferred Alternative. This will likely result in more efficient employment of human and financial resources and resulting cost savings will enable the co-managers to invest in alternative actions, including those that have conservation benefits for listed chinook.

II. Incomplete and Inadequate Evaluation of Economic Impacts

Section 3.6 of the DEIS “describes current conditions and recent trends in economic activity and value associated with commercial and sport fishing for salmon and steelhead in Puget Sound” (p. 3-125). Section 4.6 describes “the effects of the Proposed Action and alternatives on salmon commercial fisheries, salmon sports fisheries, and regional economies in the Puget Sound area. Economic impact indicators include sales by commercial salmon harvesters and processors, sales by businesses to sport fishing anglers, net economic values to commercial harvesters and processors, angler days, net economic values to sport anglers, regional employment and personal income levels” (page 4-129).

The descriptions of economic impacts under each of the alternatives are confined entirely to net economic benefits, principally net incomes. However, none of the descriptions or analyses contain any presentation of the costs of producing the fish harvested or the costs associated with managing the fisheries. Most important among these costs are the costs associated with the Puget Sound (including Hood Canal) hatchery facilities that subsidize a considerable proportion of the annual harvest of chum, coho and (non-listed) chinook salmon in Puget Sound, Hood Canal, and 37 the Strait of Juan de Fuca. It is simply improper to describe the various kinds of income reported in these sections to result from commercial and sport fisheries as *net* income without a proper accounting of *gross* economic returns and associated *costs* of producing the harvested products and of engaging in the fishing and fishing-related activities.

Consideration of the costs of producing the fish targeted for harvest is also necessary in order for the opportunity costs associated with those investments to be calculated and compared across the

alternatives to be evaluated. The complex of hatchery programs and facilities in Puget Sound and
Hood Canal is huge by any standard and extremely costly to operate. This complex represents a
huge subsidy to the commercial and sport fishing communities. Any putative calculation of the
net economic benefit arising from Puget Sound fishing activities is incomplete and seriously 38
misleading if the costs of hatchery production are ignored as they are in the DEIS. This is a
fundamental violation of NEPA standards and requirements.

Consideration of the costs of producing hatchery fish for harvest is also necessary to evaluate the
opportunities for alternative investment in activities that promote the conservation and
productivity of naturally-produced (including ESA-listed) salmon populations in Puget Sound
and Hood Canal that may be made with monies that may be made available by reductions in
Puget Sound and Hood Canal hatchery programs as a result of the adoption of alternative other
than the Preferred Alternative. Such opportunities are legitimate potential benefits of the 39
alternatives in comparison to the Preferred Alternatives. By failing to consider the costs of
hatchery production associated with the *status quo* and, hence, with the Preferred Alternative, the
economic analyses in sections 3 and 4 fail to properly consider and evaluate the full economic
benefits that may reasonably be associated with one or more of the alternatives.

For these reasons alone, the DEIS fails to comply with NEPA requirements and should be withdrawn.

CONCLUSION

In view of considerable deficiencies and omissions this review has identified in the DEIS,
Washington Trout finds the document unacceptable and out of compliance with NEPA 40
standards. The DEIS should undergo significant revision before it can be finalized. The
dismissals of several potential alternatives to the Proposed Action that were proposed in scoping 41
appear to be arbitrary. The DEIS fails to consider and analyze the alternatives to the Preferred
Alternative in sufficient detail and without bias. The analysis of the Preferred Alternative fails to 42
adequately consider or evaluate its full environmental impacts, particularly the impacts of the 43
RMP on Threatened Puget Sound chinook. The economic analyses and the evaluation of the
affected environments in the DEIS fail to include any evaluation of the full economic, social, and 44
environmental costs of chinook harvest under each of the Alternatives.

The DEIS fails to make a compelling extra-biological case for accepting potentially unacceptable 45
levels of risk in the Preferred Alternative. NOAA’s various and sometimes conflicting
responsibilities concerning Puget Sound chinook must be reconciled, but that reconciliation does 46
not always or automatically require the imposition of extra or undue risk on the PS chinook ESU.

Washington Trout respectfully recommends that NOAA Fisheries substantively revise the DEIS,
requesting additional information and appropriate changes in the RMP from the co-managers 47
before a final NEPA determination is developed.

REFERENCES

Goodman, Daniel. 2003. “Salmon supplementation: demography, evolution, and risk assessment”. Paper presented at American Fisheries Symposium on Propagated Fishes in Resource Management, Boise, Idaho, June 16, 2003.

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Salmon Recovery Science Review Panel. 2002. Report of the meeting held August 27 – 29, 2001. Northwest Fisheries Science Center, National Marine Fisheries Service, Seattle, Washington. 18 pages.

ATTACHMENTS

The following documents inform and supplement this review. They should be considered integral components of this review and evaluated and recorded accordingly. 48

1. *COMMENTS ON NOAA FISHERIES; SUSTAINABLE FISHERIES DIVISION Proposed Evaluation of and Pending Determination on a Resource Management Plan (RMP), Pursuant to the Salmon and Steelhead 4(d) Rule* (May 17 2004, Washington Trout)
2. Selected References (references cited in this review and in #1, but not attached, should also be considered and recorded as integral components of this review).
   a. *ARTIFICIAL PRODUCTION REVIEW - ECONOMICS ANALYSIS PHASE I*: IEAB Task 56, July, 2002.
   b. *Independent Science Advisory Board (ISAB) 2003. Review of Salmon and Steelhead Supplementation.* ISAB document number 2002 – 3.
   c. Lande, Russell, Bernt-Eric, Saether, and Steinar. Engen. 1997. *Threshold Harvesting For Sustainability of Fluctuating Resources*. Ecology 78(5): 1341-1350.
   d. Salmon Recovery Science Review Panel. 2001. *Report of the meeting held August 27 – 29, 2001. Northwest Fisheries Science Center, National Marine Fisheries Service, Seattle, Washington.* 18 pages.

RESPONSE TO COMMENTS RECEIVED FROM WASHINGTON TROUT (WT)

In addition to the comments to which NMFS responds below, Washington Trout also included a more technical set of comments (Washington Trout Part 2. Proposed Alternative) which were identical to those submitted by Mr. Sam Wright, addressed previously in this FEIS. Therefore the reader is referred to the Response to Comments Received from Sam Wright (SW).

WT-1

NMFS agrees that Washington Trout's complaint challenging NMFS' 2001 determination under the 4(d) rule on the Puget Sound harvest Resource Management Plan (RMP) was based in part on its assertion that NMFS' determination violated NEPA (Washington Trout v. Lohn, No. C01-1863R (W.D. Wash.)). NMFS and Washington Trout settled that case by NMFS' agreement to prepare an EIS on its 2004 RMP determination. The parties subsequently agreed to give NMFS one additional year to complete this EIS.

WT-2

According to CEQ Regulations, "The EIS shall succinctly describe the environment of the areas affected or created by the alternatives under consideration" (40 CFR 1502.15). The alternatives under consideration are relevant to implementation of the 2005–2009 Resource Management Plan, not the 2001 Resource Management Plan. To provide a meaningful and accurate analysis of environmental impacts resulting from the Proposed Action, the EIS must first describe the current environmental conditions that would potentially be altered. Describing historical conditions that have since changed would not provide an appropriate baseline from which to compare anticipated future changes. While a discussion of historical, 2001 conditions may provide background information, it would do little to assist with an analysis of incremental changes expected to occur between current conditions and future conditions of the Affected Environment under the Proposed Action or any of the alternatives.

WT-3

See response to comment WT-2.

WT-4

Comment noted, but NMFS respectfully disagrees. NMFS see this as a statement of fact in that it describes what the measures are intended to do as defined by the Resource Management Plan. It is not meant to infer that this will be accomplished, since that is the subject of NMFS' evaluation of the Proposed Action (the Resource Management Plan), or to infer that the implementation, monitoring and evaluation procedures of the other alternatives are not designed to ensure fisheries managed under those alternatives would be consistent with the same objectives for conservation and use.

WT-5

These constraints are not meant to be quantitative and comparable objectives for implementing the Purpose and Need. Rather, they provide parameters from which the implementation of the Proposed Action must occur. NMFS believes that "risks" can be managed in a manner that "optimizes" abundance, protects weaker stocks and provides "equitable" harvest sharing because there are various ways to manage a fishery to ensure these outcomes.

WT-6

CEQ Regulations do not require that the components of the Purpose and Need be prioritized. The list provides constraints and not objectives that must be met. CEQ Regulations require only that "the [EIS] shall briefly specify the underlying purpose and need to which the agency is responding…"(40 CFR 1502.13).

WT-7

It is unclear from this comment in which section of the DEIS the commentor finds this argument. The DEIS does not argue that only the Preferred Alternative meets the Purpose and Need for the Proposed Action. With one exception, any of the alternatives would meet the Purpose and Need, which is the basis for determining which alternatives to analyze in an EIS. The DEIS discloses that Alternative 4 would not meet the Purpose and Need and the reasons why it would not. However, inclusion of Alternative 4 in the analysis was required as part of a settlement agreement with the commentor (Washington Trout) as described in DEIS Subsection 2.3, *Alternatives considered in Detail*.

WT-8

See response to comment EPA-1.

WT-9

NMFS considered the tribal-only fisheries alternative but eliminated it from detailed study for the reasons described in DEIS Subsection 2.2.1, *Tribal-Only Fisheries*.

WT-10

NMFS does place high importance on its trust responsibilities to the tribes. NMFS does not agree, as the commentor seems to imply, that the fishing impacts expected under the Preferred Alternative are above those that would be consistent with its trust responsibility. DEIS Subsection 4.4, *Tribal Treaty*

Rights and Trust Responsibility, discusses each alternative relative to tribal treaty rights and NMFS' trust responsibility. The DEIS concluded that "the Proposed Action [Preferred Alternative] was predicted to be consistent with the federal trust responsibility to protect and provide tribal fishing opportunities." NEPA requires identification of reasonable alternatives that are consistent with the purposes and needs of the Proposed Action. In this case, those include the protection of tribal treaty rights and NMFS' trust responsibilities, and meeting ESA criteria as defined by Limit 6 of the 4(d) Rule. NEPA does not require evaluation of alternatives for the sole purpose of defining what fishing level is required to satisfy NMFS' trust responsibilities, or to evaluate the value of one element of the Purpose and Need against another. See also response to comment WT-21.

WT-11

Comment noted, but NMFS respectfully disagrees and finds the original reasons for eliminating the alternative from detailed study are still relevant (see Subsection 2.2.1 of the DEIS). See also response to WT-10.

WT-12

WDFW would not be prevented from collaborating with the tribes in the development of a tribal-only fishery proposal to provide to NMFS for consideration under the 4(d) Rule (personal communication with Teresa Scott, WDFW, Natural Resources Policy Analyst, September 2, 2004). However, providing a tribal-only proposal under Limit 6 would not be consistent with elements of the stated Purpose and Need for the Proposed Action: 1) provides for tribal and non-tribal fishing opportunity co-managed under the jurisdiction of U.S. v. Washington, and 2) provide equitable sharing of harvest opportunity among tribes, and among treaty and non-treaty fishers pursuant to U.S. v. Washington and U.S. v. Oregon. In other words, it would not be consistent with the Purpose and Need for the Washington Department of Fish and Wildlife and the Puget Sound tribes to put forward a joint plan under Limit 6 that would include no provision for non-tribal fishing. A fishery plan involving tribal-only fisheries would reasonably be expected to be provided to NMFS for evaluation under the Tribal 4(d) Rule.

Also response to comment WT-16.

WT-13

See response to comment WT-12.

WT-14

See response to comment WT-12.

WT-15

Under NEPA, the alternatives are chosen based on the Purpose and Needs of the Proposed Action as described in DEIS Subsection 1.3. NMFS' primary mandates are to 1) carry out its trust responsibilities; 2) apply the Endangered Species Act; and, 3) provide for sustainable fisheries and comply with the various federal laws and executive orders described in DEIS Appendix F. These mandates are not mutually exclusive. NMFS sees no conflict between its primary mandates and the Purpose and Needs for the Proposed Action, or with the range of alternatives in the DEIS (with the exception of Alternative 4; see discussion in DEIS Subsection 2.3, *Alternatives considered in Detail*).

WT-16

As described originally by the commentor during public scoping for the EIS in August 2003, the tribal-only alternative would provide the 4(d) Rule take limitation on harvest activities only for treaty tribal fishing, would estimate the level of tribal fisheries required to satisfy federal trust responsibilities to the Puget Sound treaty tribes, and would configure those fisheries for all salmon species. Non-tribal fisheries were not included in the description of the alternative (Washington Trout 2003). NMFS is confused by this comment because it is inconsistent with the description of the alternative provided by the commentor in August 2003, and with comments previously submitted by the commentor(see responses to comments WT-10, WT-11, and WT-15). Also see responses to comments SW-31 and WT-19.

The range of alternatives considered by NMFS emphasized types of management frameworks that would best achieve the conservation objectives and maximize use of the resource. Salmon abundance is highly variable from year to year, both among chinook salmon populations and other salmon species, requiring managers to formulate fisheries to respond to the population abundance conditions particular to that year. Therefore, the alternatives provide several harvest management frameworks within which the co-managers would develop their annual action-specific fishing regimes to protect Puget Sound chinook salmon and meet other management objectives. Except as needed to comply with the settlement agreement reached in Washington Trout v. Lohn, the alternatives considered did not include such specific details of an annual fishing regime as where and when fisheries occur; what gear will be used; or how harvest will be allocated among gears, areas or fishermen.

The commentor has now suggested a new alternative that would combine a tribal-only pre-terminal fishery with tribal/recreational non-tribal terminal fishery alternative. Unfortunately, not enough details are provided by the commentor to evaluate this alternative. Modelers need a description of key management criteria before they can shape the model runs and analyze an alternative; e.g., the type of management objectives, the resolution of management (population or management unit), the fishing response to low abundance. The commentor's proposal is simply a tribal and non-tribal fishing plan, and does not describe any conditions or limitations to fisheries or fishing impacts when low abundances would warrant additional protective measures. If the key management criteria/values from the Proposed Action (Alternative 1) or the fixed escapement goal approach (Alternative 2 or 3) were applied to this proposed tribal and non-tribal fishing plan, the end result on chinook salmon population status would be very similar to the outcomes in the original alternatives evaluated in the DEIS. For example, if it were based on fixed-goal management, the results would be very similar to Alternative 2 or 3 because, as in those alternatives, the abundance for several management units would be insufficient to allow fishing in pre-terminal areas. Such management guidance was not provided by the commentor for this proposed alternative.

Without elaboration on key management criteria pertaining to chinook salmon population status, the new proposal is, in essence, a redistribution of harvest between tribal and non-tribal users rather than a new type of conservation measure or management framework for Puget Sound chinook salmon. This stands in contrast to the alternatives that were included in the DEIS, where the guidance provided by the settlement agreement pursuant to Washington Trout v. Lohn made clear the difference in conservation approach to be applied for each alternative.

WT-17

The requirement for reasonable regulation of non-tribal activities as it relates to the discussion of Alternative 4 and the provisions of the Secretarial Order does not make consideration of the further restriction of non-tribal fisheries or even tribal-only fisheries a reasonable alternative to the Proposed Action considered in the DEIS. Alternative 4 would close all salmon and steelhead net fisheries that would take listed chinook salmon. The Secretarial Order provides that before further restricting tribal fisheries, as would occur under Alternative 4, NMFS must explore whether the necessary reductions could be achieved through reasonable restriction of non-tribal fishing activities. Such additional restriction of the non-tribal fishery would occur if NMFS concludes that the action as proposed would cause jeopardy to listed species; i.e., the conservation purpose of the restriction cannot be achieved by reasonable regulation of non-tribal activities and the restriction is reasonable and necessary for conservation of the species at issue. As discussed in DEIS Section 5, *Identification of the Environmentally Preferable and Agency Preferred Alternatives*, NMFS' evaluation of the Proposed Action (Alternative 1) concluded that it would not jeopardize listed Puget Sound chinook salmon (NMFS 2004). Therefore, further restrictions of either the tribal or non-tribal fisheries would not be necessary for the Puget Sound Chinook ESU. The original reasons cited in the DEIS (Subsection 2.2.1) for elimination of this alternative still apply. Also see responses to comments WT-10 and WT-15.

WT-18

NMFS cannot say what alternative Resource Management Plans the co-managers may or may not be inclined to consider. NMFS does not view a tribal-only alternative (as originally described; see DEIS Subsection 2.2.1) as a reasonable alternative. A tribal-only fishery alternative is not consistent with two elements of the Purpose and Need: 1) provides for tribal and non-tribal fishing opportunity co-managed under the jurisdiction of U.S. v. Washington; and 2) provide equitable sharing of harvest opportunity among tribes, and among treaty and non-treaty fishers pursuant to U.S. v. Washington and U.S. v. Oregon. NMFS considers a tribal-only alternative to be unreasonable because the State of Washington would not agree to it, as a co-manager of the Puget Sound fisheries under U.S. v. Washington and the Puget Sound Salmon Management Plan, nor would it have any obligation or incentive to agree to tribal-only harvest, under the treaty rights allocation principles of U.S. v. Washington. That is why these provisions were explicitly included as elements of the Purpose and Need. Tribal-only fishing plans would more likely be submitted under the Tribal 4(d) Rule.

The inclination on the part of the applicants to consider an alternative different from what they have proposed is not what makes an alternative unreasonable under NEPA. It is whether it meets the Purpose and Need of the Proposed Action, and whether it is feasible to implement, that determines whether it is a reasonable alternative to evaluate in the DEIS.

WT-19

In responding to comments or analyzing additional alternatives, NMFS must use the guidance provided to it and cannot assume a commentor meant something else. The request provided by Washington Trout to NMFS through public scoping was “Since the desire for harvest is the justification for hatchery operations, the impacts of hatchery operations should be evaluated in this EIS through the analysis of an alternative harvest regime that does not include hatchery augmentation”(Washington Trout 2002). The fact that, in practical terms, there would not be an instantaneous elimination of all hatchery fish from Puget Sound (the Pacific Coast is irrelevant since the proposed action affects only Puget Sound fisheries) was taken into account in NMFS’ original reasons for eliminating this suggestion from detailed analysis (see DEIS Subsection 2.2.2, *No Hatchery Augmentation*). There would not be a significant difference between a no-hatchery alternative and the Proposed Action for the duration of the Proposed Action (2005–2009).

WT-20

Section 2 of the DEIS clearly states that the alternatives must fit the Purpose and Need for the Proposed Action. Section 1.3 describes each element of the Purpose and Need for the Proposed Action. These statements and descriptions are meant to provide the public and other federal agencies with the information needed to shape and suggest additional alternatives.

WT-21

While the analysis suggested in this comment may be informative for other purposes, it is not consistent with NEPA as applied to the assessment of the Proposed Action. NMFS agrees with the commentor that the EIS should "further the aims and purposes of NEPA that a consideration of environmental impacts provide a reasonable spectrum of alternative ways that *might* succeed in meeting the broad purposes of a proposed action while minimizing or eliminating undesirable collateral impacts… in order to provide a useful evaluation of the relative environmental impact from meeting the need, and determine….the best balance between environmental conservation and meeting the need…." The Purpose and Need is defined by the agency and applicants preparing to make the decision; in this case, NMFS and the co-managers. Section 2 of the DEIS describes the range of alternatives that would meet the purpose and need; Section 4 of the DEIS discusses the environmental impacts of each alternative; and Section 5 of the DEIS and the Record of Decision describe the basis of NMFS' decision in terms of the balance between environmental conservation and resource use. It is unclear what is meant by "the relative value of meeting the need as now conceived," as the purpose of the EIS is to make a decision that balances environmental conservation with other elements of the Purpose and Need (taking into account cultural and economic resources as well as biological).

Alternatives that meet only a part of the full Purpose and Need are not reasonable in that they do not provide decision makers with the full range of information and a full and fair disclosure of the impacts of a range of reasonable alternatives designed to accomplish the agency's goal, i.e.; to meet the Purpose and Need for the Proposed Action (CEQ Regulations §1508.23). Evaluation of such alternatives would result in the needless generation of paperwork and accumulation of extraneous background data, and would not emphasize those alternatives that would achieve the goal (CEQ Regulations §1500.1[c] and §1500.2[b]). However, NEPA does require that the EIS discuss the reasons why some alternatives were eliminated from detailed analysis (CEQ Regulations §1502.14). The no-hatchery alternative was considered but eliminated from further analysis for a variety of reasons. The reasons for the elimination of this alternative are described in DEIS Subsection 2.2.2. (Also see responses to comments NFS-9, WT-24 through 27.)

WT-22

Although most Puget Sound hatchery chinook salmon are currently mass-marked, some Puget Sound facilities will not have all ages of mass-marked chinook returning until 2008 at the earliest. The Proposed Action covers the transitional period that ends with 100 percent mass-marking of hatchery fish. NMFS agrees that the majority of returning Puget Sound and Hood Canal hatchery chinook will be mass-marked by 2004 so that they could be distinguished in future years. However, that information is not available for a sufficient number of Puget Sound chinook salmon populations to use to model and evaluate the Proposed Action or its alternatives at this time. That information is important to determine how many of the hatchery adults would have survived in order to remove them from the returning adult aggregate in order to model a no-hatchery alternative.

WT-23

The genetic impacts of varying levels of naturally-spawning hatchery chinook salmon on natural populations will be evaluated through NMFS on-going Puget Sound hatchery program EIS process. Effects of incorporation of natural-origin spawners into hatchery broodstocks on the genetic characteristics of hatchery populations, and on the abundance of donor natural populations, will also be evaluated in the hatchery EIS. These evaluations will account for expected variations in hatchery and natural-origin chinook salmon proportions, driven by natural environmental conditions, hatchery production levels proposed under the alternatives evaluated in the EIS, and by harvest rates levied by fisheries with which the hatchery programs are integrated.

WT-24

NMFS agrees that fishery activities might affect the number and age composition of spawning Puget Sound chinook salmon and the composition of the spawning population. These effects are discussed in DEIS Subsections 4.3.1, 4.3.2, 4.3.5 and 4.3.7. It is not necessary to analyze a no-hatchery augmentation alternative to assess these fishery-related effects of the Proposed Action and its alternatives. NMFS is currently evaluating the effects of Puget Sound hatchery programs through a separate EIS. That EIS will also consider effects on harvest from the implementation of various Puget Sound hatchery production alternatives. See response to WT-23.

WT-25

Section 1502.16 of CEQ Regulations states that "The discussion [of environmental consequences] will include the environmental impacts *of the alternatives including the proposed action* [emphasis added], any adverse environmental effects which cannot be avoided should the proposal be implemented, the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and any irreversible or irretrievable commitments of resources which would be involved in the proposal should it be implemented." In its request for a no-hatchery alternative during public scoping, Washington Trout stated "Hatchery operations hurt listed fish by taking them for broodstock, releasing hatchery fish that compete with and prey upon listed fish, causing loss of genetic fitness as a result of interbreeding, and physically blocking migration at certain hatchery locations. Furthermore…justified levels of harvest…"(Washington Trout 2002). It is outside the scope of the Proposed Action to evaluate the broader effects of hatcheries; and most of the reasons suggested for including this alternative (broodstock takes, prey competition, loss of genetic fitness, and migration barriers) are not affected by fishery activities. Consequently, the DEIS discusses the effects of hatchery programs that would be expected to occur as a result of the Proposed Action and its alternatives, such as straying (DEIS Subsection 4.3.7), and possible overfishing (DEIS Subsections 4.3.1, 4.3.2, 4.3.5 and 4.3.7). However, as the commentor is aware, NMFS is evaluating the effects of Puget Sound hatchery programs under a separate EIS. That EIS will also consider effects on harvest from the implementation of various Puget Sound hatchery production alternatives. See response to comment WT-23.

Finally, even if the hatchery programs were discontinued in 2005, substantial numbers of hatchery fish from previous hatchery releases will return to Puget Sound in 2005 and over the next several years. Given that these fish will return independently of the conduct of future hatchery programs, it is not reasonable to expect that the co-managers would develop a Resource Management Plan that did not provide for harvest of these hatchery fish in the interim, particularly since many of these fish were produced specifically for harvest.

WT-26

The commentor is correct that the Recovery Science Review Panel has emphasized integrated recovery measures in the context of developing recovery plans. Consistent with these recommendations, NMFS is currently involved as part of a Puget Sound-wide effort to develop a recovery plan for listed Puget Sound chinook salmon that will integrate hatchery, harvest and habitat recovery actions. However, that effort is outside the scope of the Proposed Action, which is the implementation of a fishery management plan for salmon fisheries in Puget Sound over the next five years. The DEIS acknowledges this planning activity and the implications to future harvest activities in DEIS Subsection 4.3.1, *Threatened and Endangered Fish Species*.

The conservation standards used to assess the four alternatives in the DEIS also take into account the effects of hatchery programs and habitat conditions as described in DEIS Appendix C2. Where sufficient information is available, NMFS has developed population-specific conservation standards that include consideration of freshwater and marine environmental conditions and focus on the effect of harvest on naturally-produced salmon.

Also see responses to comments WT-23 through WT-25.

WT-27

See response to comment WT-22 through WT-26, and DEIS Subsection 2.2.2, *No Hatchery Augmentation*.

WT-28

NMFS analyzed the alternatives identified during scoping that were reasonable, technically feasible, and consistent with the Purpose and Need of the Proposed Action. NEPA does not require that the Proposed Action fall within the middle ground of all alternatives analyzed, and does not support the concept of analyzing alternatives that would result in greater environmental impacts than would occur under the Proposed Action (such as increased harvest beyond the proposed levels). CEQ regulations require that the action agency identify a reasonable range of alternatives (CEQ Regulations §1502.14), and that the agency thoroughly assess the impacts of the Proposed Action and identified alternatives on the natural, human, and built environment (CEQ Regulations §1502.16). Recall that the federal action under consideration through NEPA is the 4(d) determination on the Puget Sound Chinook Resource Management Plan (RMP). NMFS must evaluate the harvest management plan that is provided to it by the co-managers. If NMFS finds that the Proposed Action meets the criteria of Limit 6 of the 4(d) Rule and will not appreciably reduce the likelihood of survival and recovery of the affected ESU, then it must issue that finding. NMFS' evaluation of the RMP concludes that it would not appreciably reduce the likelihood of survival and recovery of the Puget Sound Chinook ESU. The CEQ regulations do not require that the lead agency impose an activity or alternative that is more impactful in scope than that being proposed by the applicant. Given the complexity of the Puget Sound Chinook ESU, there are multiple scenarios that would meet ESA requirements for the ESU; however, satisfying ESA concerns is only one element of the Purpose and Need of the Proposed Action. (Also see responses to comments WT-5, WT-6 and WT-21.)

Further, NMFS is confused by the commentor's suggestion for a more liberal fishing alternative than the Proposed Action, since this suggestion is contrary to the commentor's own subsequent comments suggesting that the Proposed Action would result in "potentially unacceptable levels of risk." (See comments WT-29, WT-30, WT-45 through WT-46.)

WT-29

See response to WT-28.

WT-30

NMFS agrees that based on its choice of criterion to choose the Environmentally Preferable Alternative, Alternatives 2, 3, or 4 would result in less biological impacts to some resources than Alternative 1, the Preferred Alternative. Section 1505.2(b) of CEQ Regulations requires that the Record of Decision identify which alternative or alternatives are considered to be environmentally preferable based on which would best express the national environmental policy as expressed in Section 101 of NEPA. CEQ's 40 Most Asked Questions states that "Ordinarily, this means the alternative that causes the least damage to the biological and physical environment; it also means the alternative which best protects, preserves and enhances historic, cultural, and natural resources" (CEQ 40 Most Asked Questions 6a). Based on CEQ Regulations, NMFS was conservative in its choice of the Environmentally Preferable Alternative by basing it only on the effects of the biological and physical environment. More broadly inclusive criteria would have made Alternative 1 the Environmentally Preferable Alternative, since Alternatives 2, 3 or 4 clearly would not "protect, preserve or enhance" the cultural and historic resources represented by the exercise of tribal treaty fishing rights. Under the broader, more inclusive interpretation of CEQ Regulations, Alternative 1 would be both the Environmentally Preferable and Agency Preferred Alternative.

CEQ's Forty Most Asked Questions 6a goes on to acknowledge that "The Council recognizes that the identification of the environmentally preferable alternative may involve difficult judgments, particularly when one environmental value must be balanced against another. However, NEPA does not require that an agency adopt the most environmentally preferable alternative but that the impacts are disclosed in a full and fair manner" (CEQ Regulations §1502.9 and 15002.16), and that the agency provides a clear record of the basis of its decision, "including consideration of economic and technical considerations and agency statutory missions"(CEQ Regulations §1505.2[b]). NMFS believes it has fully disclosed the expected impacts resulting from an alternative that is not the environmentally preferred, as required by CEQ Regulations.

WT-31

These comments have been addressed as part of NMFS' 4(d) evaluation process of the Puget Sound Chinook Harvest Resource Management Plan provided to it by the co-managers (the Proposed Action), and are attached as Appendix A to the Record of Decision.

WT-32

Management error is not incorporated in modeling any of the alternatives in the DEIS, including the Proposed Action. In this way, the alternatives are treated exactly the same. Instead, management error is incorporated into the development of harvest management objectives and the evaluation of the various management strategies represented by the different alternatives. Robustness of the different alternatives to management error is briefly described in DEIS Subsection 4.3.8.1, Indirect Effects. However, NMFS has expanded the discussion in Subsection 4.3.8.1 in FEIS Volume 2 to provide more detail on this subject.

WT-33

Since all marine area fisheries in Puget Sound are mixed-stock fisheries to a varying degree, including terminal fisheries where non-local stocks from a variety of areas are commonly found, fishing opportunities under Alternative 2 or 3 would likely be limited to the freshwater areas where only the local stock is present, given the abundances anticipated during the five years of the Proposed Action (2005–2009). The escapement goal-based alternatives were described as management for the weakest population with “no fishing” as the fishing level at low abundance. Describing special cases/conditions under “escapement goal management” where some fishing in Puget Sound would be intentionally allowed on stocks without harvestable surplus could result in a multitude of alternative variations that would need to be analyzed, for which the commentor provides no guidance. The simple terms that might be used to describe special cases like “incidental only” or “limited impact” are judgment calls that are open to interpretation. (Also see response to comments SW-1B and 1E and NFS-5, and DEIS Subsection 4.2 that provides rationale behind choice of abundance during the implementation period of the Proposed Action.)

WT-34

Alternative fishing gears such as “tangle nets” are not specifically addressed in the Proposed Action being evaluated by NMFS for ESA approval. Many gear-related measures have been and would be implemented under the Proposed Action that reduce mortality on released animals (including chinook salmon), or reduce such encounters (as with seabirds). Limitations on set time or net length can reduce fishing effort (and therefore, overall catch), but do not contribute to increased selectivity of that gear (i.e., do not increase the selectivity of the catch).

Purse seines, reef nets, beach seines and angling gear are highly selective gears from which non-targeted fish or species can be released with low incidental mortality. There are a number of selectivity measures being implemented for the current gears employed by the co-managers; for example:

a) Recovery boxes: Commercial purse seines, gillnets and reef nets use recovery boxes when release of certain fish is required; i.e., non-tribal purse seine and gillnet fisheries in Marine Catch Areas 7 and 7A during the time chinook and coho salmon are present. Recovery boxes allow fish to recover from handling prior to being released. Studies show released fish survive better when recovery boxes are used.

b) Reef net selective release: Reef net gear maintains a targeted fishery on abundant sockeye and coho salmon in Area 7, because survival from that gear of fish required to be released is very high.

c) Cut meshes: Gillnetters are required to cut net meshes in order to release non-target species. Fish released from a gill net under typical methods do not exhibit high survival. Cutting meshes to release the fish significantly reduces trauma to the animal, and improving survival.

d) Special Recreational Handling Rule: In Marine Catch Areas 1 through 6 and 13, and in two Puget Sound freshwater fisheries: it is illegal to bring a wild salmon, or a species of salmon, aboard a vessel (or otherwise "land") if it is unlawful to retain those salmon. This provision reduces trauma to released fish, thus increasing post-release survival. Depending on the success of these fisheries, they might be expanded in the future.

All implementation of selective fishing gear has some associated mortality associated with it, even if it is very low (Columbia River Compact 2004; Ruggerone and June 1996; Vander Haegen 2002a; Vander Haegen 2002b; Vander Haegen 2001; Vander Haegen 2003; also see Appendix B of the Proposed Action in DEIS Appendix A). Because of the associated non-retention mortality, fisheries could not occur, even with the use of selective gear, under Alternative 2 or 3 when abundance is below the spawning escapement objective for either management units (Alternative 2) or populations (Alternative 3).

WT-35

See response to comment WT-34. Given that non-retention mortality occurs with the use of any selective gear, it is unclear what the commentor means by "…the motivation for this alternative is the fact that this is the only approach that permits risk-averse escapement goal management to be implemented in the absence of the employment of selective fishing gears."

The conservation objectives of the Proposed Action do not distinguish between fish caught in saltwater or freshwater, by nets or by sport gear, for personal consumption or for commercial sale, as a result of landing or release. An adult fish killed after being released in the Strait of Juan de Fuca sport fishery is no different from an adult fish killed in a Skagit River sport or net fishery. There is no biological reason to distinguish among these impacts. The question of where the impacts take place, and by what gear, is more often a question of allocation and increased opportunity than conservation. It is the harvest management objectives that limit the impacts to the populations.

WT-36

There are so many demands for the limited funds and staff available for natural resource management that the state and tribes would have no trouble finding alternative uses for those funds and staff. For example, a vast majority of tribal resources are already devoted to non-salmonid fisheries, research, and recovery planning. It is likely that tribal shell fisheries management alone could use any surplus resources, even if salmon fisheries were generally closed. The DEIS states that enforcement activity may be reduced, but it would not be eliminated altogether since some enforcement is required to monitor compliance with fishery closures. Any displaced salmon fishery enforcement would likely be redirected to enforcement of other fish and wildlife rules.

NMFS agrees that state and tribal resources usually spent on fishery monitoring would likely be shifted to resource monitoring (see DEIS Subsection 2.3.2 through 2.3.4). In any case, the costs would be expected to be the same (personal communication with Teresa Scott, WDFW, Natural Resources Policy Analyst, July 27, 2004, and Will Beattie, NWIFC, Conservation Management Coordinator, July 27, 2004). NMFS is not clear what alternative actions are being suggested that have conservation benefits for listed chinook salmon. On the other hand, there can be no doubt that additional resource monitoring funds would benefit chinook salmon, and other listed fish and wildlife throughout Washington (Washington Monitoring Oversight Committee 2002).

WT-37

Although the economic analysis evaluates net economic benefits, the descriptions of economic effects are not confined to net benefits. Measures of gross economic returns evaluated in the Puget Sound Chinook Harvest DEIS include sales of commercially-harvested salmon, trip-related sales to anglers, and effects on personal income and employment associated with these sales.

Costs associated with hatchery facilities are not reported because none of the alternatives is expected to substantially affect hatchery production and operations, particularly over the five-year period when the Proposed Action will be in effect (2005–2009). The effect of potential changes in hatchery operations in the Puget Sound area is the subject of an EIS currently being prepared by NMFS, in conjunction with the Washington Department of Fish and Wildlife and the Puget Sound treaty tribes. Changes in hatchery operations may occur in the future in response to the outcome of the hatchery EIS, other state or tribal objectives or newly available information, but the effect of implementing any of the alternatives for the Puget Sound Chinook Harvest Resource Management Plan EIS on changes in hatchery operations is considered speculative and unlikely to occur within the time frame of the Proposed Action.

NMFS acknowledges that the costs associated with managing the fisheries affected by the Proposed Action could be impacted by the alternative implemented. These costs, which are borne primarily by the State of Washington and the Puget Sound Tribes, include expenditures for pre-season planning, in-season management, sampling, monitoring, evaluation and enforcement. For the Washington Department of Fish and Wildlife (WDFW), costs for salmon management in marine waters are estimated to be about $300,000 per year, and costs for salmon fishery sampling in marine waters are estimated to be about $562,000 per year. Information is currently unavailable on management or enforcement costs incurred by the Puget Sound Tribes, or for enforcement by WDFW.

If salmon fisheries in Puget Sound closed or were dramatically reduced, as envisioned under the No-Fishing Alternative (Alternative 4), it can reasonably be assumed that resources used by the State and tribes to manage or enforce those fisheries would be re-directed toward management and enforcement of other fisheries in the Puget Sound area, including shellfish or groundfish fisheries, or toward salmon research, habitat assessment, or restoration and recovery of salmon populations. The State (WDFW) and Puget Sound tribes presently have insufficient funding to adequately address the pressing issues related to species other than salmon, some of which are on the Endangered Species List, and others subject to concern over harvest allocation distribution and harvest accounting. Consequently, funds that might be available from a closure or curtailment of salmon fisheries in Puget Sound would likely be redirected to address critical high-profile species under ESA and State/Tribal allocation issues (e.g., bull trout, Puget Sound crab, Puget Sound steelhead and groundfish).

A similar situation would likely occur if Alternative 2 or 3 were implemented, in which fishing would be concentrated in terminal areas. More management resources would be devoted to improving the performance of freshwater fisheries. It can reasonably be expected that a large proportion, if not all, of current management resources would be redirected to refine terminal management tools, and monitor those fisheries.

In conclusion, because current funds for management and enforcement of fisheries affected by the Proposed Action would likely be re-directed to other fisheries in the Puget Sound area if Alternative 2, 3, or 4 were implemented, the overall effect of fishery management and enforcement efforts on generating jobs and personal income in the Puget Sound region would be minor. Some distributional effects may occur as spending by the management agencies shifted between sub-regions, but these effects would likely be minor given current funding levels.

WT-38

Because none of the alternatives is expected to result in any changes to hatchery operations over the five-year period covered by the Plan (2005–2009), and potential long-term effects of the alternatives on hatchery operations are considered speculative, analysis of current investments and associated economic impacts related to hatchery operations is not warranted in this EIS. The economic effects of hatchery operations in the Puget Sound area are being evaluated as part of an EIS currently being prepared by NMFS, in conjunction with the Washington Department of Fish and Game and the Puget Sound treaty tribes.

WT-39

See response to WT-38.

WT-40

Comment noted, but NMFS respectfully disagrees.

WT-41

See responses to comments WT-9 through WT-17, WT-19 through WT-21, WT-23 through WT-28 as well as responses to comments SW-1A through SW 1I, SW-16, SW-19, NFS-3 through NFS-6, NFS-10, and DEIS Subsection 2.2, *Alternatives Considered but Eliminated from Detailed Study*. NMFS determined that the comments could be addressed through its responses, revision to the DEIS, and description of mitigation measures. CEQ Regulations (40 CFR §1503.4) require that the agency preparing the Final Environmental Impact Statement respond to public comments by modifying or considering additional alternatives, modifying its analysis, making factual corrections, or explaining why no response is warranted. It does not require modification of the Proposed Action, although the applicants may choose to do so based upon consideration of public comment.

WT-42

Comment noted, but NMFS respectfully disagrees based on its responses to comments above.

WT-43

NMFS determined that the comments could be addressed through its responses, revision to the DEIS, and description of mitigation measures. CEQ Regulations (40 CFR §1503.4) require that the agency preparing the Final Environmental Impact Statement respond to public comments by modifying or considering additional alternatives, modifying its analysis, making factual corrections or explaining why no response is warranted. It does not require modification of the Proposed Action, although the applicants may choose to do so based on consideration of public comment. Public comment on the

RMP (Proposed Action) occurred as part of NMFS' consideration of the action through the ESA 4(d) process.

WT-44

Comment noted, but NMFS respectfully disagrees based on its responses to comments above.

WT-45

Comment noted, but NMFS respectfully disagrees. Section 4 of the DEIS (and as revised in FEIS Volume 2) includes a thorough evaluation of each of the resources in the natural, built and human environment that may be affected by the Proposed Action. Where available, NMFS has relied on resource standards developed by experts in the resource fields considered in the DEIS, including agency standards in its evaluation of the alternatives. Several examples are: 1) Subsections 4.8.1 and 4.8.4 – using NMFS' Potential Biological Removal thresholds for evaluation of impacts to marine mammals and ESA determinations on seabirds by the USFWS for its evaluation of effects on marbled murrelets, respectively; 2) Section 4.7 – using standards established by the U.S. Environmental Protection Agency to assess impacts of the alternatives on Environmental Justice; and 3) the Proposed Action – including the subject of a detailed Section 7 consultation and evaluation under Limit 6 of the ESA 4(d) Rule. Section 5 of the DEIS identifies the Environmentally Preferred and the Agency Preferred Alternative, and a detailed discussion of why NMFS has chosen its preferred alternative.

WT-46

Section 5 of the DEIS (Volume 2 of the FEIS) describes how NMFS has balanced its various mandates in its choice of the Agency Preferred Alternative. NEPA also requires NMFS to identify and discuss in its Record of Decision all the relevant factors which were balanced by the agency in making its decision including economic and technical considerations, agency statutory missions and national policy (40 CFR §1505.2). The Record of Decision is issued a minimum of 30 days after the EPA has notified the public of the availability of the FEIS (40 CFR §1506.10).

WT-47

The DEIS has been revised as indicated in responses to comments SW-15, SW-28, WT-32, EPA-1, EPA-6, EPA-10, and EPA-16 (see FEIS Volume 2). NMFS determined that the comments could be addressed through its responses, revision to the DEIS, and description of mitigation measures. CEQ Regulations (40 CFR §1503.4) require that the agency preparing the Final Environmental Impact Statement respond to public comments by modifying or considering additional alternatives, modifying its analysis, making factual corrections, or explaining why no response is warranted. It does not require modification of the Proposed Action, although the applicants may choose to do so based on consideration of public comment. Public comment on the Proposed Action occurred as part of NMFS consideration of the action through the ESA 4(d) process.

WT-48

Comment noted. NMFS acknowledges that these resources were used as integral components of the Washington Trout review, and this response serves as a record of that acknowledgement.

References

Beattie, Will. Conservation Management Coordinator, Northwest Indian Fisheries Commission, Olympia, Washington. July 27, 2004. Personal communication with Susan Bishop, NMFS, re: cost redistribution of personnel and sampling resources among EIS alternatives.

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Scott, Teresa. Natural Resources Policy Analyst, Washington Department of Fish and Wildlife, Olympia, Washington. July 27, 2004. Personal communication with Susan Bishop, NMFS, re: cost redistribution of personnel and sampling resources among EIS alternatives.

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Vander Haegen, G.E., C.E Ashbrook, K.W. Yi, and J.F. Dixon. 2003. In press. Survival of spring chinook salmon captured and released in a selective commercial fishery using gill nets and tangle nets. Fisheries Bulletin?.

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Washington Monitoring Oversight Committee. 2002. The Washington comprehensive monitoring strategy and action plan for watershed health and salmon recovery. Three volumes.

Washington Trout. 2002. Comments on the scope of the environmental impact statement for the Puget Sound resource management plan for harvest of Puget Sound chinook salmon; per Federal Register 51547 (August 8, 2002). FAX to Susan Bishop, NMFS NW Region. September 9, 2002. 6 pages.

Puget Sound Anglers,
North Olympic Peninsula Chapter
(PSA)

Letter of Comment

North Olympic Peninsula Chapter

May 11, 2004

Ms. Susan Bishop
National Marine Fisheries Service
7600 Sand Point Way
Seattle, Washington, 98115-0070

Subject: Puget Sound Chinook Harvest Resource Management Plan, Draft Environmental Impact Statement, dated April 2004

Dear Ms. Bishop,

Thank you for the opportunity to review the subject plan and to express our preference for the alternative which best meets the conservation and stock recovery goals and objectives of our organization. We heartily endorse the promulgation and implementation of Alternative 1, the proposed action.

The North Olympic Peninsula would be severely impacted by selection of Alternative 3 or 4 and impacted to a somewhat lesser degree by imposition of Alternative 2. We fully support escapement goal management and utilization of stock specific rebuilding exploitation rate limits with the realization that there will be increasing interception of ESA listed Puget Sound Chinook by Alaska and Canada in the coming years. The Pacific Fishery Management Council, through consultation and with support of the Fisheries Regulation Assessment Model, has provided excellent guidance and our Chinook numbers are increasing while providing increasing commercial and recreational opportunity.

Sincerely,

Tom Duttrey

Tom Duttrey
President
Puget Sound Anglers, North Olympic Peninsula Chapter
84 Windsong Lane
Sequim, Wa. 98382
(360) 683-0681

RESPONSE TO COMMENTS RECEIVED FROM PUGET SOUND ANGLERS, NORTH OLYMPIC PENINSULA CHAPTER (PSA)

PSA-1

Comment noted.

PSA-2

Comment noted.

PSA-3

Comment noted.

PSA-4

Comment noted.

Environmental Protection Agency (EPA)

Letter of Comment

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue
Seattle, Washington 98101

July 1, 2004

Reply To
Attn Of: ECO-088

Ref: 04-029-NOA

D. Robert Lohn, Regional Administrator
NMFS/NOAA - Northwest Region
7600 Sand Point Way N.E., Bldg 1
Seattle, WA 98115-0070

Dear Mr. Lohn:

The U.S. Environmental Protection Agency (EPA) has reviewed the draft Environmental Impact Statement (EIS) for **Puget Sound Chinook Harvest Resource Management Plan** (CEQ No. 040170) in accordance with our responsibilities under the National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act. Section 309, independent of NEPA, specifically directs EPA to review and comment in writing on the environmental impacts associated with all major federal actions and the document's adequacy in meeting NEPA requirements.

The proposed Resource Management Plan (RMP) would regulate commercial, recreational, ceremonial and subsistence salmon fisheries potentially affecting the Puget Sound Chinook Evolutionarily Significant Unit within the marine and freshwater areas of Puget Sound. The RMP also includes implementation, monitoring and evaluation procedures designed to ensure fisheries are consistent with objectives for conservation and use.

The EIS identifies three action alternatives. The Status Quo (Alternative 1) would manage the fishery for a mixture of management-unit-specific escapement thresholds and exploitation rate ceilings. Alternative 2 would utilize an escapement goal management approach while Alternative 3 would utilize escapement goal management at the population level with terminal fisheries only. Under Alternative 4, fishing-related mortality of listed Puget Sound chinook would be eliminated in salmon fisheries within the Strait of Juan de Fuca and Puget Sound. The National Marine Fisheries Service (NMFS) has identified Alternative 1 as the proposed action and preferred alternative.

We have assigned a rating of EC-2 (Environmental Concerns - Insufficient Information) to the draft EIS based on the NMFS's preferred alternative. This rating and a summary of our comments will be published in the *Federal Register*. A copy of the rating system used in conducting our review is enclosed for your reference.

The information presented in the EIS indicates that the Proposed Action would not sustain some of the Puget Sound chinook salmon populations; in particular, critical populations in the Elwha and Dungeness Rivers. Data presented in the EIS shows that these populations are in decline under the current management plan and the Proposed Action (status quo) is to continue with that plan. The Proposed Action does not meet the stated purpose because it does not conserve the productivity, abundance and diversity of some of the Puget Sound chinook salmon populations in the ESU. In addition, under the Proposed Action some populations may be eliminated, preventing tribes from exercising their federally-protected treaty fishing rights and thus not meeting the requirements under U.S. vs. Washington to provide for tribal and non-tribal fishing opportunities.

In addition, we have concerns with Puget Sound chinook salmon fishing-mortalities in Canadian waters and the EIS's applicability to the 2004 fishing season. Detailed comments discussing all of our concerns are enclosed.

Thank you for the opportunity to review this draft EIS. If you would like to discuss these issues, please contact Mike Letourneau at (206) 553-6382.

Sincerely,

Judith Leckrone Lee, Manager
Geographic Unit

Enclosures

cc: Tom Eaton, EPA (Washington Operations Office)
M. Rylko, EPA-R10 Puget Sound/Georgia Basin Coordinator

EPA's Detailed Comments
Puget Sound Chinook Harvest Resource Management Plan Draft Environmental Impact Statement

Purpose and Need

The Purpose and Need of the EIS focuses on sustainable harvesting of Puget Sound chinook salmon while providing for federally-protected tribal fishing rights. However, the Purpose and Need of the EIS also includes meeting the requirements of Limit 6 of the Endangered Species Act (ESA) 4(d) rule. Limit 6 Rule 4(d) allows for the taking of listed species if it does not appreciably reduce the likelihood of survival and recovery of threatened species. Including the Limit 6 4(d) rule in the Purpose and Need narrows the scope of alternatives and eliminates other management alternatives that might better conserve the Puget Sound chinook salmon.

EPA recommends that the Limit 6 of the ESA 4(d) rule provision in the Purpose and Need of the EIS be eliminated. We believe that the Purpose and Need should focus on ensuring 1
the sustainability of Puget Sound chinook salmon by conserving the productivity, abundance and diversity of the populations of the Puget Sound chinook Evolutionarily Significant Unit (ESU). The EIS could contain alternatives that include provisions that allow for taking of threatened species permitted under the Limit 6 of ESA 4(d) rule or the more restrictive 'no take' provisions under Section 9(a)1 of ESA. We believe that all the provisions discussed in the EIS could be met with a broader Purpose and Need.

The data presented in the EIS demonstrates that despite decreased exploitation rates, some populations of Puget Sound chinook salmon, such as those originating in the Elwha and Dungeness Rivers, continue to decline under the current management plan. The EIS does not discuss how the proposed action (status quo) will meet the stated purpose of conserving the 2
productivity, abundance and diversity of the populations within the Puget Sound chinook ESU (page 1-3) if some populations of Puget Sound chinook salmon would continue to decline even though they are currently at critical levels. The EIS should discuss how the proposed action will meet the stated purpose, or limit the purpose to conserving the productivity, abundance and diversity of the Puget Sound chinook ESU.

Puget Sound Chinook Fishing Mortalities in Canadian Waters

The EIS states that on average Canadian fisheries account for 75 percent of the fishing related mortality on Puget Sound chinook salmon. Fishing mortality of Puget Sound chinook salmon is regulated under the Pacific Salmon Treaty between Canada and the United States. While Canadian fisheries do not harvest chinook salmon at levels allowed under the Pacific Salmon Treaty due to internal Canadian conservation issues, effort and catches in some Canadian fisheries have been increasing. In addition, Canadian chinook and Coho salmon conservation measures are likely to be relaxed to some degree in the next several years resulting in increased Puget Sound chinook salmon fishery mortalities in Canadian waters. The EIS states that it is unlikely that Canadian catch levels will decrease from those projected to occur in 2003, and more likely that total effort and catch will continue to increase from 2003 levels.

The EIS makes it clear that some of the Puget Sound chinook salmon populations would
benefit significantly from reduced Canadian fishery mortality. The EIS should discuss what 3
provisions in the Pacific Salmon Treaty or other informal processes could be exercised to help
reduce the Puget Sound chinook salmon fishery mortality in Canadian waters. In addition, the
EIS should provide projections for the Puget Sound chinook salmon populations under various 4
scenarios of reduced Canadian fishery mortalities. The EIS should also discuss what plans exist,
if any, for working with the Canadians to reduce Puget Sound chinook fishery mortalities. 5

The EIS states that more details on Canadian harvest patterns and the basis of the
maximum northern fisheries scenario is included in Appendix B. While Table B-6 contains
information on Canadian listings for harvest mortality on Puget Sound chinook indicator stocks 6
by fishing area, Appendix B (Puget Sound Chinook Population Information) does not discuss the
Canadian harvest. The EIS should include the referenced material or delete the reference to the
Canadian harvest discussion in the main body of the EIS.

Proposed Action

Information presented in the EIS shows that despite implementation of the proposed management measures many of the Puget Sound chinook salmon populations will continue to decline, not meeting Rebuilding Exploitation Rate (RER), Critical Escapement Threshold (CET) nor Viable Escapement Threshold (VET) goals. In particular, chinook salmon runs in the Dungeness, Elwha, Stillaguamish, Snohomish, Samish, Cedar, Duwamish, Skagit, Nooksack and Skokomish rivers would not meet one or more of the escapement or rebuilding goals with the implementation of the management measures in the Proposed Action (Alternative 1). Implementation of the Proposed Action would result in exploitation rates that do not meet rebuilding exploitation rate (RER) goals for five of nine populations and one management unit, and VETs would be met in only nine of the 18 populations. Alternatives 2, 3 and 4 would meet more of the escapement and exploitation goals than the Proposed Action, with Alternative 4 meeting most of the goals.

The information presented in the EIS demonstrates that sport fishing accounts for a
significant portion of the Puget Sound chinook salmon fishing mortality for some populations. In 7
particular, sport fishing accounts for more than 40% of the fishing mortality in the Puyallup,
Nisqually and Skokomish river populations and over 90% of the White river population. In
addition, recreational fishing in the freshwaters of the Puget Sound area have shown an
increasing trend since the early 1990s. The EIS should discuss what measures could be designed
for the Puget Sound area sports fishery (e.g., shorter open fishing seasons, bag limits) to assist
increasing probability of sustaining the chinook salmon populations.

The EIS limits its discussion of habitat impacts to those the fishery has on marine
environments and the impacts the proposed alternatives would have on marine-derived nutrients 8

from spawning salmon. While the EIS states that some of the chinook salmon populations are at critical levels due to poor freshwater survival and that productivity has declined largely as a result of habitat degradation, it does not discuss the freshwater habitat impacts that affect the 8
productivity, abundance and diversity of the Puget Sound chinook. The EIS should discuss in detail the effects freshwater habitat impacts have on the population of Puget Sound chinook ESU. In particular, the EIS should discuss the effects freshwater habitat impacts could have on RERs, CETs and VETs.

The survival and well-being of salmon is seen as inextricably linked to the survival and well being of Indian people and the cultures of the tribes. The EIS describes salmon usage and its cultural significance to the Puget Sound tribes clearly demonstrating how salmon as an economic base and a cultural, ceremonial, and religious staple, has provided for enhanced social cohesion and promoted cultural vitality among Puget Sound tribes.

The management actions proposed in the EIS could potentially affect fishing rights guaranteed by treaty and recognized in <u>U.S. v. Washington</u> (Civil No.C70-9213, Western District, Washington; Federal Supplement 312, Western District, Washington, 1974). Under federal trust responsibilities the United States government assumes the duty of protecting Indian land and ensuring the exercise of tribal fishing and hunting rights. Federal trust responsibility requires that federal agencies carry out their activities in a manner that is protective of Indian treaty rights. Treaties assure the rights of the Puget Sound tribes to the taking of fish at all usual and accustomed grounds and stations. National Marine Fisheries (NMFS) and U.S. Fish and Wildlife Service orders require government-to-government negotiations with affected Indian tribes when exercising their authorities under the Endangered Species Act (ESA), thus acknowledging trust obligations to minimize impacts on tribes as much as possible while still meeting agency responsibilities. NMFS Order 3206 states that salmon recovery efforts must strive to achieve two goals: 1) the conservation and delisting of endangered and threatened species under the ESA; and 2) the restoration of salmon populations to a level sufficient to allow for the full exercise of treaty fishing rights.

If Puget Sound chinook populations go extinct in a tribe's usual and accustomed grounds and stations, that tribe would be prevented from exercising it's treaty fishing rights. Data presented in the EIS indicates that some populations, such as those in the Elwha and Dungeness 9
river, are at critical levels and under the proposed management plan and would continue to decline, potentially being eliminated. The EIS should describe how the proposed management plan would allow for all tribes to exercise their fishing treaty rights in their usual and accustomed grounds and stations, despite data that indicates that some populations are at a critical states and declining. The EIS should discuss what measures would be taken (e.g., increase hatchery augmentation) to assure that tribal trust responsibilities would be met.

The Proposed Action allows for mixed fish stock management which targets all fishing populations regardless of their viability. Mixed stock fishery management practices, because of 10
their inability to distinguish between weak and strong populations, are biased to over harvesting

of weaker populations. The EIS should describe how the proposed action would overcome the inherent bias that mixed harvest management has on weaker populations. 10

The Proposed Action does not meet the stated purpose because it does not conserve the productivity, abundance and diversity of some of the populations of Puget Sound chinook salmon in the ESU. In addition, under the Proposed Action some populations may be eliminated, preventing tribes from exercising their federally-protected treaty fishing rights and thus not 11
meeting the requirements under U.S. vs. Washington. The EIS should evaluate alternatives that would increase the probability of ensuring the sustainability of Puget Sound chinook salmon by conserving the productivity, abundance and diversity of the populations within the Puget Sound chinook ESU while providing for federally-protected treaty fishing rights and meeting the requirements of U.S. vs. Washington. The EIS should evaluate alternatives that decrease the fishing mortality of Puget Sound chinook salmon in Canadian waters, optimize single stock 12
fishery management practices and investigate options to limit sport fisheries mortalities.

2004 Fishing Season

The proposed action analyzed in the Draft Environmental Impact Statement (EIS) is the implementation of the Puget Sound Chinook Harvest Resource Management Plan for the 2004 - 2009 fishing years, beginning May 1, 2004. Given that it is currently July 2004 and the 13A
development of a final EIS and a Record of Decision on the proposed management actions could take an additional three to five months, it seems appropriate to not include the 2004 fishing year in this plan.

We recommend the EIS either limit the implementation of the Resource Management Plan to the 2005 - 2009 fishing years, or provide information on how the fishery will be managed in 2004 until the EIS is finalized. If provisions exist in management plans currently in place that 13B
impact Puget Sound chinook fishing mortality, these should be discussed in the EIS. The EIS should include information on how these highly variable populations of Puget Sound chinook 13C
salmon may be impacted under various interim 2004 management regimes. In addition, it should include provisions for updating the Resource Management Plan to reflect actual 2004 13D
exploitation and escapement data.

No Action Alternative

The EIS identifies Alternative 1 as the Status Quo alternative and Alternative 4 as the No Action/No Authorized Take alternative. CEQ Regulations as explained in Federal Register Notice entitled: Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations (40 FAQs) states that no action is "no change" from current management 14
direction or level of management intensity. The No Action alternative may be thought of in terms of continuing with the present course of action until that action is changed. Alternative 4 would be taking an action that is a change from the current management direction or level of management intensity where Alternative 1 would not. Therefore, Alternative 1 would be the No Action Alternative and the EIS should be modified to identify it as such.

Evaluation of a Reduced Hatchery Augmentation Alternative

Hatchery augmentation has been used to reduce the short term risks on a threatened or endangered fish population by increasing abundance in a shorter time frame than may be achievable through natural production. Chinook salmon produced by hatcheries operating in the Elwha, Dungeness, Nooksack, Stillaguamish and White River watersheds are considered essential to the recovery of the Puget Sound chinook ESU. While hatchery reform measures have helped, the EIS is clear that hatchery augmentation still has significant negative impacts on wild salmon populations including loss of within-population genetic diversity, loss of genetic diversity among different populations, and demographic effects such as masking.

The fishery management activities proposed in the EIS are designed to increase the abundance of Puget Sound chinook wild salmon populations. Management measures proposed in some of the alternatives would raise the natural production of some of the wild salmon populations over time, eventually eliminating the need for permanent hatchery augmentation.
None of the proposed alternatives in the EIS evaluate reducing hatchery augmentation as the 15
natural populations increase. Reducing hatchery augmentation as natural populations increase would reduce, and eventually eliminate the negative ecological and demographic effects hatchery populations have on wild salmon populations. The EIS should evaluate alternatives that eliminate permanent hatchery augmentation as natural populations increase.

Environmental Justice

The EIS does a very good job of analyzing disproportionate impacts on low income and minority communities. It informs the reader of the area of impact, the communities that would be impacted, the reference community and the impacts that this action would have on those communities and the measures taken to achieve meaningful public participation. The analysis presented in the EIS is easy to follow and comprehend. Table 3.7-2 on page 3-157 presents the percentage of minority persons by county, by race in the target area. Under Executive Order 12898, one must consider all the minorities as a whole when comparing to a minority criteria of
significance. The EIS should compare the summation of all the minorities within a county to the 16
state criteria. Doing so will demonstrate that King and Pierce county exceed the state minority criteria. However, we agree with the EIS's conclusion that non-tribal minority impacts would not be disproportionate. The EIS should be amended to address the summation of minority populations consistent with Executive Order 12898.

U.S. Environmental Protection Agency Rating System for Draft Environmental Impact Statements Definitions and Follow-Up Action*

Environmental Impact of the Action

LO – Lack of Objections

The U.S. Environmental Protection Agency (EPA) review has not identified any potential environmental impacts requiring substantive changes to the proposal. The review may have disclosed opportunities for application of mitigation measures that could be accomplished with no more than minor changes to the proposal.

EC – Environmental Concerns

EPA review has identified environmental impacts that should be avoided in order to fully protect the environment. Corrective measures may require changes to the preferred alternative or application of mitigation measures that can reduce these impacts.

EO – Environmental Objections

EPA review has identified significant environmental impacts that should be avoided in order to provide adequate protection for the environment. Corrective measures may require substantial changes to the preferred alternative or consideration of some other project alternative (including the no-action alternative or a new alternative). EPA intends to work with the lead agency to reduce these impacts.

EU – Environmentally Unsatisfactory

EPA review has identified adverse environmental impacts that are of sufficient magnitude that they are unsatisfactory from the standpoint of public health or welfare or environmental quality. EPA intends to work with the lead agency to reduce these impacts. If the potential unsatisfactory impacts are not corrected at the final EIS stage, this proposal will be recommended for referral to the Council on Environmental Quality (CEQ).

Adequacy of the Impact Statement

Category 1 – Adequate

EPA believes the draft EIS adequately sets forth the environmental impact(s) of the preferred alternative and those of the alternatives reasonably available to the project or action. No further analysis of data collection is necessary, but the reviewer may suggest the addition of clarifying language or information.

Category 2 – Insufficient Information

The draft EIS does not contain sufficient information for EPA to fully assess environmental impacts that should be avoided in order to fully protect the environment, or the EPA reviewer has identified new reasonably available alternatives that are within the spectrum of alternatives analyzed in the draft EIS, which could reduce the environmental impacts of the action. The identified additional information, data, analyses or discussion should be included in the final EIS.

Category 3 – Inadequate

EPA does not believe that the draft EIS adequately assesses potentially significant environmental impacts of the action, or the EPA reviewer has identified new, reasonably available alternatives that are outside of the spectrum of alternatives analyzed in the draft EIS, which should be analyzed in order to reduce the potentially significant environmental impacts. EPA believes that the identified additional information, data, analyses, or discussions are of such a magnitude that they should have full public review at a draft stage. EPA does not believe that the draft EIS is adequate for the purposes of the National Environmental Policy Act and or Section 309 review, and thus should be formally revised and made available for public comment in a supplemental or revised draft EIS. On the basis of the potential significant impacts involved, this proposal could be a candidate for referral to the CEQ.

* From EPA Manual 1640 Policy and Procedures for the Review of Federal Actions Impacting the Environment. February, 1987.

RESPONSE TO COMMENTS RECEIVED FROM THE U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA-1

The applicant has requested ESA coverage through Limit 6 of the 4(d) Rule which includes specific criteria that a Resource Management Plan must adequately address. NMFS does not have the authority to request that applicants seek ESA coverage under regulatory mechanisms other than what was requested by the applicant. Furthermore, as the Lead Agency for this applicant request, NMFS must disclose the applicants' regulatory request, which is a critical factor in the Purpose and Need for the Proposed Action. NMFS' determination on its review of the Proposed Action under the criteria of Limit 6 is the federal action triggering a NEPA analysis. Therefore, meeting the provisions of Limit 6 of the ESA 4(d) Rule is a critical element of the Purpose and Need (see Draft EIS Subsection 1.6). The criteria of Limit 6 of the 4(d) Rule require that Resource Management Plans submitted under this limit provide information that the proposed Resource Management Plan minimizes the long-term risks to population persistence (50 CFR 223.03[b][i]4[B]), and provide a biological rationale that the Proposed Action will not "appreciably reduce the likelihood of survival and recovery of the ESU in the wild" (50 CFR 223.03[b][i]4[D]). NMFS believes that, "…declining to apply take prohibitions to such programs [4(d) Limits] likely will result in greater conservation gains for a listed ESU than would blanket application of section 9(a)(1) prohibitions…"(65 FR 42422, Background). The basis and background to the 4(d) Rule and Limit 6 is discussed in Subsection 1.5 of the DEIS. Subsection 1.4 of the DEIS (*Background to Purpose and Need*) has been modified to emphasize the importance of including the Limit 6 criteria as an element of the Purpose and Need. The revised language can be found in FEIS Volume 2, Revised Draft EIS.

EPA-2

The Dungeness and Elwha chinook salmon populations are considered to be increasing and stable in abundance, respectively, based on an assessment of escapements before and after listing of the Puget Sound Chinook ESU (NMFS 2004). Escapements are predicted to remain stable for these populations under the most likely scenario of abundance and Canadian fisheries considered in the DEIS, due to supplementation of spawner abundance by local, listed hatchery programs in both rivers. Southern U.S. exploitation rates on these populations are not expected to exceed 5 percent over the duration of the Proposed Action (2005–2009).

NMFS has evaluated the co-managers' Plan using the best available information regarding the expectation of conditions over the proposed duration of the plan (2005–2009), and evaluated the outcome against NMFS' standards for listed Puget Sound chinook salmon (NMFS 2004). NMFS has concluded in its 4(d) evaluation and in a biological opinion under section 7 of the ESA that the 2005–2009 co-managers' Puget Sound Chinook Harvest Resource Management Plan would not pose jeopardy to the Puget Sound Chinook ESU. The 4(d) evaluation and section 7 Biological Opinion are incorporated herein by reference and included as Appendices B and C of the Record of Decision.

The Puget Sound Chinook ESU, not the component, individual populations, is the primary focus of NMFS' evaluation of the impacts of the RMP under the ESA. In conducting this evaluation, NMFS takes into account the recommendations of the Puget Sound TRT, which is charged with identifying the biological characteristics of a recovered ESU as part of developing delisting and recovery criteria. The TRT's preliminary recommendation is that any ESU-wide recovery scenario should include at least two to four viable chinook salmon populations in each of five geographic regions within Puget Sound, depending on the historical life history and biological characteristics of populations in each region.

The Puget Sound Chinook ESU includes 22 chinook salmon populations distributed over five distinct geographic areas and several life history types. Total exploitation rates have decreased 14 to 63 percent from rates in the 1980s. Puget Sound chinook salmon escapements have been stable or increasing since the ESU was listed in 1999 for all populations in all regions and life history types, an apparent positive response to the decline in exploitation rates in combination with other factors. Recent years' average escapement for all but the North Fork Nooksack population is above the critical escapement thresholds, and two to four of the populations in two of the five regions (10 populations over all regions) exceed their viable escapement thresholds, representing the range of life history types in each region. This pattern is expected to continue during the duration of the Proposed Action. Five of the ten RERs are expected to be met under the Proposed Action. Escapements for one of the populations (Green-Duwamish) for which RERs are not expected to be met are expected to meet or exceed the viable escapement threshold for this population across the duration of the Proposed Action.

Although concerns remain regarding low abundance of four populations in the remaining three regions, analysis indicated that conducting the Proposed Action between 2005–2009 is expected to have generally little to no effect on the ability to achieve viability criteria in these regions. For example, all but two of the populations that are not expected to meet their viable thresholds under the Proposed Action are also not expected to meet their viable thresholds even if Puget Sound fisheries were eliminated. Based on the stable or increasing trends in escapement; the apparent positive response to significant decreases in exploitation rates for most populations; the distribution and life history representation of chinook populations throughout the ESU relative to their status and the TRT guidance; the low level of exploitation in southern U.S. fisheries for those populations at low abundance; taking into account its Tribal trust responsibility; and the buffer against genetic and demographic risks provided by some associated hatchery programs, NMFS' evaluation of the Proposed Action concluded it would not appreciably reduce the likelihood of survival and recovery of the Puget Sound Chinook ESU.

EPA-3

The Pacific Salmon Treaty allows the parties (the U.S. and Canada) to reach agreements regarding how their intercepting fisheries will be managed, subject to a number of constraining considerations, such as the desire to avoid undue disruption of existing fisheries, both countries' interest in protecting treaty Indian and aboriginal fisheries, etc. (Also see response to comment SW-18.) As a practical matter, the agreed bilateral fishing arrangements tend to be multi-year in duration, and only limited opportunities and mechanisms exist to modify the agreed regimes. The existing arrangements expire after 2008 for chinook and southern coho and chum fisheries, and after 2010 for Fraser River sockeye and pink fisheries. That is why the duration of the Proposed Action in the DEIS coincides with the negotiation of a new Pacific Salmon Treaty agreement in 2009. Until then, the DEIS must take into account the terms of the existing Pacific Salmon Treaty Agreement when evaluating alternatives within the scope of the Proposed Action; i.e., steelhead net and salmon fisheries within Puget Sound. NMFS is unaware of any "informal" processes that may be available to reduce Puget Sound chinook salmon fishing mortality in Canadian waters.

EPA-4

Scenario A (high abundance and 2003 expected Canadian and Alaskan fisheries), and Scenario C (low abundance and 2003 expected Canadian and Alaskan fisheries), described as using 2003 pre-season projections for Canadian fisheries, represent a "reduced Canadian fishery mortality" condition. Actual catches in 2003 Canadian fisheries were higher than pre-season projections and more in line with expected harvest levels in upcoming years.

EPA-5

Canadian fisheries affecting Puget Sound chinook and other salmon are governed by existing agreements developed pursuant to the Pacific Salmon Treaty. The existing arrangements were agreed to in 1999, following several years of very intense bilateral negotiations between the U.S and Canadian governments. The pertinent fishing regimes apply through 2008, except for the provisions governing Fraser River sockeye and pink salmon, which expire after the 2010 fishing season. Working through their representatives to the Pacific Salmon Commission (PSC), the body emplaced to oversee implementation of the Pacific Salmon Treaty, NMFS and the state and tribal co-managers meet annually to discuss the status of salmon stocks and fisheries with their Canadian counterparts. These discussions occur at both the technical and policy levels, and focus on ensuring that the applicable provisions of the agreed regimes are faithfully implemented by both countries. Both countries are obligated to those regimes unless otherwise agreed. It is quite probable that U.S. representatives to the Pacific Salmon Commission process will continue to argue – as they have in the past – for management measures that would further reduce Puget Sound chinook salmon mortality in Canadian fisheries. However, no one can predict the outcome of those discussions, and until something changes or the existing regimes expire, the only valid and prudent assumptions are that the Canadians will comply fully with the agreed regimes and harvest up to their allowed limits (see DEIS Subsection 4.2, *Basis for Comparison of Alternatives and Approach to Alternatives Analysis*). (Also see responses to comments SW-18 and EPA-3.)

EPA-6

NMFS agrees and has deleted the language from DEIS Subsection 4.2.3.2, *Basis for Comparison of Alternatives and Approach to the Alternatives Analysis*. See FEIS Volume 2, Revised Draft EIS.

EPA-7

Actually, the results of the DEIS evaluation indicate that the specific populations cited by the commentor (Puyallup, Nisqually, Skokomish and White River) would meet their objectives under all alternatives in the DEIS. More broadly, restriction of recreational fisheries for some of the populations not expected to meet their objective under the Proposed Action would not increase the probability of meeting harvest objectives, since the majority of fishing-related mortality is in tribal fisheries; e.g., Nooksack early chinook salmon. For other populations, harvest management objectives are not expected to be met even if Puget Sound fisheries were eliminated because of the magnitude of harvest in Canadian and Alaskan fisheries; e.g., Dungeness, Elwha, and Nooksack.

All measures to shape the recreational fisheries are currently part of the tools of the Proposed Action. However, which measures to use would vary from year to year depending on the status of the various Puget Sound Chinook populations. Appendix C of the Proposed Action, found in DEIS Appendix A, describes some of the actions that would be taken in the recreational fisheries when low abundance thresholds and RERs were not expected to be met. The types of actions include area or time closures, mark-selective or species-selective regulations, limitations on the number of fish retained or type of gear used.

Puget Sound chinook salmon populations are currently stable or increasing (NMFS 2004), although several are near their critical escapement thresholds, and the average escapements since listing under the ESA are generally above the average escapements in the years prior to listing. Although the DEIS indicates that while the exploitation rates under the Proposed Action may delay the rebuilding of some populations within the ESU, it does not conclude that any Puget Sound populations would be eliminated as the commentor suggests (see DEIS Subsection 4.3.1.1, *Alternative 1 – Proposed Action/Status Quo*). NMFS' preliminary evaluation of the Proposed Action is that it would not appreciably reduce the likelihood of survival or recovery of listed Puget Sound Chinook salmon (NMFS 2004). See response to comment EPA-2.

EPA-8

NMFS has provided additional language in DEIS Subsection 3.3.1.1, *Puget Sound Chinook,* that gives a broader overview of the effect of habitat activities on the Puget Sound Chinook ESU, and added language to Appendix C2 that describes the effects of habitat impacts and environmental conditions on CETs, VETs and RERs. The added language can be found in FEIS Volume 2, Revised Draft EIS.

EPA-9

Puget Sound chinook salmon populations are currently stable or increasing (NMFS 2004), although several are near their critical escapement thresholds, and the average escapements since listing under the ESA are generally above the average escapements in the years prior to listing. Seven populations have exceeded their viable escapement thresholds in recent years; three have done so consistently. Although the DEIS indicates that while the exploitation rates under the Proposed Action may delay the rebuilding of some populations within the ESU, it does not conclude that any Puget Sound populations would be eliminated (see DEIS Subsection 4.3.1.1). NMFS' preliminary evaluation of the Proposed Action is that it would not appreciably reduce the likelihood of survival or recovery of listed Puget Sound chinook salmon (NMFS 2004).

The future trend in populations will depend on a variety of factors, including harvest (NMFS 2000; PSTRT 2003). Depending on the influence of other sources of mortality, reductions in harvest may have a limited or negligible effect on these trends (NMFS 2004). (See response to comment EPA-8, and comments SW-2, SW-10, SW-26.) The recovery planning process currently underway for the Puget Sound Chinook ESU will specifically address the integration of all the factors affecting the ESU and has as its major objectives the two goals listed by the commentor. Regarding the DEIS, any of the alternatives would implement harvest management objectives that are consistent with current environmental conditions, and take into account fishing-related mortality even in fisheries outside the

Action Area. Under the DEIS alternatives, those objectives would be revised as habitat changes. Mitigation measures for effects unrelated to the Proposed Action, are outside the scope of the Action. The effect of different hatchery production levels on tribal treaty rights will likely be evaluated as part of an EIS NMFS is conducting on Puget Sound hatchery programs.

The Puget Sound Treaty Tribes assert, in providing the RMP jointly with WDFW to NMFS, their strong belief that current Puget Sound chinook abundance is far below what is required to satisfy treaty tribal fishing rights. In most areas, chinook harvest is limited to what is caught incidentally in fisheries targeted at other species, and targeted to ceremonial and subsistence needs. However, under the Proposed Action, all Puget Sound tribes are currently able to exercise their treaty-reserved fishing rights for salmon in their usual and accustomed grounds and stations, although at much reduced levels from the past.

EPA-10

This comment is refers to mixed-stock management practices that manage the abundance of fish in a fishery made up of multiple stocks as an aggregate; i.e., as if it was only one stock. The Proposed Action would not manage mixed-stock fisheries as an aggregate. Current management tools can estimate the contribution of each management unit to the fishery. As described in DEIS Section 2.3.1 (*Alternative 1 – Proposed Action/Status Quo*), the Proposed Action would manage mixed-stock fisheries for the harvest management objective of the weakest management unit in the fishery, foregoing harvest of stronger management units, if necessary, to protect the weaker management units. DEIS Section 2.3.1 has been revised to make this point more clearly in FEIS Volume 2, Revised Draft EIS.

EPA-11

See responses to comments EPA-2, EPA-9 and WT-15.

EPA-12

See responses to comments EPA-3, EPA-4, EPA-5, EPA-7, EPA-10, and NFS-8 and NFS-10.

EPA-13A

NMFS agrees with the commentor and has changed the EIS to reflect the 2005–2009 fishing seasons. NMFS completed an ESA section 7 consultation on a fishing plan for the 2004 Puget Sound steelhead net, and salmon commercial and recreational fisheries that take listed Puget Sound chinook (NMFS 2004).

EPA-13B

The 2004 salmon and steelhead fisheries discussed in response to comment EPA-13A will be conducted under the terms of the Puget Sound Chinook Harvest Resource Management Plan consistent with those described in the DEIS, so no revisions to the DEIS are necessary.

EPA-13C

See responses to comments EPA-13A and EPA-13B.

EPA-13D

Because chinook salmon adults return through October in many systems, final escapement estimates for the 2004 chinook salmon return will not be available until Spring of 2005. Catch of chinook salmon returning in 2004 in commercial and recreational fisheries also occurs into the Fall, and therefore, final catch estimates will not be available until late Winter or Spring of 2005. The data required to estimate exploitation rates on all chinook salmon cohorts that contributed to fisheries in 2004 is based on coded-wire tag recoveries and information collected over a wide range of fisheries and jurisdictions, and generally takes up to six years to complete. Therefore, information on 2004 exploitation rates and escapement will not be available in time to include in the FEIS.

CEQ Regulations (40 CFR §1503.4) require that the agency preparing the Final Environmental Impact Statement respond to public comments by modifying or considering additional alternatives, modifying its analysis, making factual corrections, or explaining why no response is warranted. It does not require modification of the Proposed Action (the Resource Management Plan), although the applicants may choose to do so based on consideration of public comment. However, the Proposed Action does contain provisions for annual reporting that includes estimates of exploitation rates and escapement (DEIS Subsection 2.3.1), and requires a periodic review and update of the entire Resource Management Plan (Subsection 7.5 of the Proposed Action, found in DEIS Appendix A).

EPA-14

NMFS agrees with EPA's characterization of Alternatives 1 and 4 with regard to CEQ Regulations. However, the titles of the alternatives refer to specific alternatives mandated in the settlement agreement reached with Washington Trout (Washington Trout v. Lohn). This potential confusion was clarified for readers in DEIS Subsection 4.2.1 (*No Action Alternative*) by stating that Alternative 1 is the No Action Alternative under CEQ regulations. In addition, all alternatives were compared with Alternative 1 as the No Action alternative as required by CEQ regulations to evaluate how the other alternatives would change relative to existing conditions.

EPA-15

Evaluation of the effects of decreased hatchery chinook salmon production levels on natural population abundance is outside of the scope of the Puget Sound Chinook Harvest Management Plan DEIS. Alternatives to current hatchery chinook salmon production levels in Puget Sound, including increases and decreases in juvenile fish production levels, will be evaluated within a separate on-going EIS being administered by NMFS and directed at regional hatchery programs.

EPA-16

Comment noted. NMFS has made the necessary revisions to DEIS Section 3.7 in FEIS Volume 2, Revised Draft EIS.

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Puget Sound Chinook Harvest Resource Management Plan

Final Environmental Impact Statement

National Marine Fisheries Service
Northwest Region
with Assistance from the Puget Sound Treaty Tribes
and Washington Department of Fish and Wildlife

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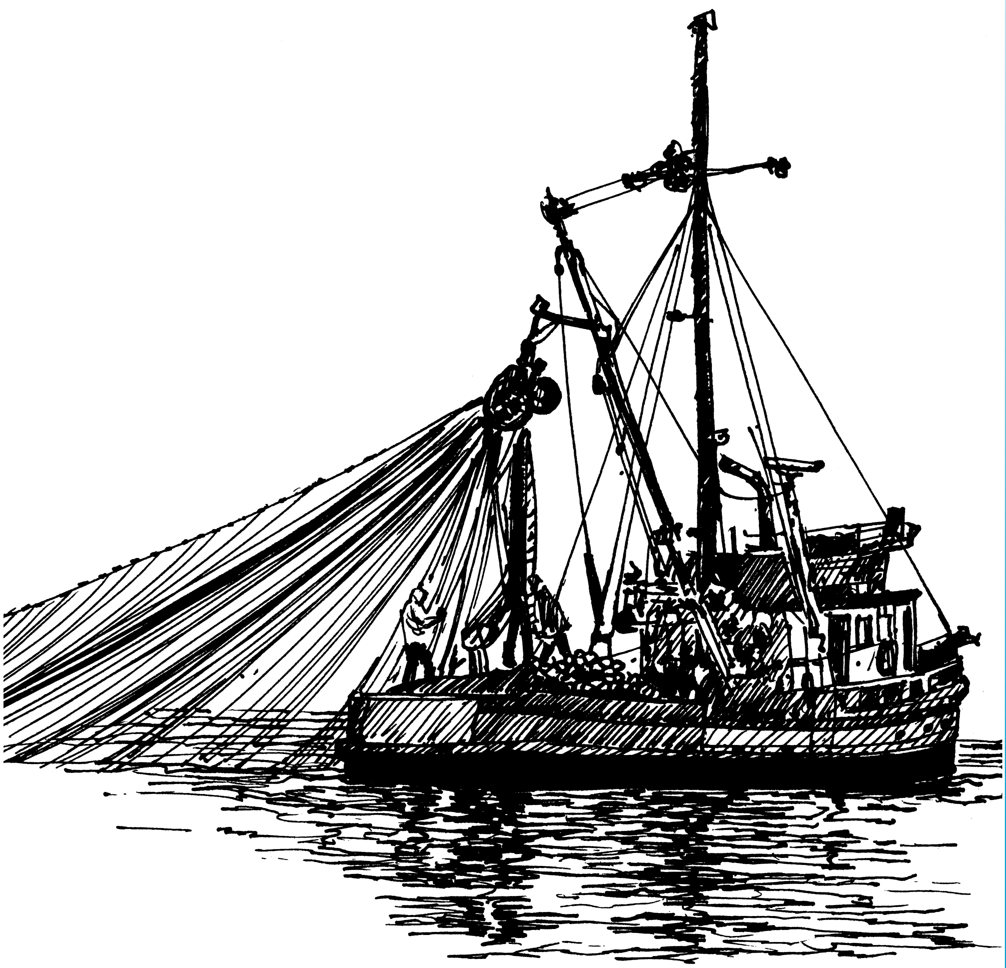
Volume 2



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EXECUTIVE SUMMARY

The Proposed Action analyzed in the ~~Draft~~ Final Environmental Impact Statement is implementation of the Puget Sound Chinook Harvest Resource Management Plan, jointly-developed by the Washington Department of Fish and Wildlife, and the Puget Sound treaty tribes, under Limit 6 of the Endangered Species Act (ESA) 4(d) Rule for implementation in the ~~2004~~ 2005–2009 fishing years, beginning May 1, ~~2004~~ 2005 (May 1, ~~2004~~ 2005 – April 30, 2010). The proposed Resource Management Plan would regulate commercial, recreational, ceremonial, and subsistence salmon fisheries potentially affecting the listed Puget Sound Chinook Salmon Evolutionarily Significant Unit within the marine and freshwater areas of Puget Sound, from the entrance to the Strait of Juan de Fuca inward. It excludes Washington Commercial Salmon Management Catch Reporting Area 4B during the months from May to September, when this area is under the jurisdiction of the Pacific Fisheries Management Council. Harvest objectives specified in the Resource Management Plan account for fisheries-related mortality of Puget Sound chinook salmon throughout the migratory range of this species – from Oregon and Washington to Southeast Alaska. The Resource Management Plan also includes implementation, monitoring, and evaluation procedures designed to ensure that fisheries are consistent with the objectives of the Resource Management Plan for conservation and use. Fishery activities under the Resource Management Plan would affect the listed Puget Sound Chinook Salmon and Hood Canal Summer-Run Chum Salmon Evolutionarily Significant Units. Salmon abundance is highly variable from year to year, both among chinook populations and other salmon species, requiring managers to formulate fisheries to respond to the population abundance conditions particular to that year. Therefore, the Resource Management Plan does not include the specific details of an annual fishing regime – i.e., where and when fisheries occur; what gear will be used; or how harvest is allocated among gears, areas, or fishermen. However, the Resource Management Plan does provide the framework and objectives against which the co-managers must develop their annual action-specific fishing regimes to protect Puget Sound chinook salmon and meet other management objectives.

The purpose and need for the Proposed Action (Section 1) is to provide for harvest of salmon species in Puget Sound marine and freshwater areas that:

- Ensures the sustainability of Puget Sound chinook salmon by conserving the productivity, abundance and diversity of the populations within the Puget Sound Chinook Evolutionarily Significant Unit
- Protects treaty Indian fishing rights and meets federal treaty trust responsibilities
- Provides equitable sharing of harvest opportunity among tribes, and among treaty and non-treaty fishers pursuant to U.S. v. Washington and U.S. v. Oregon

- Meets the requirement of Limit 6 of the 4(d) Rule under the Endangered Species Act (ESA) by: "... not appreciably reducing the likelihood of survival and recovery" of ESA listed Puget Sound chinook (50 CFR 223.203[b][6][i]).
- Manages risk associated with abundance estimation, population dynamics, and management implementation
- Optimizes harvest of abundant Puget Sound salmon (coho, chinook, sockeye, pink, chum) while protecting weaker commingled chinook stocks
- Accounts for all sources of fishery-related mortality
- Achieves the guidelines for allocation of harvest benefits and conservation objectives for chinook salmon under the Pacific Salmon Treaty.

Since the Puget Sound Chinook Evolutionarily Significant Unit was listed in 1999, the National Marine Fisheries Service (NMFS) has evaluated the impact of Alaskan, Canadian and southern U.S. salmon fisheries affecting listed Puget Sound chinook under section 7 of the ESA, and evaluated fisheries resource management plans in 2001 and 2003 for listed Puget Sound chinook under the 4(d) Rule Limit 6. National Environmental Policy Act (NEPA) reviews were also conducted on the 2001 and 2003 Resource Management Plans as part of the overall assessment of those Resource Management Plans. The current application of Limit 6 to the 2003 Resource Management Plan ~~expires~~ expired May 1, 2004. The co-managers jointly-developed another harvest RMP for Puget Sound commercial and recreational salmon, and steelhead net fisheries taking listed Puget Sound chinook for the 2004–2009 fishing seasons which began May 1, 2004. NMFS conducted a consultation under Section 7 of the ESA and issued a Biological Opinion in June of 2004 that the 2004 fishing season was not likely to jeopardize the Puget Sound Chinook ESU (NMFS 2004). The co-managers provided the RMP to NMFS, and NMFS is evaluating the RMP under Limit 6 of the Endangered Species Act (ESA) section 4(d) rule for the 2005–2009 fishing season, beginning May 1, 2005.

Application of Limit 6 to the proposed Resource Management Plan would ensure that in conducting fishery activities, the co-managers would not be subject to ESA take prohibitions because these activities would be conducted in a way that contributes to conserving the listed Evolutionarily Significant Units, or would be governed by regulations that adequately limit impacts to listed salmon. For NMFS to apply the provisions of Limit 6 for implementing a Resource Management Plan, the co-managers must jointly prepare a fishing plan that meets the requirements defined under Limit 6 of the 4(d) rule. NMFS must then make a determination pursuant with the government-to-government processes of the Tribal 4(d) Rule that the Resource Management Plan, as proposed and implemented by the co-managers, does not appreciably reduce the likelihood of survival and recovery of listed Puget

Sound chinook (50 CFR 223.203[b][6][i]). The NMFS determination under the 4(d) Rule is the major Federal action that triggers review under NEPA (NOAA Administrative Order 216.603(e)[2][a]).

Washington Trout, a Puget Sound environmental group, challenged the adequacy of the NEPA Environmental Assessment used by NMFS for its determination for the 2001 Puget Sound Chinook Harvest Resource Management Plan (Washington Trout v. Lohn, No. C01-1863R, Western District, Washington). As part of the settlement agreement reached with Washington Trout (July 22, 2002), NMFS agreed to prepare an Environmental Impact Statement for its 2004 determination related to a long-term Resource Management Plan.

The alternatives considered and analyzed in this ~~Draft~~ Final Environmental Impact Statement were formulated based on scientific information, alternatives described in the settlement agreement in Washington Trout v. Lohn, and public comments received during the scoping process for the Environmental Impact Statement on the ~~2004~~ Puget Sound Chinook Harvest Resource Management Plan. Several alternatives suggested by the public were eliminated from further consideration because they did not meet the purpose and need of the Proposed Action or were contained within the alternatives that were considered in more detail. It should be noted that Alternative 4 is also inconsistent with several elements of the purpose and need for the Proposed Action, and would not be considered were it not one of the alternatives identified for analysis in the settlement agreement to Washington Trout v. Lohn. In the analyses, Alternative 4 provides an upper-bound estimate of the decrease in mortality on fish and wildlife species affected by Puget Sound salmon fisheries, and an upper-bound estimate of socio-economic effects. A description of the Proposed Action and alternatives is provided in Section 2, Alternatives Including the Proposed Action. The alternatives considered for detailed analyses are:

Alternative 1:	The Proposed Action (the proposed Resource Management Plan)
Alternative 2:	Escapement goal management at the management unit level with no restriction on where fisheries may take place
Alternative 3:	Escapement goal management at the individual population level with terminal fisheries only
Alternative 4:	No authorized take of listed Puget Sound chinook salmon within the Strait of Juan de Fuca and Puget Sound area.

NEPA requires disclosure of how current environmental and social conditions would change with the Proposed Action or its alternatives. For this analysis, the Proposed Action (Alternative 1) most closely approximates current salmon harvest management practices and baseline environmental conditions, because the same type of harvest management plan has been implemented since 2000–2001. Therefore, Alternative 1 is the baseline against which the environmental, social, and economic consequences of the action are compared. The predicted direct and indirect effects of alternatives on baseline environmental conditions (Alternative 1) are described in Section 4, Environmental Consequences, along with predicted cumulative effects on the natural, built and human environment when combined with other related actions.

The predicted outcome of implementing any of the alternatives evaluated in this ~~Draft~~ Final Environmental Impact Statement will depend on the Puget Sound chinook salmon abundance available to the fisheries in any individual year, and the amount of Puget Sound chinook harvest taken in Canadian and Alaskan fisheries prior to chinook salmon reaching Puget Sound fisheries. Canadian fisheries, which are outside the jurisdiction of U.S. fishery management agencies, account for 25 to 80 percent of the fishing-related mortality for most chinook populations within Puget Sound. Each alternative was evaluated for four scenarios that captured the general range in magnitude of abundance and the level of Puget Sound chinook salmon harvest in Canadian and Alaskan fisheries that is reasonably expected to occur across the duration of the Proposed Action (the ~~2004~~ 2005–2009 fishing seasons), in order to capture the range of predicted impacts of the Proposed Action or alternative. A more detailed discussion of the basis and choice of these scenarios is presented in Subsection 4.2 of this Draft Environmental Impact Statement: Basis for Comparison of Alternatives and Approach to Alternatives Analysis.

Scenario	Abundance	Canadian/Alaskan Fisheries
Scenario A	2003 Puget Sound abundance	2003 Canadian/Alaskan fisheries harvest.
Scenario B	2003 Puget Sound abundance	High Canadian/Alaskan fisheries harvest.
Scenario C	30% reduction from 2003 abundance	2003 Canadian/Alaskan fisheries harvest.
Scenario D	30% reduction from 2003 abundance	High Alaskan/Canadian fisheries harvest.

The indications of a plateau or potential reduction in marine survival (the primary influence on abundance), and expectations that Canadian fisheries will continue to increase as they have in recent years, led the Interdisciplinary Team to conclude that Scenario B is the *most likely* to occur during implementation of the Proposed Action. However, the other scenarios followed the same general patterns of impact when comparing among alternatives for each resource.

The ~~Draft~~ Final Environmental Impact Statement examines the predicted effects of the Proposed Action and three alternatives on a range of issues including fish species (salmon and non-salmon), federal treaty trust responsibilities, subsistence use, economics, environmental justice and wildlife

(Section 4, Environmental Consequences). From the information provided in this ~~Draft~~ Final Environmental Impact Statement, the Regional Administrator of the NMFS Northwest Region must decide:

1) Which harvest management strategy to adopt for salmon fisheries that take listed Puget Sound chinook salmon in Puget Sound and the Strait of Juan de Fuca that would meet the requirements for Limit 6 of the 4(d) take prohibition

2) If a harvest strategy other than that proposed by the co-managers is preferred, whether to limit the geographic location of salmon fisheries that take listed Puget Sound chinook within the Puget Sound Action Area.

CEQ Regulations (§1502.14[e]) require that the agency "Identify the [agency's] preferred alternative or alternatives, if one or more exists, in the draft [environmental impact] statement…unless another law prohibits the expression of such a preference." The Environmentally Preferable Alternative "ordinarily, means the alternative that causes the least damage to the biological and physical environment; it also means the alternative which best protects, preserves, and enhances historic, cultural and natural resources" (CEQ 40 Most Asked Questions, No. 6a). The Preferred Alternative is the alternative NMFS believes best fulfills the purpose and need for the Proposed Action. The Preferred Alternative and the Environmentally Preferable Alternative need not be the same. NMFS may take into account various other considerations in choosing its Preferred Alternative, including such factors as the agency's statutory mission and responsibilities, and economic, environmental, technical, and social factors.

The following factors weighed most heavily in NMFS' decision concerning the Agency Preferred Alternative and the Environmentally Preferable Alternative: 1) effects on fish, and in particular the ESA-listed Puget Sound chinook salmon; 2) various levels of restriction on tribal treaty rights (from voluntary to mandated) and trust responsibilities, and the subsequent effects thereon; 3) treaty Indian ceremonial and subsistence uses; 4) various levels of environmental justice effects on Puget Sound tribes; 5) stable or increasingly adverse economic impacts to fishing communities; 6) secondary effects of fishing resulting from interactions of hatchery salmon that escape fisheries with wild salmon (i.e., straying); and 7) fishing-related impacts to fish habitat. For other resources evaluated in the Draft Environmental Impact Statement (wildlife, ownership and land use, water quality), there were no or very small differences among the alternatives, or uncertainty in the outcome precluded assessment of the effect (see Section 5, Identification of the Environmentally Preferable and Agency Preferred Alternative, for further details).

Alternative 1, the Proposed Action, is the NMFS' preferred alternative because NMFS believes this alternative would be most successful at balancing resource conservation, trust obligations to Native

American tribes, promotion of sustainable fisheries and prevention of lost economic potential associated with overfishing, declining species and degraded habitats. NMFS did not choose Alternative 4, the Environmentally Preferable Alternative, as its preferred alternative due to: 1) the anticipated substantial adverse impacts to tribal treaty rights, treaty Indian ceremonial and subsistence fishing uses, environmental justice effects, and economic effects on fishing communities predicted for this alternative; 2) the expected reduction in adverse biological impacts from implementation of Alternative 4 were not predicted to be substantial enough to outweigh the losses in these other areas, particularly for listed Puget Sound chinook salmon; and 3) failure to achieve the purpose and need for the Proposed Action.

NEPA regulations and guidance indicate that agencies have discretion in choosing a preferred alternative different from the environmentally preferred alternative "based on relevant factors including economic and technical considerations and agency statutory missions" (40 CFR 1505.2[b]). NMFS has three primary mandates with regard to this Proposed Action: 1) implement the ESA; 2) carry out its federal trust responsibilities with Native American tribes, including protecting the exercise of federally-recognized treaty tribal fishing rights and; 3) provide for sustainable fishing opportunity. In addition, Presidential Executive Orders require that NMFS minimize conflicts between its implementation of the ESA and exercise of tribal activities (E.O. 13175), e.g., treaty reserved fishing rights, and fishing (E.O. 12962). The Secretarial Order (DOI Order 3206) requires that any restrictions of tribal fishing under the ESA 1) be reasonable and necessary for the conservation of the species at issue; 2) occur only when the conservation purpose of the restriction cannot be achieved by reasonable regulation of non-Indian activities; 3) be the least restrictive alternative available to achieve the conservation purpose; 4) not discriminate against Indian activities either as stated or implied; <u>and</u> 5) that voluntary tribal measures are not adequate to achieve the necessary conservation purpose. NMFS staff has proposed to conclude that Alternative 1 (the Proposed Action) would not appreciably reduce the likelihood of survival or recovery of listed Puget Sound chinook salmon[1]. Therefore, the further reductions in fisheries, and tribal fisheries specifically, that would occur with implementation of Alternative 2, 3, or 4 are not required to meet ESA requirements, and would represent an unreasonable and unnecessary constraint on the exercise of federally-recognized treaty fishing rights. In addition, the approach represented in Alternative 1 is more robust overall to management error and key uncertainties in environmental parameters (see Subsection 4.3.8, Fish: Indirect and Cumulative Effects) and therefore should better

[1] NMFS' Proposed 4(d) Evaluation and Determination for the Puget Sound chinook resource management plan is currently undergoing public comment and review.

protect salmonid resources evaluated in the Environmental Impact Statement and better promote sustainable fishing opportunities.

Under the most likely scenario to occur over the duration of the Proposed Action (the ~~2004~~ 2005–2009 fishing seasons), implementation of Alternative 2, 3, or 4 is predicted to result in the loss of more than 94 percent of the local and regional sales, employment, and personal income generated by commercial salmon fishing associated with the Puget Sound fishery. Reductions in sport fishing-related economic activity would range from 12 to 72 percent (see Subsection 4.6, Economic Activity and Value: Environmental Consequences). These predicted effects would be most severe in communities dependent upon commercial and sport fishing activities. Combined with substantial declines in fishing industries that these communities have already experienced over the past 20 years, these predicted effects would further affect the character and viability of these communities, especially tribal communities (see Subsections 4.5, Treaty Indian Ceremonial and Subsistence Salmon Uses: Environmental Consequences; and 4.7, Environmental Justice: Environmental Consequences). The primary basis for the identification of Alternative 4 as the Environmentally Preferred Alternative was the increased abundance in fish species. Alternative 4 (as well as Alternative 2 or 3) would provide for substantially larger escapements of salmonids, larger abundance of forage fish, and a slightly greater possibility of rebuilding some individual listed Puget Sound chinook populations more quickly. However, given the discussion above, it is unclear what realistic effect this would have on the status of salmonid populations. NMFS has tentatively concluded that Alternative 1 will meet ESA requirements. Management objectives for the other salmonid species are also predicted to be met. Since Alternative 1 also provides for the conservation needs of these resources, NMFS does not consider the predicted reduction in adverse biological impacts from the implementation of Alternative 4 substantial enough to outweigh the significant economic losses that would be prevented under Alternative 1.

Finally, NEPA regulations require that the selected alternative be consistent with the purpose and need for the Proposed Action. Alternative 4 would be inconsistent with several elements of the purpose and need for the Proposed Action, and would not have been considered were it not one of the alternatives identified for analysis in the settlement agreement to Washington Trout v. Lohn. It would not: 1) provide for the meaningful exercise of federally protected treaty fishing rights; 2) provide for tribal and non-tribal fishing opportunity co-managed under the jurisdiction of U.S. v Washington; or 3) optimize harvest of abundance of Puget Sound salmon while protecting weaker commingled chinook salmon stocks.

List of Acronyms

CCEG	Current-condition escapement goal
CEQ	President's Council on Environmental Quality
CET	Critical escapement threshold
CFR	Code of Federal Regulations
CWT	Coded-wire tag (or tagged)
EPA	U.S. Environmental Protection Agency
ER	Exploitation rate
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FIRE	Finance, Insurance and Real Estate sectors
FR	Federal Register
FRAM	Fisheries Regulation Assessment Model
IMPLAN	Impact Analysis and Planning Professional (Minnesota IMPLAN Group)
LIFT	License and Fish Ticket database (Washington Department of Fish and Wildlife)
NEPA	National Environmental Policy Act
NFP	Northwest Forest Plan
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPFMC	North Pacific Fisheries Management Council
NWIFC	Northwest Indian Fisheries Commission
PBR	Potential Biological Removal value
PFMC	Pacific Fisheries Management Council
PSAMP	Puget Sound Ambient Monitoring Program
PSC	Pacific Salmon Commission
PST	Pacific Salmon Treaty
RER	Recovery exploitation rate
RMP	Resource Management Plan
SFA	Sustainable Fisheries Act
TMOSNRT	*TENYO MARU* Oil Spill Natural Resources Trustees
USFWS	United States Fish and Wildlife Service
VET	Viable escapement threshold

VSP	Viable Salmonid Population guidelines
WDFW	Washington Department of Fish and Wildlife
WTP	Willingness to pay
WWTIT	Western Washington Treaty Indian Tribes

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APPENDICES

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Glossary

4(d) Rule	Regulations adopted by the Secretary of Commerce that he/she deems necessary and advisable for the conservation of threatened species. For this document, the 4(d) Rule specifically means those regulations published by NMFS on July 10, 2000 for fourteen listed salmon ESUs.
Action area	See Puget Sound Action Area, below.
Adjudicated fishing rights	Fishing rights of federally-recognized Indian tribes that have been established pursuant to court decree.
Adverse impact	An impact that has a negative consequence.
Alleles	Location in the genetic material (DNA) where genetic traits are carried. The type and frequency of the alleles in a population constitutes the genetic diversity of the population.
Alternatives	Reasonable actions that fit the purpose and need for the Proposed Action.
Angler days	Trips by sport fishermen.
Annex	The detailed agreements that implement the principles of the Pacific Salmon Treaty.
Asymptote	A straight line approached by a given curve as one of the variables in the equation of the curve approaches infinity.
Authorized take	Take of a listed species defined in the ESA as “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct” conducted in a manner approved by the federal agency with jurisdiction over that listed species; i.e., NMFS or USFWS.
Bag limit	The number of fish allowed to be harvested in recreational fisheries within a certain time frame, e.g., angler trip. It may also be measured relative to another species; e.g., two salmon, only one of which is a chinook.
Beneficial impact	An impact that has a positive consequence.
Blackmouth	Immature chinook salmon.
Brood year	The year in which returning salmon adults spawn or the year in which the parents of a group of fish of the same age spawned.
Bycatch	Unintentional capture of marine birds or mammals during fisheries using any of a variety of gear types.
Carcass biomass	The volume of spawning salmon, measured in this document by spawner abundance.
Ceremonial uses	Salmon is a traditional food of Puget Sound Native American tribes. Examples of ceremonies that require traditional meals, including salmon, are: winter ceremonials, naming ceremonies, giveaways and feasts, and funerals.
Cetaceans	Whales, dolphins, porpoise.

Chinook-directed fisheries	Fisheries with the objective of harvesting chinook salmon.
Coded-wire tags	Minute, implanted tags in a portion of hatchery-reared salmon that reveal information about their origin.
Cohorts	Fish of a given age and stock at the beginning of a particular year of life.
Co-managers	Washington Department of Fish and Wildlife, and Puget Sound Treaty Tribes.
Commingle	To mix together.
Critical escapement threshold	A level of escapement below which extinction risk increases substantially.
Cumulative impact	The impact on the environment that would result from the incremental effects of the proposed action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (CEQ 1508.7).
Current-condition escapement threshold	The number of spawners that meet the productivity and capacity constraints of a given river system.
Depensatory mortality	Mortality that occurs at very low population abundance that has the affect of destabilizing or further destabilizing the population.
Depressed population	A population whose production is below expected levels based on available habitat and natural variations in survival rates, but above the level where permanent damage to the population is likely.
Direct effect	An effect that would be caused by the proposed action or alternatives and occur at the same time and place as the action. Direct effects typically arise from construction activities, and may also occur from operations associated with the proposed action or alternatives (40CFR 1508.8[a]).
Disproportionate effect	An incidence (or prevalence) of an effect, a risk of an effect, or likely exposure to environmental hazards that would potentially cause adverse effects on a minority and/or low income population that significantly exceeds that experienced by a comparable reference population – a form of effects analysis used in the Environmental Justice subsection (4.7).
Diurnal foraging	Daytime foraging.
Endangered species	The ESA defines a threatened species as "any species which is in danger of extinction throughout all or a significant portion of its range other than a species of the Class *Insecta* determined by the Secretary to constitute a pest whose protection under the provisions of this Act would present an overwhelming and overriding risk to man."
Escapement	The number of spawning adult salmon that return to a particular geographic area.
Escapement floor	The number of spawning adult salmon for a population or management unit that harvest management actions are designed to meet or exceed.

Escapement goal	A management objective expressed as the number of fish returning to natural or artificial (hatchery) spawning areas.
Escapement goal management	A harvest management strategy whereby fisheries are managed to achieve an escapement goal(s).
Estuarine habitat	Tidal flats and river mouths (like Padilla Bay and the mouth of the Nooksack River).
Exploitation	Harvest.
Exploitation rate	The total mortality in a fishery or aggregate of fisheries expressed as the proportion of the un-fished cohort removed by fishing.
Exploitation rate ceiling	The maximum exploitation rate allowed for a population or management unit. A ceiling differs from a target in that fisheries are not managed to achieve the ceiling, but generally to fall below it.
Ex-vessel value	The dollar value that commercial fishermen receive for their product once it leaves the fishing vessel.
Fecundity	Fertility. For salmon, fecundity is measured as the number of eggs produced per female.
Federal trust responsibility	Duties and responsibilities of the federal government to manage the property and natural resources of the Tribes for the benefit of the Tribes.
Federally-recognized tribes	Any Indian or Alaska Native tribe, band, nation, pueblo, village or community that the Secretary of the Interior acknowledges to exist as an Indian tribe. The Secretary of the Interior is required to publish an annual list of such tribes in the Federal Register (25 USC sections 479a and 479a-1).
Fingerlings	Actively-feeding juvenile salmon within river systems.
Fishing regime	The specific group of fishery actions/regulations that are taken to achieve fishery management objectives.
Fry	Newly-emerged salmon.
Genetic diversity	The variation in inherited traits.
Genetic integrity	Maintenance of unique genetic characteristics of a population.
Genome	The genetic material (DNA, chromosomes) contained in living cells.
Ghost net	Fishing nets, especially gillnets, that have been lost but continue to capture fish, marine birds, marine mammals and crabs.
Harvest	Fish killed as a result of encounters with fishing gear.
Harvest rate	Total fishing mortality in a fishery expressed as a proportion of the total fish abundance available (standing stock) in a given fishing area at the start of a time period.
Hatchery-origin fish	Fish whose parents spawned or were spawned in a hatchery.
Hatchery-spawning fish	Same as hatchery-origin fish.

Healthy population	A population experiencing production levels consistent with its available habitat and within the natural variations in survival for the population.
Hood Canal region	For purposes of this analysis, the Hood Canal region includes Jefferson, Kitsap and Mason Counties, and the following river systems: Skokomish, Hamma Hamma, Dosewallips, Duckabush, Big Quilcene, and Little Quilcene.
Hook-and-line fishery	Fisheries that use hook-and-line gear, e.g., troll and sport fisheries, to catch fish.
Hook-ups	The occurrence of catching marine birds in hook-and-line sport fisheries.
Incidental catch	Fish captured during a fishery targeted at another species.
Incidental take	Accidental harm or death caused to a threatened or endangered species during a fishery targeted at another species.
Indicator populations	Hatchery produced salmon that are marked with coded-wire tags and are used to represent associated wild spawning populations.
Indirect effect	Reasonably foreseeable effects that would be caused by the proposed action or alternatives, but which would occur later in time or further removed from the project site or action area than direct effects. Indirect effects may also include those resulting from actions that may have both beneficial and detrimental effects, even if on balance the lead agency believes the effect will be beneficial. Indirect effects may be growth-inducing or otherwise related to changes in land use patterns, population density, or growth rate, and may affect air quality, water, and/or other natural systems (40CFR 1508.8[b]).
Inland marine deeper water habitat	Marine waters of Puget Sound greater than 66 feet deep.
Listed species	Species listed under the Endangered Species Act as threatened or endangered.
Low effect	Measurable but of small amount or occurs infrequently.
Marine Catch Areas	Geographic areas in marine and freshwaters defined for the purposes of reporting catch.
Marine-derived nutrients	The input of nutrients into freshwater systems associated with the return, death and decomposition of adult salmon.
Management unit	A population or group of populations aggregated for the purpose of achieving a management objective.
Marine shelf habitat	Deepwater habitat of the Strait of Juan de Fuca west of a line from the mouth of the Elwha River north to Race Rocks on the southern tip of Vancouver Island, influenced by oceanic currents.
Mesocosm	Communities in the middle or community structure that transitions from one layer to another, e.g., rock-insect-fish.
Moderate effect	Measurable at some level between low and substantial.
Morphology	The form and structure of an organism.

Morphological	Pertaining to the form and structure of an organism.
Mortality	Number or amount of salmon killed.
Natal stream	Stream of origin.
Natural escapement	The number of fish spawning in the wild regardless of whether their parents spawned in the wild or in a hatchery.
Naturally-spawning	Spawning in the wild.
Nearshore marine habitat	Marine areas of Puget Sound between high tide and the end of the photic zone (66 feet depth).
Net economic value to commercial fishermen	The amount of total revenues received by vessel operators less the costs of production, including wages, operational expenses (like fuel and equipment), and fixed costs (such as insurance and depreciation).
Net economic value for sport anglers	The amount anglers would be willing to pay over and above what they actually pay is the measure of net economic value (or the value received) to anglers.
No effect	Not measurable and/or expected, or of such a rare occurrence that it is impossible to measure or detect.
North Hood Canal	The Economic Activity analysis of this Environmental Assessment addresses North Hood Canal (Jefferson County) and Clallam County in a subregion identified as Strait of Juan de Fuca/North Hood Canal.
North Puget Sound region	For purposes of this analysis, the North Puget Sound region includes Snohomish, Skagit, Whatcom, Island and San Juan Counties, and the following river systems: Nooksack, Samish, Skagit, Stillaguamish, and Snohomish.
Nutrient loading	The nutrients released into a system proportional to carcass density.
Otoliths	Bones in the head of a fish that indicate age.
Out-of-watershed-origin chinook	Chinook originating from a watershed other than that in which they are found, or chinook originating from a watershed other than that under discussion.
Population areal unit	The geopolitical unit used for purposes of the Environmental Justice analysis. Contains the populations used to define the target area: by county.
Precocious	Age-2 fish.
Productivity of systems	The survival rate of a population from a particular watershed from one life stage to another measured after taking into consideration mortality occurring during that period, e.g., juveniles produced per spawning adult.
Progeny	Offspring of spawning salmon.
Proposed Action	The Puget Sound chinook harvest management framework proposed by the Washington Department of Fish and Wildlife and the Puget Sound Treaty Tribes (co-managers).

Puget Sound Action Area	All marine waters of the State of Washington east of, and including, the Strait of Juan de Fuca; all State of Washington freshwater tributaries to these marine waters east of the Strait of Juan de Fuca; the freshwater tributaries of the Strait of Juan de Fuca east of, and including, the Elwha River drainage; and the counties that border these waters.
Pulsed openings	Fishery openings scheduled for short duration. These openings are generally scheduled throughout the period over which salmon move through an area so that harvest is not focused on any one segment of the run.
Rebuilding exploitation rate	A harvest objective used by NMFS that defines the level of salmon fishery exploitation that would result in a low probability that the harvest action will endanger the population, and a relatively high probability that it will not impede recovery.
Recovery exploitation rate	A harvest objective used by the co-managers that defines the level of salmon fishery exploitation that would result in a low probability that the harvest action will endanger the population, and a relatively high probability that it will not impede recovery.
Recruits	The number of salmon in an the unfished cohort produced from a single brood year (parental escapement).
Redds	"Nests" constructed by salmon in gravel.
Redd superimposition	A phenomena that occurs when later arriving adult spawners spawn in the same places as earlier arriving adult spawners, in effect, digging up redds dug by previous spawners. This generally causes significant mortality to the eggs laid by the previous spawners.
Reference area	For purposes of the Environmental Justice analysis in this Environmental Assessment, the reference area is the State of Washington.
Resource management plan	A plan that includes a process, specific regulations, management objectives or other information required to manage a natural resource. For this document, the natural resource would be salmon.
Run timing	The time over which a population or group of populations move through or into an area, e.g., the time over which adults return to the spawning grounds.
Salmonids	All fishes belonging to the taxonomic family *Salmonidae*; i.e., salmon and trout.
Smolts	Actively-feeding juvenile salmon, physiologically ready to migrate to salt water.
Smolting	Transitional life stage of juvenile salmon at the point where they move from fresh water to salt water; may occur in a river or within an estuary.
South Hood Canal	The Economic Activity analysis of this Environmental Assessment addresses South Hood Canal (Mason and Kitsap counties) and South Puget Sound (King, Pierce and Thurston counties) in a subregion identified as South Puget Sound/South Hood Canal.

South Puget Sound region	For purposes of this analysis, the South Puget Sound region includes King, Pierce, and Thurston Counties, and the following river systems: Cedar, Green/Duwamish, Puyallup, Nisqually, Deschutes, and Shelton.
Southern U.S. fisheries	Chinook salmon fisheries occurring in Puget Sound and off the Pacific coast of Washington, Oregon and California.
Spawner density	The number of spawning salmon per area of spawning habitat.
Spawning escapement	The number of sexually-mature adults returning to spawning grounds.
Strait of Juan de Fuca region	For purposes of this analysis, the Strait of Juan de Fuca region includes Clallam County and the following river systems: Elwha and Dungeness.
Stratum	Sampling groups.
Straying	The occurrence of some hatchery-origin fish failing to return to the hatchery at the time of spawning.
Straying rate	The proportion of total hatchery-origin escapement not removed from the natural environment through trapping, or the number of hatchery-origin salmon that otherwise strayed from their point of release.
Subsistence uses	The ways in which indigenous people utilize the environment and the resources it provides (such as salmon) to meet the nutritional needs of the members of the society.
Substantial effect	A high impact that is measurable and/or expected, or likely to occur more frequently than anticipated.
Sub-yearlings	Juvenile salmonids that migrate as fingerlings.
Take	The ESA defines take as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, import or export, ship in interstate commerce in the course of commercial activity, or sell or offer for sale in interstate or foreign commerce any wildlife species listed as endangered, without written authorization.
Take prohibition	Ban of take.
Target area	The geographical study area for purposes of the Environmental Justice analysis; synonymous with the Puget Sound Action Area in this case.
Target population	The potentially affected residents of each county within the target area.
Terminal areas	Locations containing only populations that return to a single river system.
Terminal fisheries	Freshwater fisheries only; i.e., within rivers and lakes.
Terminal net fisheries	Freshwater fisheries that use net fishing gear; e.g., drift gill nets, set gill nets, beach seines, dip nets.
Threatened species	The ESA defines a threatened species as “any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.”
Transport vectors	Stream flow, stream channel structure, and similar factors.
Unlisted species	Species that have not been listed under the Endangered Species Act as threatened or endangered

Usual and accustomed fishing areas	Traditional Indian fishing grounds so designated through judicial process. Defined in the Boldt Decision (383 Federal Supplement 312: 313) as every fishing location where members of an Indian tribe customarily fished from time to time at and before treaty times, however distant the then-usual habitat of the tribe, and whether or not other tribes then also fished in the same waters.
U.S. v. Washington	Commonly referred to as “The Boldt decision”, U.S. v Washington is the on-going Federal court proceeding that enforces and implements reserved treaty fishing rights with regard to salmon and steelhead returning to Western Washington.
Viable escapement threshold	A level of escapement that would generally indicate recovery or a point beyond which ESA protection is no longer required.
Viable Salmonid Population guidelines	Generic values or descriptive guidelines for abundance, productivity, spatial structure and diversity provided by NMFS in Viable Salmonid Populations and the Recovery of Evoluntionarily Significant Units (McElhany et al., 2000) used as one factor in assessing the status of population where population-specific information is not available.
Wild exploitation rate	The total mortality in a fishery or aggregate of fisheries expressed as the proportion of the un-fished cohort whose parents spawned the wild that are removed by fishing.
Wild-origin fish	Fish whose parents spawned in the wild
Yearlings	Juvenile salmon that have reared at least one year in freshwater

Purpose and Need for the Proposed Action

1

1.0 PURPOSE AND NEED FOR THE PROPOSED ACTION

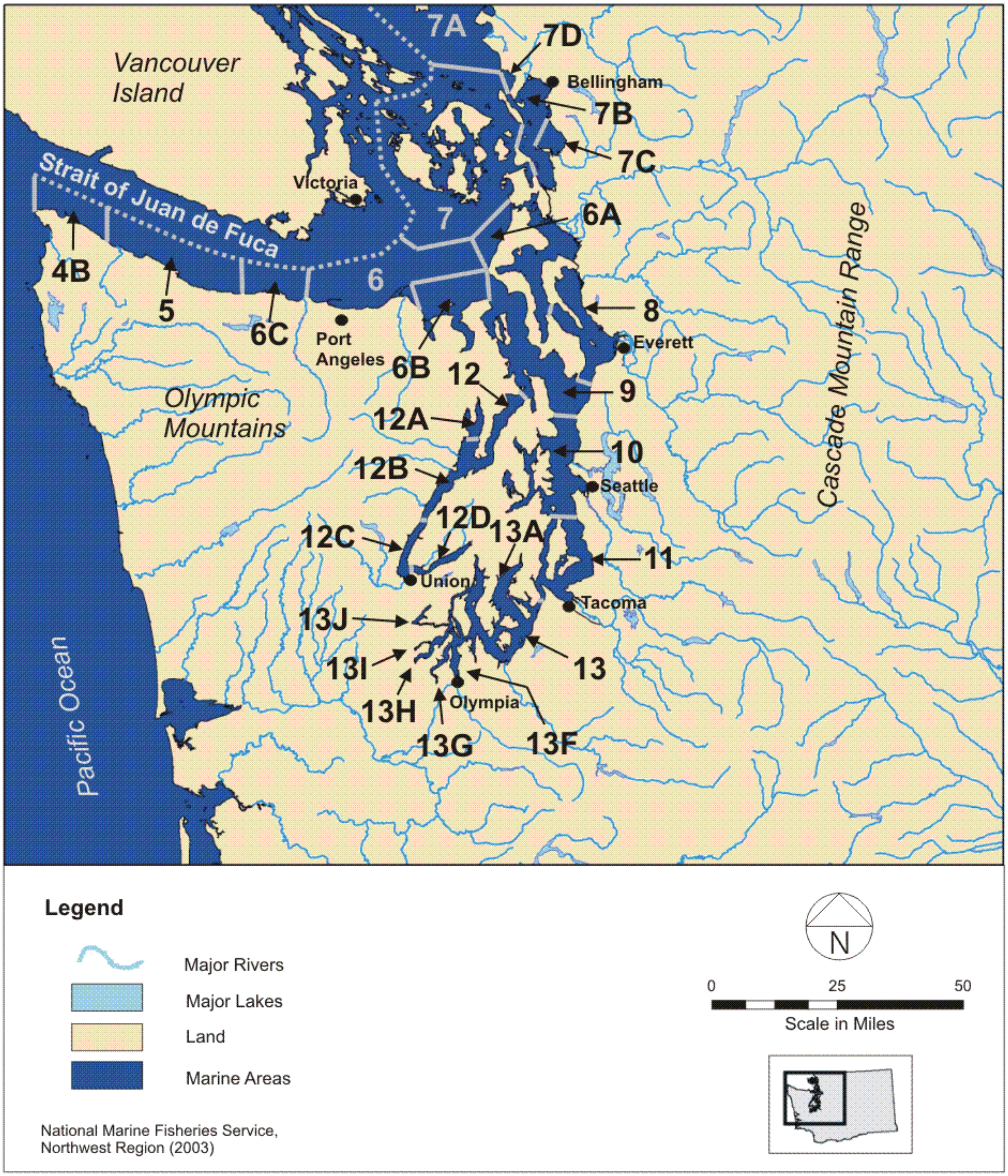
1.1 Introduction

The Proposed Action is implementation of the ~~2004–2009~~ Puget Sound Chinook Harvest Resource Management Plan (RMP), jointly-developed by the Washington Department of Fish and Wildlife, and the Puget Sound treaty tribes (hereafter referred to as the 'co-managers'), under Limit 6 of the Endangered Species Act (ESA) 4(d) Rule (see Subsection 1.5) for the 2005 through 2009 fishing seasons. The RMP regulates salmon harvest and steelhead net fisheries within Puget Sound and the Strait of Juan de Fuca that take Puget Sound chinook. The ESA defines take as:

> " . . . to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, import or export, ship in interstate commerce in the course of commercial activity, or sell or offer for sale in interstate or foreign commerce any wildlife species listed as endangered, without written authorization."

The proposed RMP is the fisheries management component of the co-managers' recovery plan for Puget Sound chinook salmon. It encompasses commercial, recreational, ceremonial, and subsistence salmon fisheries potentially affecting the listed Puget Sound Chinook Evolutionarily Significant Unit (ESU) within the marine and freshwater areas of Puget Sound, from the entrance of the Strait of Juan de Fuca inward (Figure 1.1-1). It excludes Washington Commercial Salmon Management Catch Reporting Area 4B (hereafter referred to as Marine Catch Areas) during the months of May to September, when this area is under the jurisdiction of the Pacific Fisheries Management Council. Harvest objectives specified in the RMP account for fisheries-related mortality of Puget Sound chinook throughout the migratory range of this species – from Oregon and Washington to Southeast Alaska. The RMP also includes implementation, monitoring, and evaluation procedures designed to ensure fisheries are consistent with the RMP's objectives for conservation and use. Fishery activities under the RMP would affect the listed Puget Sound chinook and Hood Canal summer-run chum ESUs. The RMP does not include the specific details of an annual fishing regime – i.e., where and when fisheries occur; what gear will be used; or how harvest is allocated among gears, areas or fishermen. Salmon abundance is highly variable from year to year, both among chinook populations and other salmon species, requiring managers to formulate fisheries to respond to the population abundance conditions particular to that year. Therefore, the RMP provides the framework and objectives against which the co-managers must develop their annual action-specific fishing regimes to protect Puget Sound chinook salmon and meet other management objectives.

Figure 1.1-1. Washington commercial salmon management marine catch reporting areas



1.2 Summary of the Proposed Action

The Proposed Action is implementation of the ~~2004–2009~~ Resource Management Plan (RMP) for Puget Sound chinook salmon for the 2005 through 2009 fishing seasons. The RMP is a jointly-prepared proposal of the Washington Department of Fish and Wildlife, and the Puget Sound treaty tribes (co-managers) under Limit 6 of the ESA 4(d) Rule. The RMP is a set of objectives for chinook salmon populations that guide the co-managers in shaping annual harvest management measures. It encompasses:

- Tribal and non-tribal commercial, recreational, ceremonial and subsistence salmon fisheries, and steelhead net fisheries taking listed Puget Sound chinook
- Marine areas and freshwater rivers of Puget Sound, from the entrance of the Strait of Juan de Fuca inward, excluding fisheries under the jurisdiction of the Pacific Fisheries Management Council
- Implementation, monitoring, and evaluation procedures designed to ensure fisheries are consistent with the objectives of the RMP
- Application of Limit 6 for the period May 1, ~~2004~~ 2005 through April 30, 2010.

1.3 Purpose and Need for the Proposed Action

The need for the Proposed Action is to provide for harvest of salmon species in Puget Sound marine and freshwater areas that:

- Provides for the meaningful exercise of federally-protected treaty fishing rights
- Provides for tribal and non-tribal fishing opportunity co-managed under the jurisdiction of U.S. v. Washington
- Meets the requirement of Limit 6 of the 4(d) Rule under the Endangered Species Act (ESA): ". . . not appreciably reducing the likelihood of survival and recovery" of Puget Sound chinook (50 CFR 223.203[b][6][i]).

The purpose of the Proposed Action to meet the need for the action is to:

- Ensure the sustainability of Puget Sound chinook salmon by conserving the productivity, abundance and diversity of the populations within the Puget Sound chinook ESU
- Manage risk associated with abundance estimation, population dynamics, and management implementation
- Meet the criteria under Limit 6 of the ESA 4(d) Rule
- Optimize harvest of abundant Puget Sound salmon (coho, chinook, sockeye, pink, chum) while protecting weaker commingled chinook stocks

- Account for all sources of fishery-related mortality
- Provide equitable sharing of harvest opportunity among tribes, and among treaty and non-treaty fishers pursuant to U.S. v. Washington and U.S. v. Oregon
- Achieve the guidelines for allocation of harvest benefits and conservation objectives for chinook salmon under the Pacific Salmon Treaty
- Protect treaty Indian fishing rights and meet federal treaty trust responsibilities.

1.4 Background to Purpose and Need

The Puget Sound Chinook Evolutionarily Significant Unit (ESU)[i] was listed as threatened under the Endangered Species Act (ESA) in March 1999 (64 Federal Register 14308, March 24, 1999; 50 CFR 223.102[a][16]). The ESU encompasses all naturally-spawned spring, summer, and fall-runs of chinook salmon in the Puget Sound region from the North Fork Nooksack River to the Elwha River on the Olympic Peninsula. Puget Sound chinook salmon have a complex life history, migrating from their natal streams throughout Puget Sound to the Pacific Ocean. In their ocean migration, they travel north along the west coast into Canadian waters, and at times as far north as Alaskan waters (Figure 1.4-1). In doing so, they are caught in a broad range of fisheries, managed by an array of agencies, bodies and governments, including the U.S. Department of Commerce; States of Washington, Oregon, and Alaska; more than 20 Native American tribal jurisdictions; the North Pacific Fisheries Management Council; the Pacific Fisheries Management Council (PFMC); Canadian Department of Fisheries and Oceans; and the Pacific Salmon Commission (PSC) (Figure 1.4-2). Salmon fisheries within Puget Sound and the Strait of Juan de Fuca are jointly managed by the Washington Department of Fish and Wildlife (WDFW) and the Puget Sound treaty tribes, under the continuing jurisdiction of U.S. v. Washington (Civil No. C70-9213, Western District, Washington; see 384 Federal Supplement 312, Western District, Washington, 1974).

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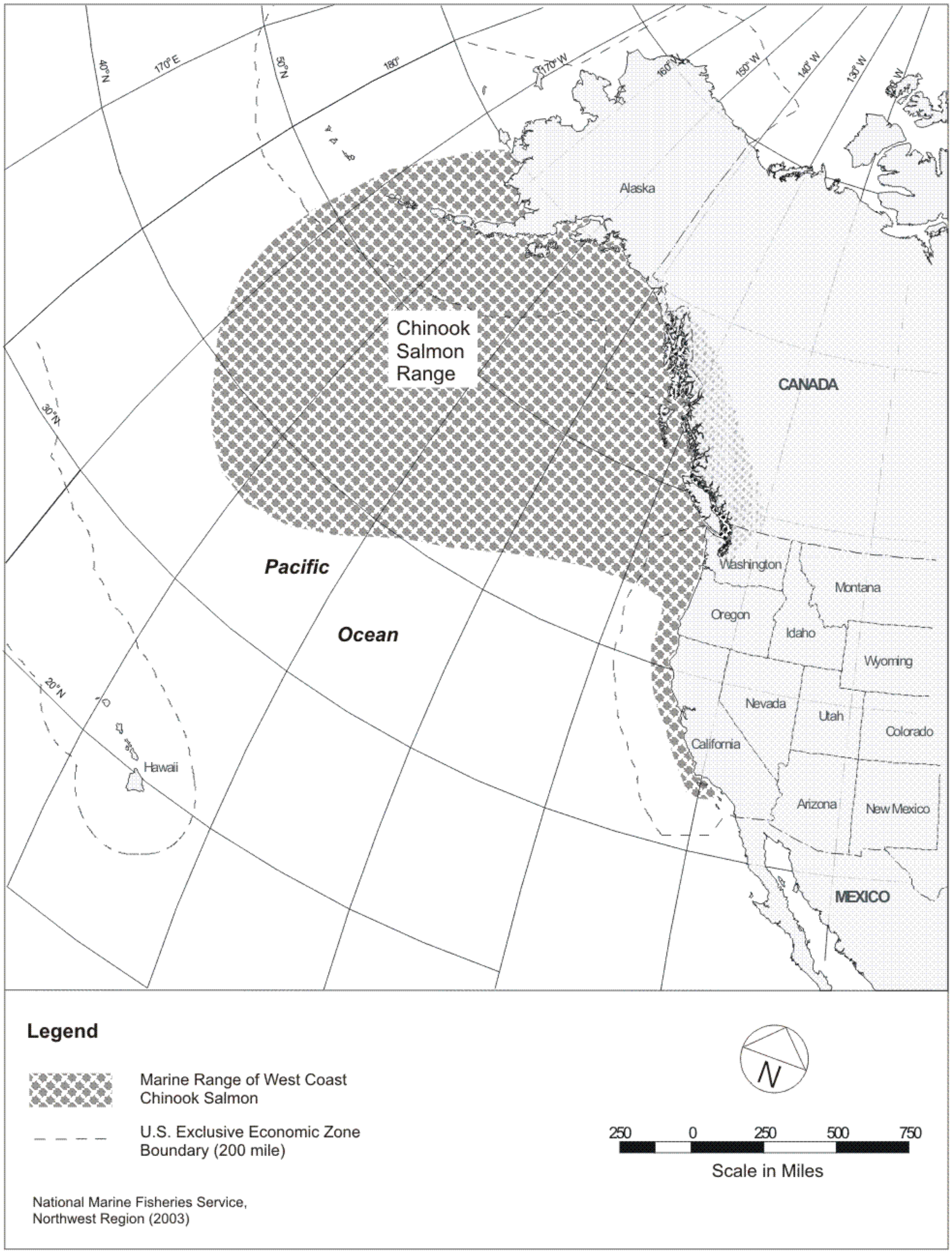
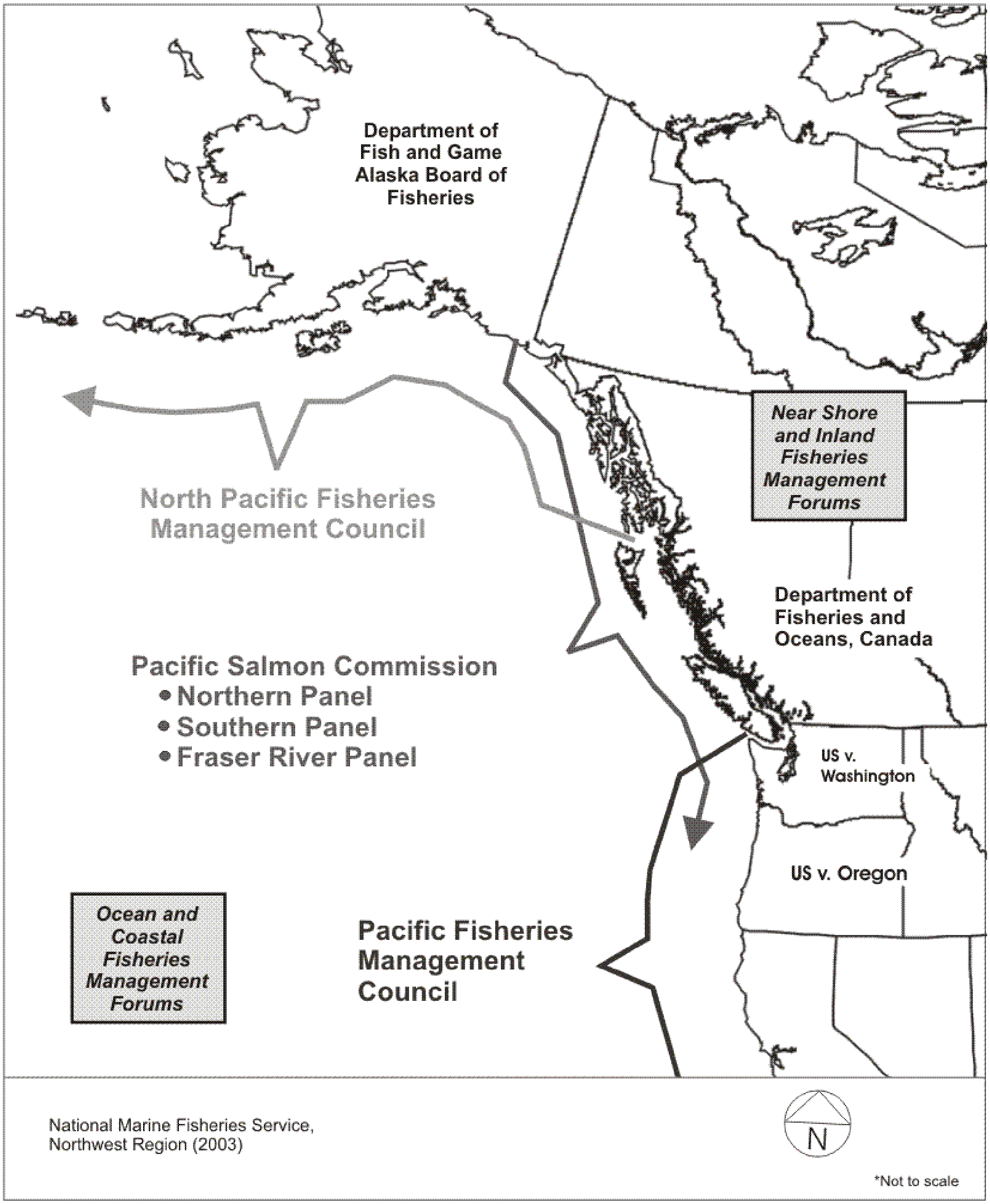
[i] For the purposes of fulfilling the mandates of the ESA, NMFS treats ESUs as “species” as the Act defines the term “...including any subspecies of fish or wildlife or plants, and any distinct population segment of any species or vertebrate fish or wildlife which interbreeds when mature” (16 U.S.C. § 1531-1544).

Figure 1.4-1. Marine range of west coast chinook salmon.



Source: K. Schultz, National Marine Fisheries Service 2001.

1 Figure 1.4-2. Fisheries management forums.



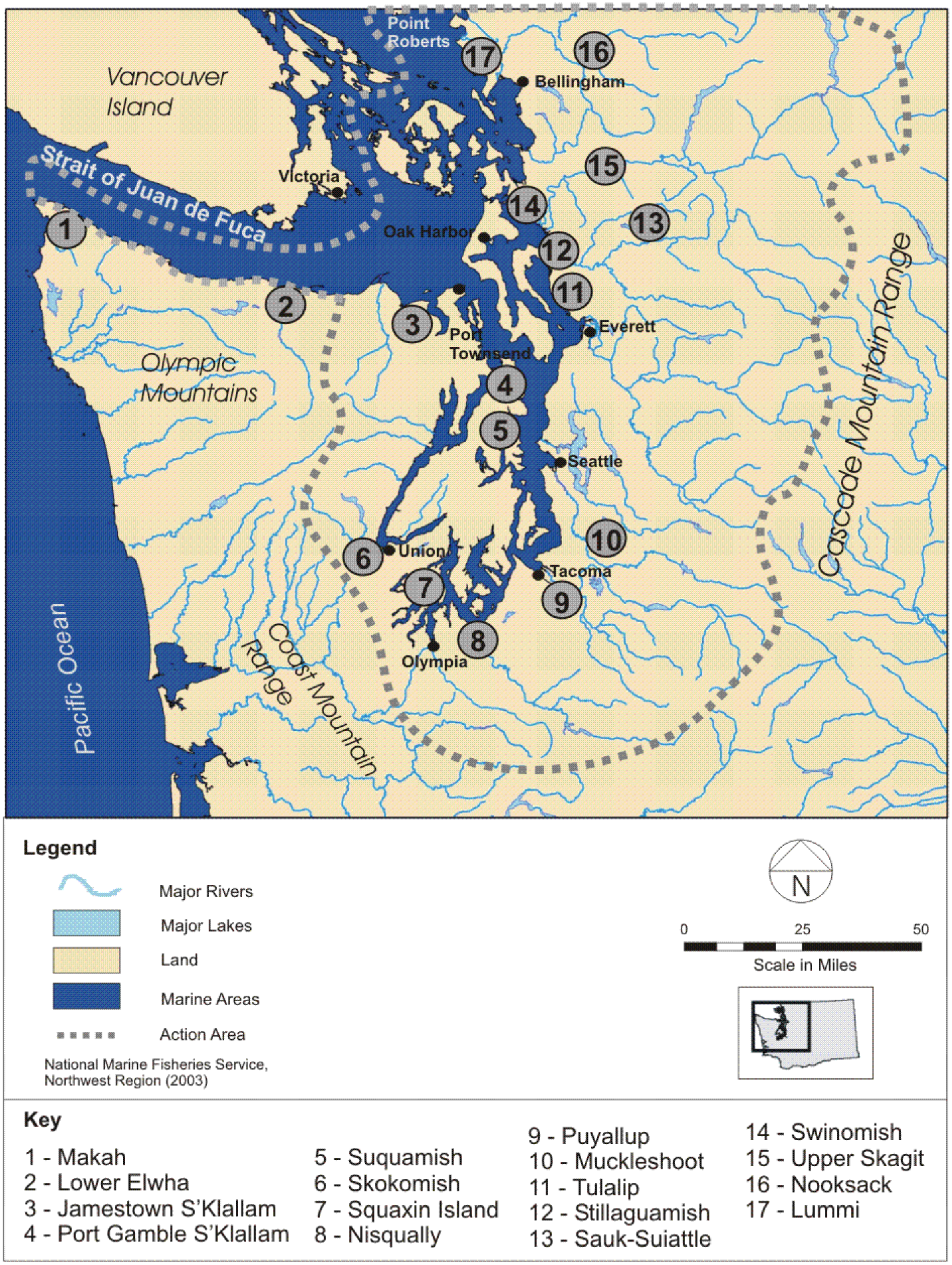
2

U.S. v. Washington is the on-going Federal court proceeding that enforces and implements reserved treaty fishing rights with regard to salmon and steelhead returning to western Washington. The Puget Sound treaty tribes include the Makah, Lower Elwha Klallam, Jamestown S'Klallam, Port Gamble S'Klallam, Suquamish, Skokomish, Squaxin Island, Nisqually, Puyallup, Muckleshoot, Tulalip, Stillaguamish, Sauk-Suiattle, Swinomish, Upper Skagit, Nooksack and Lummi tribes (Figure 1.4-3).

Since the Puget Sound Chinook Evolutionarily Significant Unit (ESU) was listed in 1999, the National Marine Fisheries Service (NMFS) has evaluated the impact of Alaskan, Canadian and southern U.S. salmon fisheries affecting listed Puget Sound chinook under section 7 of the ESA, and evaluated fisheries resource management plans (RMP) in 2001 and 2003 for Puget Sound chinook under the 4(d) Rule Limit 6. NEPA reviews were also conducted on the 2001 and 2003 RMPs as part of the overall assessment of those RMPs. The current application of Limit 6 to the RMP expired~~s~~ on May 1, 2004. The co-managers jointly-developed another harvest RMP for Puget Sound commercial and recreational salmon, and steelhead net fisheries taking listed Puget Sound chinook for the 2004–2009 fishing seasons that began May 1, 2004. NMFS conducted a consultation under Section 7 of the ESA and issued a Biological Opinion in June of 2004 that the 2004 fishing season was not likely to jeopardize the Puget Sound Chinook ESU (NMFS 2004). The RMP is hereby incorporated by reference (see Appendix A). The co-managers provided the RMP to NMFS, and NMFS is evaluating the RMP under Limit 6 of the Endangered Species Act (ESA) section 4(d) rule for the 2005–2009 fishing season, beginning May 1, 2005. Implementation of the RMP for the 2005–2009 fishing seasons is evaluated in this EIS.~~The co-managers have provided another jointly-developed harvest RMP for Puget Sound commercial and recreational salmon, and steelhead net fisheries taking listed Puget Sound chinook to NMFS for consideration under Limit 6 of the Endangered Species Act (ESA) section 4(d) rule for the 2004–2009 fishing years, beginning May 1, 2004. The RMP is hereby incorporated by reference (see Appendix A).~~

Application of Limit 6 to the proposed RMP would ensure that in conducting fishery activities, the co-managers would not be subject to ESA section 9 take prohibitions because these activities would be conducted in a way that contributes to conserving the listed ESUs, or would be governed by regulations that adequately limit impacts to listed salmon. For NMFS to apply the provisions of Limit 6 for implementing a RMP, the co-managers must jointly prepare a fishing plan that meets the requirements defined under Limit 6 of the 4(d) rule (see Subsection 1.5). Because implementation of the proposed fishing plan relies on NMFS' determination that the plan meets the criteria of Limit 6 of the 4(d) Rule, meeting the Limit 6 criteria is an essential element of the Purpose and Need for the Proposed Action.

Figure 1.4-3. Locations of federally-recognized Puget Sound treaty tribes that are parties to the proposed action.



NMFS must then make a determination pursuant with the government-to-government processes of the Tribal 4(d) Rule that the RMP, as proposed and implemented by the co-managers, does not appreciably reduce the likelihood of survival and recovery of Puget Sound chinook (50 CFR 223.203[b][6][i]). The NMFS determination under the 4(d) Rule is the Federal action that triggers review under the National Environmental Policy Act (NEPA) (NOAA Administrative Order 216.6.03[2][a]).

Washington Trout, a Puget Sound environmental group, challenged the adequacy of the NEPA Environmental Assessment used by NMFS for its determination for the 2001 Puget Sound chinook harvest RMP (Washington Trout v. Lohn, No. C01-1863R, Western District, Washington). As part of the settlement agreement reached with Washington Trout (July 22, 2002), NMFS agreed to prepare an Environmental Assessment for its determination for a one-year RMP in 2003, and an Environmental Impact Statement for its determination related to a long-term RMP in 2004 and subsequent years[ii]. NMFS agreed to include alternatives suggested by Washington Trout in its list of alternatives for analysis. Under the terms of the settlement agreement, the alternatives for the Environmental Impact Statement include:

1) The Proposed Action (the proposed RMP)
2) Escapement goal management at the management unit level with no restriction on where fisheries may take place
3) Escapement goal management at the individual population level with terminal fisheries only
4) No authorized take of listed Puget Sound chinook salmon within the Strait of Juan de Fuca and Puget Sound area.

A description of the Proposed Action and alternatives is provided in Section 2.

This Environmental Impact Statement was prepared by the National Marine Fisheries Service and a team of technical consultants in support of the environmental determination to be made by NMFS concerning the Proposed Action. This Environmental Impact Statement evaluates the environmental consequences associated with the RMP jointly-developed by the co-managers (the Proposed Action/Status Quo), and reasonably foreseeable environmental impacts associated with alternatives to

[ii] Because of the delay in completing the EIS in time for the 2004 fishing season, Washington Trout agreed to an ESA section 7 consultation by NMFS for the 2004 fishing season. This agreement was entered into the court, and the original stipulation was modified to reflect the new agreement.

the proposed RMP, including those alternatives evaluated pursuant to the terms of the settlement agreement with Washington Trout.

1.5 ESA 4(d) Rule and Limit 6

Salmon and steelhead trout species in Washington have been in decline for years. Since 1992, nearly 30 ESUs of these species have been listed as threatened or endangered under the Endangered Species Act (ESA). Section 9 of the ESA imposes take prohibitions on species listed as endangered. However, section 4(d) of the ESA states that whenever a species is listed as threatened, the Secretary “shall issue such regulations as he deems necessary and advisable to provide for the conservation of the species.” Such protective regulations may include any or all of the prohibitions that apply automatically to protect endangered species under ESA section 9(a)(1). Those section 9(a)(1) prohibitions, in part, make it illegal for any person subject to the jurisdiction of the United States to “take” endangered species, as previously defined in Section 1.1.

Between 1997 and 1999, NMFS listed 14 ESUs of salmon and steelhead as threatened under the ESA, but did not immediately invoke the ESA section 4(d) protections (Table 1.5-1). In July 2000, NMFS promulgated 4(d) rules for the 14 threatened ESUs accompanied by a set of “limits” on the application of the ESA section 9 take prohibitions, provided that the specified categories of activities contribute to conserving listed salmonids or are governed by a program that adequately limits impacts to listed salmon and steelhead (65 Federal Register 42422, July 10, 2000).

In promulgating the 4(d) Rule, NMFS determined that the section 9 take prohibitions can be invoked with limited exceptions. NMFS thereby established a mechanism whereby entities can be assured that an activity they are conducting or permitting is consistent with ESA requirements, and avoids or minimizes the risk of take of listed threatened salmonids. When such a program contributes to conservation for listed salmonids, NMFS does not find it necessary or advisable to apply ESA section 9(a)(1) take prohibitions to activities governed by those programs. Under such limits to the section 9 take prohibitions, these categories of human activities must contribute to conservation for listed salmonids and their habitat, or be governed by a program that adequately limits impacts on listed salmon and steelhead. NMFS anticipates that by involving individuals and entities at the local and state program levels, they would become more engaged with salmon and steelhead conservation while providing NMFS with additional management tools for conservation of listed salmonids.

Table 1.5-1. The fourteen salmon and steelhead Evolutionarily Significant Units included in the ESA 4(d) rule and their listing information.

Evolutionarily Significant Unit (ESU)	Listing Status
Puget Sound Chinook Salmon ESU	Listed as a threatened species on March 24, 1999.
Lower Columbia River Chinook Salmon ESU	Listed as a threatened species on March 24, 1999.
Upper Willamette River Chinook Salmon ESU	Listed as a threatened species on March 24, 1999.
Oregon Coast Coho Salmon ESU [iii]	Listed as a threatened species on August 10, 1998.
Ozette Lake Sockeye Salmon ESU	Listed as a threatened species on March 25, 1999.
Hood Canal Summer-run Chum Salmon ESU	Listed as a threatened species on March 25, 1999.
Columbia River Chum Salmon ESU	Listed as a threatened species on March 25, 1999.
Upper Willamette River Steelhead ESU	Listed as a threatened species on March 25, 1999.
Middle Columbia River Steelhead ESU	Listed as a threatened species on March 25, 1999.
South-Central California Coast Steelhead ESU	Listed as a threatened species on August 18, 1997.
Central California Coast Steelhead ESU	Listed as a threatened species on March 19, 1998.
Snake River Basin Steelhead ESU	Listed as a threatened species on August 18, 1997.
Lower Columbia River Steelhead ESU	Listed as a threatened species on March 19, 1998.
Central Valley, California Steelhead ESU	Listed as a threatened species on March 19, 1998.

Source: 65 Federal Register 42422, July 10, 2000.

NMFS designed the limit approach to the 4(d) rule to meet the following objectives:

1) Ensure technical feasibility to yield consistent results in conserving listed species
2) Ensure effectiveness over a broad range of activities to contribute to conserving salmon throughout the Pacific Northwest and California
3) Develop a user-friendly process to encourage wide acceptance.

With these objectives in mind, NMFS established categories of actions that could reasonably proceed in a manner that contributes to conservation of listed salmonids. The 4(d) rule comprises 13 (total)

[iii] On February 24, 2004, the Ninth Circuit Court of Appeals dismissed the appeals in the Alsea Valley Alliance case. The practical effect of the decision is that there is currently no Federal protection under the ESA for Oregon Coastal coho.

limits on the ESA section 9 take prohibitions (65 Federal Register 42422, July 10, 2000),[iv] The limits cover activities from fishery management plans, to research programs, to habitat restoration activities and, in doing so, create several new avenues to comply with the ESA. The limits also create a means for NMFS to assess possible take impacts over broad areas and sets of actions rather than simply accounting for whether a given activity resulted in direct or incidental take.

Under Limit 6, state and tribal governments conducting jointly-managed fishing activities would not be subject to the ESA section 9 take prohibitions (with respect to actions implemented under the Resource Management Plan), provided that the fishing activities are implemented under a RMP that meets the requirements of Limit 6. For NMFS to determine that a RMP meets the requirements of Limit 6, the RMP must clearly define its intended scope and area of impact, and define management objectives consistent with the criteria referenced in Limit 6 of the 4(d) rule. It is important to note that a RMP determined by NMFS to meet Limit 6 requirements would not authorize activities conducted under a RMP *per se*; the co-managers would continue to regulate RMP activities. However, Limit 6 offers an option, in addition to those of ESA sections 7 and 10, to the co-managers to conduct fishing activities that avoid possible liability under the ESA while providing NMFS with an additional management tool for conserving listed species.

1.6 Fisheries Affecting Puget Sound Chinook Salmon

Puget Sound chinook salmon are harvested in a wide range of fisheries over a broad geographic area and with a variety of methods. They are caught in ocean fisheries throughout their migratory range from Alaska to California, and in marine areas and freshwater rivers of Puget Sound and the Strait of Juan de Fuca (NMFS 2001; NMFS 2000; and NMFS 1999) (Figure 1.6-1). The magnitude of catch depends on the location, timing, duration and type of fishery. Most listed Puget Sound chinook are caught incidentally in fisheries targeted for unlisted salmon stocks, or in fisheries directed at other species like groundfish or trout. Fisheries are regulated with time/area and gear restrictions. The same is true for other salmon species. Fisheries targeted for one species or population catch commingled fish of other salmon species and populations. Subsection 3.3 of this document and Appendix A of the RMP

[iv] At the same time, NMFS adopted a 4(d) rule for Tribal Resource Management Plans (Tribal Plan) that allows Indian tribes to qualify for a limit on the take prohibition in cases where the Secretary has determined that implementing the Tribal Plan would not appreciably reduce the likelihood that listed species would survive and recover (65 Federal Register 42481). This Environmental Impact Statement focuses on the 4(d) rule for salmon and steelhead.

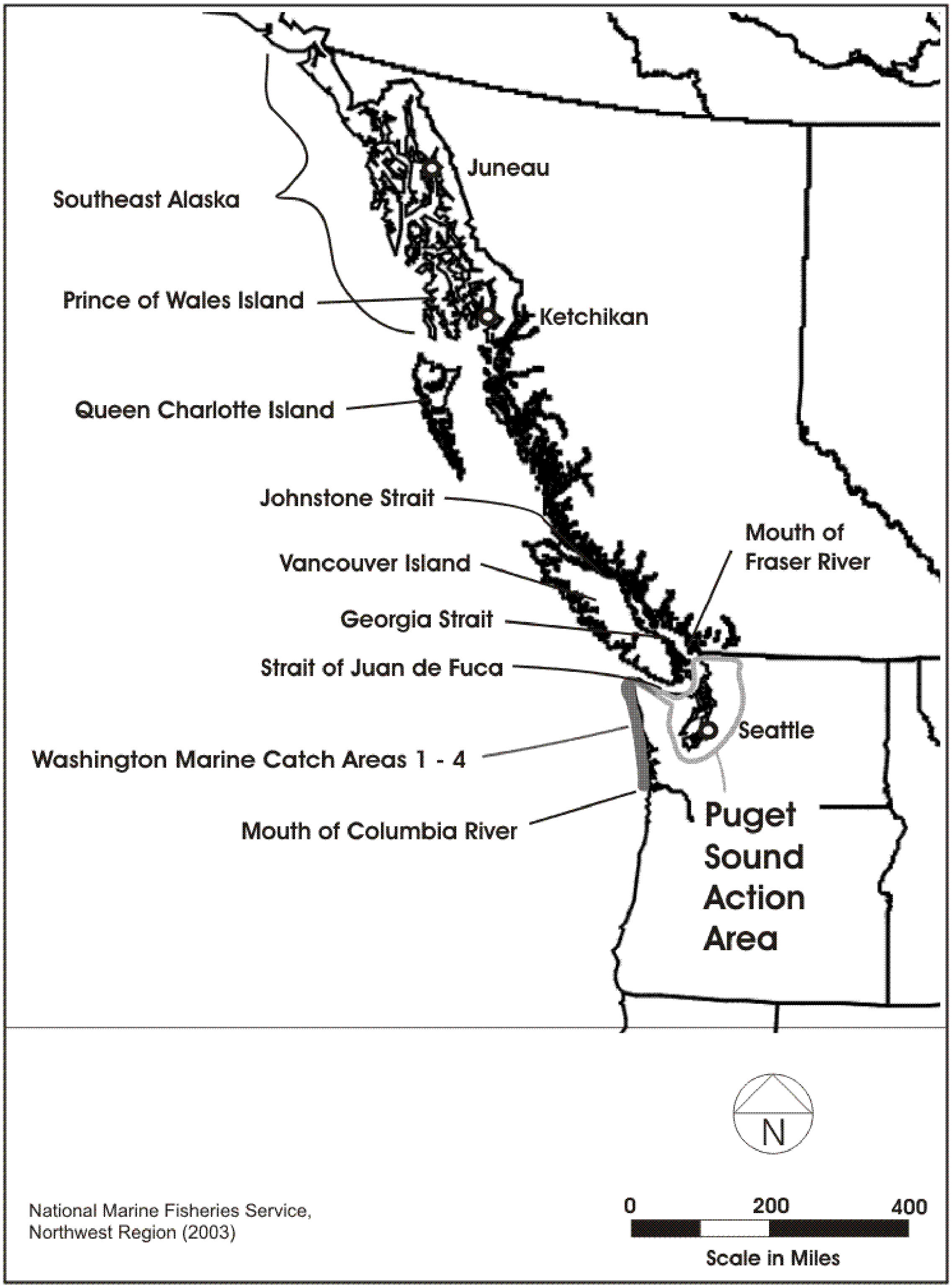
present more detailed information on the distribution of catch among Alaskan, Canadian and southern U.S. salmon fisheries. The following three subsections discuss the harvest of salmon in the areas through which salmon migrate, and the consequent affect on the amount of salmon that can be harvested in Puget Sound by the co-managers.

Southeast Alaska

Chinook salmon are harvested in commercial, recreational and subsistence fisheries throughout Southeast Alaska. Since 1995, the total landed chinook catch has ranged from 217,000 to 339,000 salmon (Pacific Salmon Commission 2001). These fisheries are managed by the Alaska Board of Fisheries and the Alaska Department of Fish and Game, under the oversight of the North Pacific Fisheries Management Council, to ensure consistency of fisheries management objectives with the Magnuson – Stevens Fisheries Conservation and Management Act.

Commercial fisheries employ troll, gillnet, and purse seine gear. Commercial trolling accounts for about 68 percent of the chinook harvest (NMFS 2002). Gillnet and seine fisheries occur within Alaskan state waters, and target pink, sockeye, and chum salmon, with substantial incidental catch of coho, and a relatively low incidental catch of chinook.

Figure 1.6-1. Major fishing areas in Alaska, British Columbia and the southern United States where listed Puget Sound chinook salmon are caught.



Recreational fishing in Southeast Alaska, in recent years, has comprised more than 500,000 angler days (trips by sport fishermen) annually. Recreational fishing occurs primarily in June, July, and August. A majority of the effort is associated with non-resident fishers, and is targeted at chinook salmon.

More than 3,000 subsistence and personal-use permits were issued in southeast Alaska in 1996 (NMFS 2002), but only a small proportion of the subsistence harvest of salmon (33,000 in 1996) is chinook.

Southeast Alaska harvests consist primarily of chinook salmon from the Columbia River, Oregon coast, Washington coast, West Coast Vancouver Island, and northern British Columbia (Pacific Salmon Commission Chinook Technical Committee 2001). In general, very few Puget Sound chinook salmon are caught in Alaska, except for Strait of Juan de Fuca stocks (Pacific Salmon Commission Chinook Technical Committee 1999).

British Columbia

In British Columbia, chinook salmon are harvested in commercial, recreational and aboriginal fisheries. Conservation concerns over Canadian chinook and coho stocks have constrained these fisheries in recent years. The landed catch of chinook in 2001 British Columbia marine fisheries was 265,000 fish (Pacific Salmon Commission 2001).

Troll fisheries occur on the north and west coasts of Vancouver Island. Commercial and test troll fisheries directed at pink salmon in northern areas, and sockeye on the west coast of Vancouver Island and the southern Strait of Georgia, incur relatively low incidental chinook mortality. Net fisheries, including gillnet and purse seine gear, in British Columbia marine inshore waters are primarily directed at sockeye, pink, and chum salmon, but also incur incidental chinook mortality.

Nearshore waters along the entire west coast of Vancouver Island were closed to recreational salmon fishing in 1999–2001 (Pacific Salmon Commission, 2000; Pacific Salmon Commission, 2001) to conserve weak chinook salmon populations. Limited recreational fisheries have been implemented in the inlets along the west coast of Vancouver Island. Marine recreational fisheries occur along the central British Columbia coast, and within Johnstone Strait, the Strait of Georgia, and the Strait of Juan de Fuca. Sport fisheries in inshore marine areas land the largest portion of the chinook harvest in southern British Columbia.

Fisheries in northern British Columbia are targeted primarily at local stocks, as well as chinook from the Columbia River, Washington and Oregon coasts, Strait of Georgia, and west coast of Vancouver

Island (Pacific Salmon Commission Chinook Technical Committee 2001). Puget Sound chinook comprise a minor portion of the catch in northern British Columbian fisheries, but a significant portion of the mortality on North Puget Sound and Strait of Juan de Fuca spring and summer/fall chinook can occur in these fisheries (see Subsections 3.3.1 through 3.3.2). West coast Vancouver Island fisheries that target Columbia River, Puget Sound, and Strait of Georgia populations have a major impact on all Puget Sound summer/fall chinook salmon stocks, and a lower, but significant impact on spring chinook. The Strait of Georgia fisheries target Strait of Georgia and Puget Sound chinook, and have heavy impacts on North Puget Sound spring chinook, North Puget Sound summer/fall chinook, and Hood Canal summer/fall chinook. Strait of Georgia fisheries also have a significant, but lower impact on all other Puget Sound chinook populations (Pacific Salmon Commission Chinook Technical Committee 1999).

Washington Ocean

Treaty tribal and non-tribal commercial troll fisheries that target chinook, coho, and pink salmon, and recreational fisheries that target chinook and coho salmon, are scheduled from May through September, under the authority of the co-managers. Annual fishing regimes, including establishing catch allocations, are overseen by the Pacific Fisheries Management Council, pursuant to the Magnuson – Stevens Sustainable Fisheries Act. Tribal fleets operate within their defined usual and accustomed fishing areas. Principles governing the co-management objectives and the allocation of harvest benefits among treaty tribal and non-tribal users, for each river of origin, were developed as a result of litigation in Hoh v. Baldrige (522 Federal Supplement 683, 1981). The declining status of Columbia River-origin chinook stocks has been the primary constraint on coastal fisheries, though consideration is also given to attaining allocation objectives for troll, terminal net, and recreational harvest of Washington coastal-origin stocks. Washington ocean fisheries harvest primarily chinook from the Columbia River and Fraser River (Pacific Salmon Commission Chinook Technical Committee 2001). Puget Sound chinook salmon make up a low percentage of the catch, with South Puget Sound and Hood Canal chinook populations exploited at a slightly higher rate than North Puget Sound and Strait of Juan de Fuca chinook.

The summer troll fishery has been structured, in recent years, to focus on chinook salmon-directed fishing in May and June, and chinook/coho salmon-directed fishing from July into mid-September,[v] to enable full utilization of treaty tribal and non-tribal chinook and coho salmon quotas. These quotas are developed in a pre-season planning process that considers harvest impacts to all contributing stocks, and function as catch ceilings. In general, the chinook salmon harvest occurs 10 to 40 miles offshore, whereas the coho salmon fishery occurs within 10 miles off the coast, but annual variations in the distribution of the target species may cause this pattern to vary. The majority of the summer troll chinook salmon catch has, in recent years, been caught off the northern Washington coast (which, during the summer, includes the westernmost areas of the Strait of Juan de Fuca – Washington Catch Area 4B). In a recent 5-year period (1997–2001), troll catch ranged from 18,000 to 49,300 chinook (Pacific Fisheries Management Council 2001).

Recreational fisheries in Washington ocean areas are also conducted under specific quotas for each species, and under allocations to each catch area. Most of the ocean recreational fishing effort occurs off the southern Washington coast. In the last five years, ocean recreational chinook salmon catch has ranged from 2,200 to 23,000 chinook salmon (Pacific Fisheries Management Council 2001).

Puget Sound chinook salmon populations comprise less than 10 percent of coastal troll and sport catch (see Subsections 3.3.1 and 3.3.2). The contribution of Puget Sound populations is higher in northern areas on the coast, as would be expected, since these areas are adjacent to Puget Sound. The exploitation rate of most individual chinook salmon management units in these coastal fisheries is less than one percent in most years. However, these exploitation rates vary annually in response to the varying abundance of commingled Columbia River, local coastal, and Canadian chinook salmon populations.

Puget Sound Salmon Fisheries

Principles governing the co-management objectives (conservation, use, access), and the allocation of harvest benefits (catch and fishing opportunity), among treaty tribal and non-tribal users, for each river of origin, are defined in the Puget Sound Management Plan (1985), the implementation framework for U.S. v. Washington (see Subsection 1.7, and Appendix F of this Environmental Impact Statement).

[v] In odd-numbered years, the coastal troll fishery may also target pink salmon, the majority of which originate in the Fraser River. In the odd-numbered years 1991, 1993, 1995, 1997, 1999, and 2001, the annual troll harvest of pink salmon has ranged form 1,800 to 48,300 (PFMC 2001).

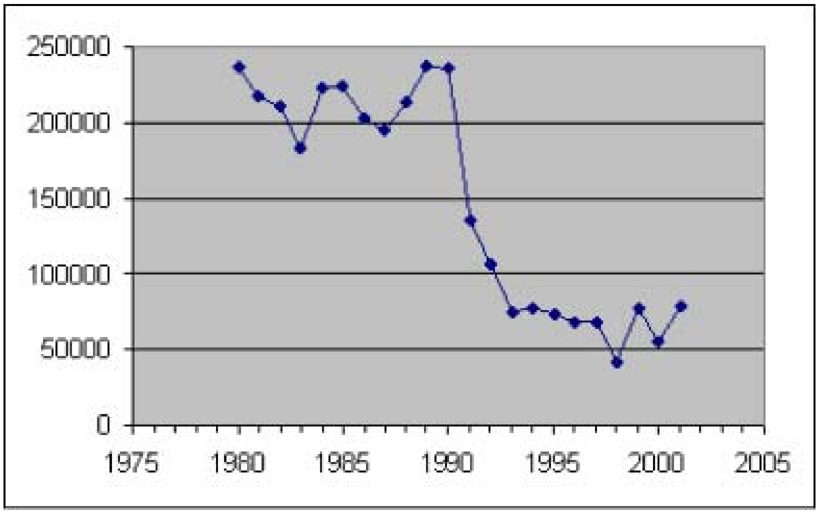
Tribal fleets operate within the confines of their usual and accustomed fishing areas in Puget Sound. Salmon fisheries in Puget Sound are constrained to meet the conservation objectives of the weakest species and management unit.

Commercial Chinook

Commercial fisheries in Puget Sound are conducted using troll, set nets and drift gill nets, purse/roundhaul seines, beach seines, and reef net gear (Figure 1.6-2). Several tribes conduct small-scale commercial troll fisheries that target chinook salmon in the Strait of Juan de Fuca and Rosario Strait. In the western Strait of Juan de Fuca, most of the fishing effort occurs in winter and early spring, with annual closures between mid-April and mid-June to protect maturing spring chinook salmon. Annual harvest ranged from 1,000 to 2,000 chinook salmon in a recent 5-year period (1997–2001). Commercial net fisheries are conducted throughout Puget Sound, and in the lower reaches of larger rivers. Total commercial net and troll harvest of chinook salmon has fallen from levels in excess of 200,000 in the 1980s to an average of 64,000 chinook salmon for the period 1997 through 2001 (Figure 1.6-2).

Due to current conservation concerns, commercial fisheries that target chinook salmon are of limited scope, and are mostly directed at abundant hatchery chinook salmon production in terminal areas: Bellingham/Samish Bay and the Nooksack River; Tulalip Bay; Elliott Bay and the Duwamish River; Lake Washington; the Puyallup River; the Nisqually River; Budd Inlet; Chambers Bay; Sinclair Inlet; southern Hood Canal; and the Skokomish River (Figure 1.6-3).

Figure 1.6-2. Commercial net and troll catch of chinook salmon in Puget Sound, 1980–2001.[vi]



Source: Personal communication from Will Beattie, Northwest Indian Fisheries Commission, December 20, 2002.

Indian tribes schedule ceremonial and subsistence chinook salmon fisheries to provide basic nutritional benefits to their members, and to maintain the intrinsic and essential cultural values imbued in traditional fishing practices and spiritual links with the natural environment. The magnitude of ceremonial and subsistence harvest of chinook salmon is small, relative to commercial and recreational harvest, particularly where it involves critically-depressed populations. Subsistence harvest is discussed in Subsection 3.5 of this Environmental Impact Statement.

Commercial Sockeye, Pink, Coho, and Chum Fisheries

Net fisheries directed at Fraser River sockeye salmon are conducted annually and at Fraser River pink salmon in odd-numbered years,[vii] in the Strait of Juan de Fuca, Rosario Strait, and the Strait of Georgia (Figure 1.6-3). Nine tribes and the Washington Department of Fish and Wildlife issue regulations for these fisheries, with oversight by the Fraser River Panel under Pacific Salmon Treaty Annexes. Annual management plans include sharing and allocation provisions, but fishing schedules are developed based on in-season assessment of the abundance of early, early summer, summer, and late-run sockeye salmon stocks. Sockeye salmon harvest exceeded 2 million fish in the 10-year period 1991–2001, but

[vi] Includes Marine Catch Area 4B from May through September, although 4B is within the jurisdiction of the Pacific Fisheries Management Council at this time

[vii] Fraser River pink salmon follow a two-year life cycle, returning only in odd-numbered years.

the fishery has been constrained in recent years due to lower survival and pre-spawning mortality; thus, harvest has been substantially lower. Catches of sockeye, pink and chinook salmon in recent years are shown in Table 1.6-1. Specific regulations to reduce incidental chinook salmon mortality, including requiring release of all live chinook salmon from purse seine hauls, have reduced incidental contribution to less than 1 percent of the total catch.

Commercial and recreational fisheries directed at Puget Sound sockeye salmon populations occur in Elliot Bay, the Lake Washington Ship Canal, and Lake Washington (Cedar River sockeye), and at a smaller scale on the Skagit River (Baker River sockeye) (Figure 1.6-3). The Cedar River population does not achieve harvestable abundance; i.e., abundance exceeds the escapement goal consistently, but significant fisheries occurred in 1996 and 2000, when more than 50,000 sockeye salmon were harvested. These fisheries involve low incidental mortality to Puget Sound chinook salmon.

Commercial and recreational fisheries that target Puget Sound-origin pink salmon occur in terminal marine areas and fresh water in Bellingham Bay and the Nooksack River, Skagit Bay and Skagit River, and Possession Sound/Port Gardner (Snohomish River system) (Figure 1.6-3). The pink salmon catch in these areas for the 10-year period 1991–2001 is shown in Table 1.6-2. Incidental chinook salmon catch in these pink salmon fisheries adds substantially to the total terminal-area catch of chinook salmon.

1 Figure 1.6-3. Puget Sound overview.

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Table 1.6-1. Fraser River sockeye, pink and incidental chinook catch in Puget Sound, 1995–2001.

		1995	1996	1997	1998	1999	2000	2001
Strait of Juan de Fuca	Sockeye	41,106	30,414	12,510	26,730	20,328	44,728	34,973
	Pink	48,333	8	3,723	35	4,526	91	8,583
	Chinook	4,681	497	422	258	471	630	911
Rosario Strait and the Strait of Georgia	Sockeye	372,789	243,936	1,354,532	509,153	69	446,757	216,324
	Pink	2,065,779	1	1,790,883	807	11	254	474,513
	Chinook	5,321	3,934	29,592	3,668	3	801	965

Source: Northwest Indian Fisheries Commission tribal fish ticket database, 2002.

Table 1.6-2. Commercial net fishery harvest of pink salmon from the Nooksack, Skagit, and Snohomish river systems, 1991–2001.

	Bellingham Bay Nooksack River	Skagit Bay and River	Possession Sound Port Gardner
1991	17,447	133,672	46,039
1993	1,335	143,880	9,648
1995	7,339	524,810	48,006
1997	1,196	46,169	34,537
1999	2,484	32,339	13,055
2001	12,280	198,534	86,097

Source: Northwest Indian Fisheries Commission tribal fish ticket database, 2002.

Commercial fisheries directed at coho salmon also occur throughout Puget Sound and in some rivers. In the a recent 5-year period (1997–2001), the total landed coho salmon catch ranged from 108,000 to 390,000 coho salmon, well below the levels of the early 1990s, when the total harvest exceeded 1.0 million coho salmon (Table 1.6-3).

Table 1.6-3. Landed coho salmon harvest: Puget Sound net fisheries. Regional totals include the freshwater catch.

	Strait of Juan de Fuca	Rosario Strait and Strait of Georgia	Nooksack Samish	Skagit	Stillaguamish-Snohomish	South Puget Sound	Hood Canal	Total
1997	1,200	10,525	15,034	1,348	25,193	78,634	9,925	141,859
1998	8,083	1,980	22,892	10,359	24,743	65,617	21,974	155,648
1999	5,586	1	50,175	7,411	18,439	21,189	4,845	107,646
2000	12,505	1,549	68,206	13,239	89,881	181,857	23,014	390,251
2001	17,671	738	76,685	20,089	75,078	143,489	12,860	346,610

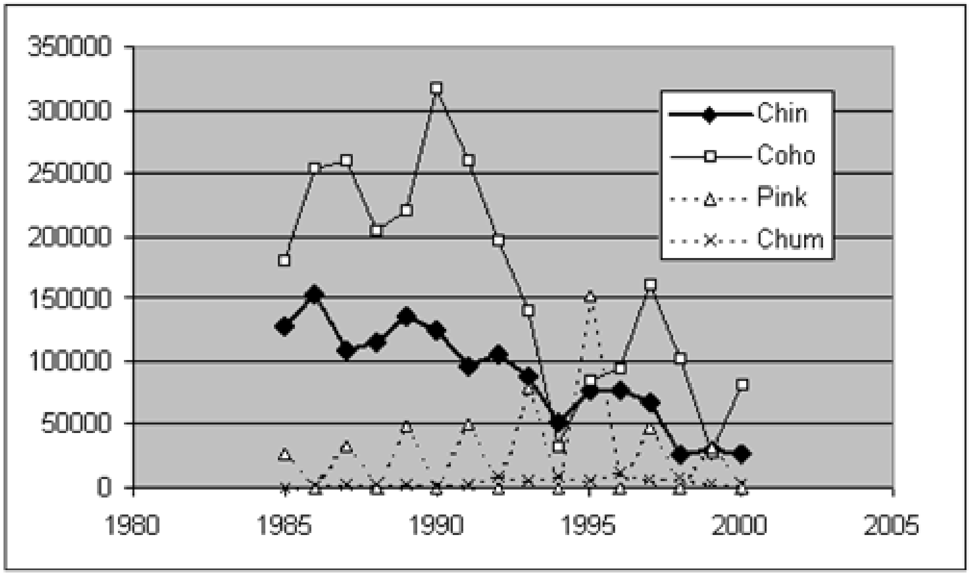
Source: Northwest Indian Fisheries Commission tribal fish ticket database, 2002.
Note: All sources combined. Troll catch removed from the Strait of Juan de Fuca.

Recreational Fisheries

Recreational salmon fisheries in Puget Sound occur in marine and freshwater areas, under regulations promulgated by the Washington Department of Fish and Wildlife. In marine areas, the principal target species are chinook and coho salmon. Since the mid-1980s, the total annual marine harvest of chinook salmon has steadily declined to levels of less than 50,000 chinook salmon in recent years (Figure 1.6-4). Coho harvest also declined markedly in the early 1990s and since then has varied from 3,000 to 15,000 coho salmon. Pink salmon fisheries are substantial only in odd-numbered years. In most years since the mid-1980s, harvest has been about 5,000 pink salmon.

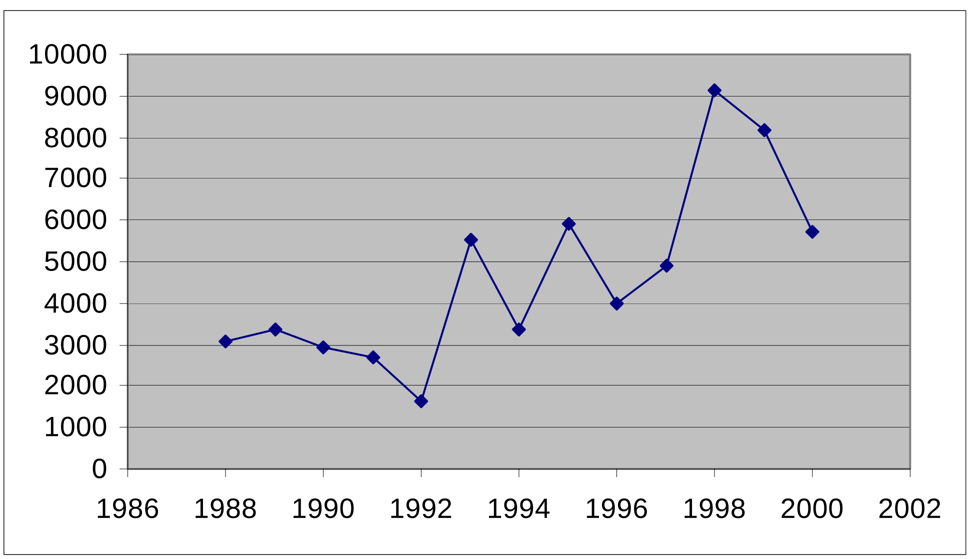
Recreational fisheries targeting mature chinook salmon occur during the summer months (July through September), and continue through the fall and winter months, primarily in central Puget Sound, targeting immature chinook salmon (called "blackmouth"). The recreational chinook salmon catch has been increasingly constrained to avoid overharvest of weak Puget Sound populations. Recreational fisheries are managed under the same harvest objectives for chinook and coho salmon that apply to commercial fisheries. Perhaps in response to increasingly constrained bag limits and seasons in marine areas, recreational harvest of chinook salmon in freshwater areas of Puget Sound has shown an increasing trend since the early 1990s (Figure 1.6-5).

Figure 1.6-4. Number of chinook salmon caught in Puget Sound marine fisheries.



Source: Personal communication from Will Beattie, Northwest Indian Fisheries Commission, December 20, 2002.

Figure 1.6-5. Number of chinook salmon caught in Puget Sound freshwater recreational fisheries.



Source: Personal communication from Will Beattie, Northwest Indian Fisheries Commission, December 20, 2002.

1.7 Regulatory Jurisdictions Affecting Washington Fisheries

Planning and regulations put forth by the Washington co-managers are coordinated with other jurisdictions, in consideration of the effects of Washington fisheries on Columbia River and Canadian chinook salmon populations, and the effects of fisheries in other areas on Washington salmon populations including those in Puget Sound (discussed in Subsection 3.2.4, Environmental Setting). Pursuant to U.S. v. Washington, the Puget Sound Salmon Management Plan (1985) provides the fundamental principles and objectives for co-management of salmon. Subsection 1.10 (below) describes in greater detail the various jurisdictions, international agreements, and laws affecting the management of Puget Sound salmon.

Pacific Salmon Treaty

The Pacific Salmon Treaty was finalized March 17, 1985, between Canada and the United States. The Treaty establishes a framework for managing salmon stocks either originating from one country and intercepted by the other, or affecting the management or biology of the stocks of the other country. The Treaty commits the co-managers to equitable cross-border sharing of harvest, and conservation of U.S. and Canadian stocks. The thrust of the original Treaty, and subsequently negotiated agreements (Annexes) for chinook salmon, was to constrain harvest on both sides of the border in order to rebuild depressed salmon stocks. The Pacific Salmon Commission oversees implementation of the Treaty and subsequent revisions to its annexes.

U.S. v. Washington

Salmon fisheries within Puget Sound and the Strait of Juan de Fuca are jointly managed by the Washington Department of Fish and Wildlife and the Puget Sound treaty tribes (the co-managers) under the continuing jurisdiction of U.S. v. Washington. U.S. v. Washington is the on-going Federal court proceeding that enforces and implements reserved Tribal treaty fishing rights with regard to salmon and steelhead returning to western Washington. The Puget Sound Salmon Management Plan (1985) remains the guiding framework for jointly-agreed management objectives, allocation of harvest, information exchange among the co-managers, and processes for negotiating annual harvest regimes.

Pacific Fisheries Management Council

The Pacific Fisheries Management Council was created by the Magnuson Fishery Management and Conservation Act in 1977, and re-authorized by passage of the Sustainable Fisheries (Magnuson-Stevens) Act (SFA) by the United States Congress in 1997. The Council coordinates and oversees the ocean fishery management objectives among the three state jurisdictions (Washington, Oregon and

California) by mandating regulations that prevent overfishing and maintain sustainable harvest. The function of the Council is to assure that conservation objectives are achieved for all chinook and coho salmon stocks, and that harvest is equitably shared among the various user groups.

Amendment 14 to the Pacific Fisheries Management Council (PFMC) Framework Management Plan restricts the Council's direct oversight of conservation to those chinook stocks for which the exploitation rate in Pacific Fisheries Management Council fisheries has exceeded 2 percent, in a specified base period. However, the PFMC must also align its harvest objectives with conservation standards required for salmonid Evolutionarily Significant Units, listed under the Endangered Species Act (discussed Subsection 1.5, above).

1.8 Environmental Review Process

1.8.1 Public Scoping

A notice was published in the Federal Register on August 8, 2002, to announce the start of a 30-day public comment period, and the date and location of the public scoping meeting. The Federal Register notice included addresses and contacts to obtain the RMP currently in effect and NMFS' evaluation of that RMP as reference material to help interested parties understand the proposed action. The notice also provided the email address and telephone number of NMFS Northwest Region personnel to contact for questions about the public comment period or public meeting. Only the U.S. Fish and Wildlife Service called to clarify the date of the end of the public comment period. The Northwest Region Office of NMFS Public Affairs also notified media and various organizations that were involved with, potentially affected by, or that expressed interest in NMFS' determinations on Puget Sound salmon fishery activities. The Federal Register notice stated that the environmental review would analyze the Proposed Action (the proposed RMP), a range of reasonable and practicable alternatives, and the associated impacts of each. At a minimum, the notice stated that the alternatives would include those mandated in the settlement agreement with Washington Trout.

One public scoping meeting was held on August 22, 2002, from 6:30 to 8:30 p.m. in the Building 9 auditorium at the Sand Point NOAA campus in Seattle, Washington. Public testimony was invited on the issues and alternatives that should be considered in the Environmental Impact Statement. Public comments were recorded and a written transcript of the comments prepared. A form to provide written comments was also made available should attendees to the meeting wish to provide additional comment. NMFS received two sets of written comments on issues and alternatives to be included in the Environmental Impact Statement. The U.S. Fish and Wildlife Service contacted NMFS to say that it might send comments; however, no comments were received.

1.8.2 Issues and Concerns Raised During Scoping

Comments from the various respondents overlapped to a great degree, highlighting several key issues and suggesting two potential additional alternatives to analyze (described in Section 2 of this Environmental Impact Statement). Issues identified during public scoping that will be addressed in this Environmental Impact Statement ~~on the 2004 RMP~~ for implementation of the RMP during the 2005–2009 fishing seasons include the following:

- Effects on chinook spawner levels of the various management approaches at both the population and management-unit levels
- Probability that alternatives may achieve management objectives, including chinook recovery
- Role of marine-derived nutrients in salmon population health and setting chinook spawning escapement levels
- The derivation for management objectives, including how productivity and capacity were considered
- The effect of limitations and uncertainties inherent in chinook population modeling
- Effect of harvest on chinook age structure
- Effect of fishing activities on hatchery-related issues.

1.9 Decisions to be Made

From the information in this Environmental Impact Statement, the Regional Administrator of the NMFS Northwest Region must decide:

1) Which harvest management strategy to adopt for salmon fisheries that take listed Puget Sound chinook salmon in Puget Sound and the Strait of Juan de Fuca that would meet the requirements for Limit 6 of the 4(d) take prohibition
2) If a harvest strategy other than that proposed by the co-managers is preferred, whether to limit the geographic location of salmon fisheries that take listed Puget Sound chinook within the Puget Sound Action Area.

In most cases, the Regional Administrator of NMFS, Northwest Region, must also determine if the selected alternative (management strategy) would or would not be a major Federal action, significantly affecting the quality of the human environment. If the Regional Administrator determines that the action *would not* significantly affect the quality of the human environment, then he can prepare and sign a Finding of No Significant Impact (FONSI), and the project can proceed. If the Regional Administrator determines that the action would significantly affect the natural, built, and/or human environment, then preparation of an Environmental Impact Statement will be required. However, an

Environmental Impact Statement ~~for the 2004 RMP~~ was mandated by the terms of the settlement agreement with Washington Trout.

1.10 Relationship to Other Plans

1.10.1 Pacific Salmon Treaty Annexes

In 1999, negotiations between the United States and Canada resulted in new annexes for the Pacific Salmon Treaty. Annex 4 of the June 30, 1999, agreement stipulates management goals and measures for important chinook and coho salmon stocks that are harvested in southeast Alaska, Canadian and southern United States fisheries, including the fisheries that are the subject of this Environmental Impact Statement. Annex 4 establishes an abundance-based chinook salmon management regime for the populations and fisheries subject to the Pacific Salmon Treaty. It includes increased specificity on the management of all fisheries affecting chinook salmon, and seeks to address the conservation requirements of a larger number of depressed stocks, including some now listed under the ESA. The new agreement establishes exploitation rate guidelines or quotas for fisheries subject to the Pacific Salmon Treaty based on the forecast abundance of key chinook stocks. This regime will be in effect for the period 1999 through 2008.

1.10.2 Pacific Coast Framework Management Plan

The fundamental principles and implementation of the conservation standards of the Magnuson-Stevens Act are outlined in the Pacific Coast Framework Management Plan. The goals and objectives of the Framework Plan are intended to provide a philosophical framework to guide the decisions of the Pacific Fishery Management Council. The Framework Plan includes specific management goals and objectives for salmon stocks, usually stated as escapement goals, exploitation rates, or harvest rates. These objectives are based on the fundamental principle of providing optimum yield, which was re-defined to mean “maximum sustainable yield, as reduced by relevant economic, social, or ecological factors” (Pacific Fishery Management Council 2000). The Council has adopted amendments to the Framework Plan to address specific conservation and management issues. Amendment 14 is intended to revise the process by which the Council considers the salmon specifications and management measures, and includes conservation objectives – expressed as the number of natural, adult spawners – for chinook salmon stocks from Puget Sound and the Strait of Juan de Fuca. It does not revise the guiding principles of the Framework Plan.

Management units that are listed under the Endangered Species Act or contribute 5 percent or less of the salmon catch within the jurisdiction of the Pacific Fisheries Management Council are exempt from

PFMC management. In these cases, management must be consistent with Endangered Species Act standards established by NMFS, and with conservation and allocation objectives established by the state and tribal governments. Puget Sound chinook salmon generally contribute less than 3 percent of the catch in fisheries under the jurisdiction of the Pacific Fisheries Management Council. However, the Puget Sound Chinook Harvest Resource Management Plan (RMP) commits the co-managers to explicit consideration of coastal fishery impacts, to ensure that the overall conservation objectives are achieved for all Puget Sound chinook management units.

1.10.3 Puget Sound Salmon Management Plan

The Puget Sound Salmon Management Plan (1985) is the implementation framework for the allocation, conservation and equitable sharing principles of U.S. v. Washington that governs management of salmon resources in the Puget Sound Action Area between the Puget Sound treaty tribes and State of Washington. It defines the basis for deriving management objectives and allocation accounting, proscribes procedures for information exchange and dispute resolution, and includes provisions for annual review and modification. Salmon management plans, like the Proposed Action, must be consistent with terms of the Puget Sound Salmon Management Plan. The Plan also envisioned the adaptive management process that motivated the RMP; i.e., that improved technical understanding of the productivity of populations, and assessment of the actual performance of management regimes in relation to management objectives and the status of stocks, would result in continuing modification of harvest objectives.

1.10.4 Puget Sound Recovery Planning

Federal, state, local and tribal governments and community organizations are currently collaborating in the development of a recovery plan for listed salmon species in Puget Sound, including the Puget Sound Chinook ESU. This effort is collectively called the Shared Strategy forum. The Shared Strategy plan will include conservation goals for listed Puget Sound salmon; and the habitat, hatchery, and harvest actions that will need to be taken to achieve these goals for each watershed in Puget Sound and the Strait of Juan de Fuca. The Proposed Action (Puget Sound Harvest Resource Management Plan) is intended to contribute to the development of the harvest framework for the Shared Strategy plan. When complete, the Shared Strategy will provide its plan to NMFS for assessment as to whether the plan would suffice as the recovery plan for Puget Sound salmon listed under the ESA.

1.10.5 Wild Salmonid Policy

The Wild Salmonid Policy was adopted in 1997 by the Fish and Wildlife Commission to guide the Washington Department of Fish and Wildlife in harvest, hatcheries or habitat actions it takes that affect the salmon resource, such as the Proposed Action. For harvest actions, the policy mandates that fisheries will be managed to meet its spawning escapement policy and criteria for genetic conservation and ecological interactions (Washington Department of Fish and Wildlife 1997). This includes performance criteria requiring harvest regimes to be responsive to annual abundance, holding incidental harvest rates to 10 percent or less of the Washington abundance, and shaping fisheries and using selective gear where possible to reduce or eliminate impacts to weak populations. This guidance must be implemented consistent with ". . . meeting treaty harvest opportunity needs" (Washington Department of Fish and Wildlife 1997).

1.10.6 Gravel to Gravel

"Gravel to Gravel" was adopted by the Western Washington Treaty Tribes in 1997 as the regional salmon recovery policy covering the coast of Washington and Puget Sound by the Western Washington Treaty Tribes. The policy " . . . is intended as a model to provide overall guidance and consistency for managing and recovering wild salmon, trout, and char stocks through intensive habitat, harvest, and hatchery strategies" (Western Washington Treaty Tribes 1997). It provides general policy goals designed to guide development of specific harvest plans such as the Proposed Action. These goals are to:

1) Manage fisheries for sustainable abundance and to maintain biological and geographic diversity
2) Provide for harvestable numbers of fish that will support fishing communities and maximize fishing opportunities.

1.11 Roles and Responsibilities of the Federal Government, State and Tribes in Fisheries Management

1.11.1 Federal Agencies

The Pacific Fisheries Management Council, under the oversight of the Secretary of Commerce, is responsible for setting harvest levels for coastal salmon fisheries in Washington, Oregon, and California. The Council adopts the management objectives of the relevant local authority, provided they meet the standards of the Magnuson–Stevens Sustainable Fisheries Act. The Endangered Species Act has introduced a more conservative standard for coastal fisheries, when they significantly impact listed stocks.

Within Puget Sound, NMFS oversees the implementation of the ESA for salmon and marine mammals, and the U.S. Fish and Wildlife Service oversees the implementation of the ESA for terrestrial species and non-anadromous fish species. These agencies work with the co-managers to develop harvest plans and implement harvest actions that are consistent with the ESA; for example, the Puget Sound Chinook Harvest Resource Management Plan (the Proposed Action).

1.11.2 Tribes

Five treaties ratified by the United States and various Washington Tribes between 1854 and 1856 guaranteed Tribes fishing rights in common with citizens of the Territory. These are the treaties of Medicine Creek, Quinault, Neah Bay, Point Elliott, and Point-No-Point. Findings of U.S. v. Washington, commonly referred to as the Boldt Decision, clarified these treaties with regard to allocation of salmon harvests between treaty tribal and non-tribal fishers, holding that Tribes are entitled to a 50 percent share of the harvestable run of fish. Hoh v. Baldrige established the principle that where annual fishery management plans might affect an individual Tribe, the plans must take into account returns to individual streams, thus establishing a key management principle of river-by-river or run-by-run management.[viii] The Puget Sound Salmon Management Plan and the management agreements under Hoh v. Baldrige established principles governing the management of shared salmon resources and established the principle of co-management whereby Tribes are equal co-managers with the State and represent themselves in the regional and international management forums (see Subsection 3.4 of this Environmental Impact Statement for a more detailed discussion of tribal treaty rights and tribal trust responsibilities). The Puget Sound treaty tribes co-manage Puget Sound fisheries with the state of Washington, and participate with tribes from California, Oregon and other Washington areas in managing fisheries under the jurisdiction of the Pacific Fisheries Management Council and the Pacific Salmon Treaty.

The Puget Sound treaty tribes participated in the development of this Environmental Impact Statement by providing representation on the NMFS NEPA Interdisciplinary Team, and through review of the NMFS Interdisciplinary Team work products.

1.11.3 State Agencies

States have management responsibilities for non-tribal salmon fisheries occurring in waters within 3 miles of the coast and in all inshore and freshwater areas. States participate directly in the management of salmon fisheries through their representation on the North Pacific Fisheries

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[viii] Under the Puget Sound Salmon Management Plan, a run equates to a group of fish returning to a freshwater system which flows into saltwater, or groups of freshwater systems flowing into saltwater (see definitions of 'run' and 'stock' in the Puget Sound Salmon Management Plan, May 15, 1985).

Management Council, the Pacific Fisheries Management Council, Pacific Salmon Commission, and through participation on technical and policy committees that guide salmon management decisions. State fishery agencies, along with NMFS and Tribal fishery agencies, provide much of the technical information and research used in managing the fisheries. The state of Washington co-manages Washington's salmon and steelhead fisheries with the Washington tribes.

State fishery management policies are set by commissions appointed by the administrative branch, and are defined in state administrative codes.[ix] The Washington Fish and Wildlife Commission consists of nine members appointed by the governor for 6-year terms. The Commission is the supervising authority for the Washington Department of Fish and Wildlife. With the 1994 merger of the former Departments of Fisheries and Wildlife, the Commission has comprehensive species authority as well. Through formal public meetings and informal hearings held around the state, the Commission provides an opportunity for citizens to actively participate in management of Washington's fish and wildlife.

WDFW also participated on the NEPA Interdisciplinary Team, and provided review of Team work products.

1.12 Overview of the NEPA Environmental Impact Statement

This Environmental Impact Statement, prepared under the guidelines of the National Environmental Policy Act (NEPA), is organized in five main sections, each presenting a different aspect of the NEPA analysis. Each section builds on the information provided in the previous sections. These sections reflect the content requirements proscribed by the Council on Environmental Quality (CEQ regulations at Sections 1500 through 1508).

Section 1, the Purpose and Need for the Proposed Action, provides background information about the Proposed Action, its purpose, and its relationship to other harvest management and resource plans, management planning processes, and previous NEPA analyses.

Section 2, Alternatives Including the Proposed Action, describes alternative management strategies in detail, including the proposed implementation of the ~~2004-2009~~ Puget Sound Chinook Harvest Resource Management Plan (RMP) for the 2005–2009 fishing seasons. Section 2 also describes

[ix] Alaska, Washington, and Oregon have all recently adopted legislation to guide management of fisheries and resources. These wild salmonid policies are incorporated herein by reference.

alternatives that were considered but excluded from further detailed analysis, and the reasons why some alternatives were eliminated from consideration.

Section 3, the Affected Environment, describes those components of the natural, built and human environment that would be affected by the Proposed Action or alternatives. This section provides a basis for understanding the effects of the action.

Section 4, Environmental Consequences, describes the predicted effects of the Proposed Action or alternatives on elements of the natural, built and human environment described in Section 3. Section 4 provides a comparative basis to assess the significance of the direct, indirect, and cumulative effects of the Proposed Action or alternatives.

Section 5, Determination of Agency Preferred Alternative, briefly describes the National Marine Fisheries' (NMFS) preferred alternative. According to CEQ regulations (CEQ §1502.14), an agency must identify a preferred alternative in the Draft Environmental Impact Statement if one exists. In Section 5, the relative merits and disadvantages of all alternatives evaluated are summarized in order to clearly establish why NMFS has chosen one alternative over the others as its preferred alternative.

Alternatives Including the Proposed Action

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2.0 ALTERNATIVES INCLUDING THE PROPOSED ACTION

2.1 Introduction

This section discusses the alternatives that were considered for analysis in this Environmental Impact Statement; identifies those excluded from further analysis with an explanation for why (Subsection 2.2); and describes those that have been considered for detailed analysis (Subsection 2.3). The National Environmental Policy Act requires consideration of all reasonable alternatives that fit the purpose and need for the proposed action (CEQ Regulations 1502.14; CEQ 40 Questions 1 and 2). The statement of purpose and need for the Proposed Action is provided in Section 1.3 of this Environmental Impact Statement.

The alternatives considered and analyzed in this Environmental Impact Statement were formulated based on scientific information, alternatives described in the settlement agreement in Washington Trout v. Lohn, and public comments received during scoping for the Environmental Impact Statement on the ~~2004~~ Puget Sound Chinook Harvest Resource Management Plan ~~that is~~ proposed for implementation during the 2005–2009 fishing seasons (Subsection 1.8).

The National Environmental Policy Act requires disclosure of how current environmental and social conditions would change with the Proposed Action and/or its alternatives. For this analysis, the Proposed Action (Alternative 1) most closely approximates current salmon harvest management practices and baseline environmental conditions, because the same type of harvest management plan has been implemented since 2000-2001 (CEQ 40 Questions, question 3).[i] Therefore, Alternative 1 is the baseline against which the environmental, social, and economic consequences of the action are compared. The predicted direct and indirect effects of alternatives on baseline environmental conditions (Alternative 1) are described in Section 4 of this Environmental Impact Statement, along with predicted cumulative effects on the natural, built and human environment when combined with other related actions.

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[i] CEQ interprets the 'no action' alternative in two ways (CEQ 40 Questions, question 3):

1) For a continuing action, such as a long-term plan or program of action, the 'no action' is defined as 'no change' from current management direction or level of management intensity.
2) For a project, 'no action' is defined as 'the proposed activity would not take place, and the resulting environmental effects from taking no action would be compared with the effects of permitting the proposed activity or an alternative activity to go forward."

Fundamentally, these two interpretations are the same since each is intended to define the environmental baseline conditions that exist prior to implementation of the proposed action or its alternatives.

The criteria applied in narrowing the range of alternatives included:

- Relevance to the Action – Is the alternative consistent with the identified purpose and need for the Proposed Action?
- Redundancy – Is the primary characteristic of the alternative contained in another, broader, alternative?
- Environmental Considerations – Could the alternative effectively address conservation mandates of the subject jurisdictions? Could the alternative effectively address conservation concerns of the ESA?
- Technical Feasibility – Is there evidence or compelling reason to expect that the alternative approach would be technically feasible?

2.2 Alternatives Considered but Eliminated from Detailed Study

Three alternatives suggested in public comment received during scoping for the EIS on the ~~2004~~ Puget Sound Chinook Harvest Resource Management Plan proposed for implementation during the 2005–2009 fishing seasons or discussed during the internal consultation process were eliminated from further analysis. These include: 1) tribal-only fisheries, 2) no hatchery augmentation, and 3) exploitation-rate management. These alternatives were considered either outside the scope of this Environmental Impact Statement because they are not relevant to the Proposed Action, or they have been encompassed within alternatives analyzed in detail (Subsection 2.3, following). A more detailed explanation for why NMFS eliminated these alternatives from detailed study is provided in Subsections 2.2.1 through 2.2.3.

2.2.1 Tribal-Only Fisheries

A tribal-only fishing alternative was suggested during public comment. As described, this alternative would provide the 4(d) Rule take limitation on harvest activities only for treaty tribal fishing, would estimate the level of tribal fisheries required to satisfy federal trust responsibilities to the Puget Sound treaty tribes, and would configure those fisheries for all salmon species. This alternative is not consistent with the purpose and need of the Proposed Action. Since the purpose is to put in place a resource management plan under Limit 6 of the 4(d) Rule (i.e., a joint state-tribal plan), it would not be reasonable to expect that the Washington Department of Fish and Wildlife and the Puget Sound tribes would put forward a joint plan under Limit 6 that would include no provisions for non-tribal fishing. A fishery plan involving tribal-only fisheries would reasonably be expected to be provided to NMFS for evaluation under the Tribal 4(d) Rule.

2.2.2 No Hatchery Augmentation

A no-hatchery-augmentation alternative would assume that hatchery augmentation programs and the fish produced from those programs do not exist. It has been excluded from further detailed analysis because it is not reasonable or practicable. Even if the hatchery programs were discontinued in ~~2004~~ 2005, substantial numbers of hatchery fish from previous hatchery releases will return to Puget Sound in ~~2004~~ 2005 and over the next several years. It is not reasonable to expect that the co-managers would develop a resource management plan that did not provide for harvest of these hatchery fish, particularly since many of these fish were produced specifically for harvest. This alternative is also technically infeasible to assess with current tools and available data, since it is not yet possible to distinguish returning hatchery adults from wild adults for many Puget Sound chinook salmon populations. Finally, most of the reasons suggested for including this alternative (broodstock takes, prey competition, loss of genetic fitness, and migration barriers) are not affected by fishery activities. An analysis of harvest activities will only provide information about the change in escapement, catch and exploitation rate, and would not provide the information necessary to address the reasons given for the request. These issues would be more appropriately addressed in a National Environmental Policy Act analysis of proposed hatchery operations, if necessary. A pending National Environmental Policy Act review is currently under development for the Puget Sound salmon hatchery program. Fishery-related hatchery issues, such as straying and possible over-fishing, are addressed in the alternatives evaluated in this Environmental Impact Statement. Therefore, it is not necessary to develop and analyze an additional alternative in order to evaluate them.

2.2.3 Exploitation Rate Management

Under an exploitation-rate management alternative, Puget Sound and Strait of Juan de Fuca salmon fisheries would be managed for a constant total exploitation rate on each Puget Sound chinook management unit regardless of the expected abundance. This alternative is encompassed within the Proposed Action (Alternative 1). Therefore, a separate alternative to address this issue would be redundant and would not be consistent with the National Environmental Policy Act mandate to reduce excessive paperwork (CEQ Regulations 1500.4).

2.3 Alternatives Considered in Detail

Three alternatives are analyzed in detail in this Environmental Impact Statement. The alternatives selected for detailed analysis represent different frameworks from which to develop annual fishing regimes. They are meant to provide a flexible framework for managing fisheries to meet conservation and use objectives. They do not include the specific details of an annual fishing regime; i.e., where and when fisheries occur, what gear will be used, or how harvest will be allocated among gears, areas or fishermen. Salmon abundance is highly variable from year to year, both among chinook salmon populations and other salmon species, due to changing environmental conditions. In addition, resource use objectives vary from year to year based on the concerns and needs of the stakeholder groups, which are also influenced by annual abundance and population status. These circumstances require managers to shape fisheries to respond to the population abundance and resource use conditions particular to that year. Therefore, each year, the co-managers would use the framework to develop annual fishing regimes for Puget Sound fisheries that are responsive to the year-specific circumstances related to the status of populations and other resource use objectives. Each alternative represents a distinctly different approach to setting management objectives, and each would have different outcomes in terms of escapement levels, harvest-related mortality, long-term resource protection, and harvest opportunity. These predicted outcomes are described in Section 4 of this Environmental Impact Statement. The following subsections describe the alternatives in more detail. More specificity about the technical assumptions and methods involved in analyzing each of the alternatives can be found in Appendix B. Table 2.3-1 summarizes the elements of the alternatives.

Before describing the alternatives in more detail, it is important to point out that Alternative 4 is inconsistent with several of the elements of the purpose and need for the Proposed Action described in Subsection 1.3, and would not be considered were it not one of the alternatives identified for analysis in the settlement agreement to Washington Trout v. Lohn. Alternative 4 is inconsistent with the purpose and need for the Proposed Action because it does not: 1) provide for the meaningful exercise of federally-protected treaty fishing rights; 2) provide for tribal and non-tribal fishing opportunity co-managed under the jurisdiction of U.S. v. Washington; or 3) optimize harvest of abundant Puget Sound salmon while protecting weaker commingled chinook salmon stocks. In addition, unless necessary for reasons of conservation, Alternative 4 is inconsistent with other legal mandates and policies related to treaty tribal fishing rights. It is unrealistic and unnecessary for the co-managers to engage in the regulatory burden of seeking coverage of their Puget Sound Chinook Harvest Resource Management Plan under Limit 6 of the 4(d) Rule with NMFS if that plan involved no take of listed chinook salmon, since actions that do not result in take of a listed species do not require consultation with NMFS.

Table 2.3-1. Comparison of alternatives considered for detailed analysis.

Element	Alternative 1 – Proposed Action/Status Quo	Alternative 2 – Management Unit Escapement Goal	Alternative 3 – Population Escapement Goal/ Terminal Fisheries Only	Alternative 4 – No Action/No Authorized Take
Management objectives	Exploitation rate ceilings Escapement thresholds	Fixed escapement goals	Fixed escapement goals	No take of listed chinook within the Puget Sound Action Area.
Focus of management	Weak population	Weak population	Weak population	Not applicable
Access	All marine and freshwater areas of Puget Sound	All marine and freshwater areas of Puget Sound	Freshwater areas only	Marine areas closed. Freshwater areas closed April–November.
Level of management	Management Unit, most managed for weakest population	Management Unit	Population	Not applicable
Protection of ESU diversity	Fisheries shaped to minimize timing, age, size selectivity	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1 for fisheries on other salmon that remain open.
Fishing at low abundance	Minimum Fishing Regime	No fishing	No fishing	No fishing
Monitoring	Fishery Monitoring Escapement Monitoring Biological Sampling Coastwide Coded-Wire-Tag Indicator Stock Program Smolt Production Monitoring	Monitoring would continue as in Alternative 1, although fishery monitoring in marine areas would likely be greatly reduced given the low expectation of fisheries in these areas.	Monitoring would continue as in Alternative 1, <u>except</u> fishery monitoring in marine areas would be eliminated.	Monitoring would continue as in Alternative 1, <u>except</u> fishery monitoring in marine areas would be eliminated and the biological sampling would likely be reduced.
Enforcement	Puget Sound-wide coverage in marine and freshwater areas	Same as Alternative 1 except marine patrols would probably be redirected when the likelihood of marine fisheries was low. Freshwater patrols as in Alternative 1.	Marine patrols redirected. Freshwater patrols as in Alternative 1.	Redirected to other natural resources.
Reporting	Fishery results Escapement estimates Biological sampling results	Reduced from Alternative 1.	Reduced from Alternative 1	Reduced or eliminated from Alternative 1.

Finally, existing case law provides that treaty tribal fishing can be limited for conservation purposes, but only if the associated legal standards are first met. Implementation of Alternative 4 would require closure of all salmon fisheries that took listed Puget Sound chinook salmon, including treaty tribal fisheries. In cases involving an activity that could raise the potential issue of a take under the ESA and further restriction of treaty tribal fishing, an analysis will be conducted to determine whether all of the following conservation standards have been met:

(i) the restriction is reasonable and necessary for conservation of the species at issue

(ii) the conservation purpose of the restriction cannot be achieved by reasonable regulation of non-Indian activities

(iii) the measure is the least restrictive alternative available to achieve the required conservation purpose

(iv) the restriction does not discriminate against Indian activities, either as stated or applied

(v) voluntary tribal measures are not adequate to achieve the necessary conservation purpose.

A thorough discussion of Tribal Rights and Treaty Trust Responsibilities is provided in Section 3.4 of this Environmental Impact Statement.

Therefore, Alternative 4, No Action/No Authorized Take, is included among the alternatives for detailed analysis because it was one of the alternatives included in the settlement agreement in Washington Trout v. Lohn. It provides an upper-bound estimate of the decrease in mortality on fish and wildlife species affected by Puget Sound salmon fisheries, and an upper-bound estimate of socio-economic effects.

2.3.1 Alternative 1 – Proposed Action/Status Quo

Alternative 1 represents the Puget Sound chinook harvest management framework proposed by the co-managers (Puget Sound treaty tribes and Washington Department of Fish and Wildlife). Although management objectives have been updated as new information has become available and the co-managers have continued to refine their approach, it is the same general management framework that has been implemented since 2000. All marine and freshwater areas currently fished[ii] would remain available under Alternative 1, subject to shaping by the co-managers to address conservation or use objectives. More detailed descriptions of these fisheries are provided in Subsection 1.6 of this Environmental Impact Statement. The following discussion describes the approach of Alternative 1 in

[ii] Not all freshwater areas are currently fished by the co-managers because of ongoing conservation concerns, or due to fisheries in the area being infeasible.

general detail. A detailed explanation of the management framework for individual management units is presented in the Resource Management Plan itself in Appendix A.

Under Alternative 1, Strait of Juan de Fuca and Puget Sound salmon fisheries would be managed for a mixture of management-unit-specific escapement thresholds and exploitation rate ceilings. The type of objective would vary by management unit (Table 2.3-2). Several of the management units encompass two or more populations. One half of these management units would be managed for the weakest population component and to avoid falling below the low escapement thresholds for all populations, and fisheries within the Puget Sound Action Area would be managed to achieve the conservation objectives for the weakest chinook management unit. Because it is often a point of confusion, it is important to note that this approach is different than mixed-stock management practices that manage the abundance of fish in a fishery made up of multiple populations as an aggregate; i.e., as if it was only one population. Alternative 1 would not manage mixed-stock fisheries as an aggregate. Under Alternative 1 mixed-stock fisheries would be managed for the harvest management objective of the weakest management unit in the fishery, foregoing harvest of stronger management units, if necessary, to protect the weaker management units.

The exploitation rate objectives would be ceilings not targets. This means that fisheries in each year would not be shaped to achieve the exploitation rate ceilings but rather to not exceed them. In any particular year, fisheries may be managed for rates well below these ceilings. Fisheries in the Green, Skokomish and Nisqually Rivers would be managed to meet or exceed escapement thresholds. This means that in many years, escapements would be well above their escapement thresholds, although in some years escapement may fall below their thresholds due to management imprecision. However, the degree to which escapement deviates from the threshold varies from year to year depending on the management decisions and error in forecasted abundance[iii]. Except for the Nisqually River management unit, management units managed for escapement thresholds are also coupled with ceilings on exploitation rates in mixed-stock fisheries. When abundance is insufficient to meet the escapement thresholds, additional actions would be taken to come as close to the goal as possible.

[iii] Therefore, for the purposes of this analysis, fisheries have been designed to harvest all chinook above the escapement threshold in these systems.

Table 2.3-2. Puget Sound chinook resource management plan harvest conservation objectives: Recovery exploitation rates, escapement goals, critical abundance thresholds, and minimum fishing rates under Alternative 1.

Management Unit/ Population	Recovery Exploitation Rates	Upper Management Threshold	Low Abundance Threshold	Critical Exploitation Rate Ceilings
Western Strait of Juan de Fuca	10% SUS	850	500	6% SUS
Eastern Strait of Juan de Fuca Dungeness Elwha	 10% SUS 10% SUS	 925 2,900	 500 1,000	 6% SUS 6% SUS
Nooksack[2] North Fork South Fork	Under development	4,000[3] 2,000[3] 2,000[3]	 1,000 [3] 1,000 [3]	9% SUS anticipated to be 7% or less in 4 of the next 5 years
Skagit spring Upper Sauk Cascade Siuattle	38%	2,000 986 440 574	576 N/A N/A N/A	15% SUS even-years 17% SUS odd-years
Skagit summer/fall Upper Skagit Lower Sauk Lower Skagit	50%	14,500 8,434 1,926 4,140	4,800 2,200 400 900	18% SUS
Stillaguamish[2] North Fork summer South Fork fall	25%	900[3] 600[3] 300[3]	650 [3] 500 [3] N/A	15% SUS
Snohomish[2] Skykomish Snoqualmie	21%	4,600[3] 3,600[3] 1,000[3]	2,800 1,745 [3] 521 [3]	15% SUS
Lake Washington Cedar River	15% PT SUS	1,200[3]	200 [3]	12% PT SUS
Green	15% PT SUS	5,800	1,800	12% PT SUS
White River spring	20%	1,000	200	15% SUS
Puyallup	50%	500	500[4]	12% PT SUS
Nisqually		Terminal fishery managed to achieve 1,100 natural spawners		
Mid-Hood Canal Dosewallips	15% PT SUS	750	400	12% PT SUS
Skokomish	15% PT SUS	3,650 aggregate, 1,650 natural	1,300 aggregate 800 natural	12% PT SUS

Source: Puget Sound Indian Tribes and Washington Department of Fish and Wildlife (~~11/4/2003~~3/18/04).
Exploitation rates expressed as:
SUS = Total, southern United States.
PT SUS = Pre-terminal southern United States. [1]

[1] A fishery that harvests significant numbers of fish from more than one region of origin. Does not include additional impacts in terminal fisheries.
[2] Managed for weakest population component.
[3] Natural-origin spawners.
[4] 500 adults to the South Prairie Creek index.

Under Alternative 1, all populations have low abundance thresholds[iv] and all management units have upper management thresholds[v] that trigger additional fishery responses when escapement is anticipated to be lower or higher than these thresholds (Table 2.3-2). For all management units, when abundance is projected to result in escapement below the low abundance threshold, or the amount of exploitation in Alaskan and Canadian fisheries would make it difficult or impossible to meet harvest objectives, exploitation rates in southern U.S. fisheries would be held to rates no greater than those rates defined by a minimum fishing regime (Table 2.3-2). The minimum fishing regime is designed to preserve an acceptable level of harvest opportunity on other salmon species and hatchery chinook stocks. As such, the minimum fishing regime is based primarily on policy interpretation of this acceptable level of harvest opportunity rather than primarily on biological considerations as is the case with the escapement thresholds and general exploitation rate objectives. The co-managers believe the minimum fishing regime achieves a balance of protection for the chinook salmon populations, preserves harvest opportunity on other salmon species and stronger chinook salmon stocks, and provides a minimum level of fishing that allows some exercise of tribal treaty rights. The status of several populations is such that they would be expected to be managed under the minimum fishing regime over the duration of the Proposed Action. The expected range of impacts on these populations is discussed in more detail in Section 4.3 of this Environmental Impact Statement.

Under Alternative 1, if after accounting for expected Alaskan and Canadian catches; and incidental, test, and tribal ceremonial and subsistence catches in southern U.S. fisheries; a management unit is expected to have a spawning escapement greater than its upper management threshold, and its projected exploitation rate is less than its exploitation rate ceiling objective, the amount in excess of the upper escapement threshold (harvestable surplus) would be considered to be available for targeted harvest. In that case, additional fisheries may be implemented until the exploitation rate ceiling is met or its expected escapement equals the upper management threshold. In other words, the primary objective of the fishery could be to harvest the amount in excess of the upper management threshold for that management unit, in addition to incidental harvest occurring in fisheries on other species or

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[iv] These thresholds are set at levels below which concerns about demographic and genetic effects on population stability begin to arise. They are intentionally set above the level at which a population may become demographically unstable, or subject to loss of genetic integrity. More detail for each population can be found in Appendix A of the Puget Sound Chinook Comprehensive Management Plan – Harvest Management Component.

[v] These thresholds are intended to represent optimum productivity of the management unit or population. More detail for each management unit can be found in Appendix A of the Puget Sound Chinook Comprehensive Management Plan – Harvest Management Component.

hatchery chinook stocks. These fisheries are commonly called directed fisheries. Otherwise, Alternative 1 would prohibit directed harvest on listed populations of Puget Sound chinook salmon, unless they were expected to have harvestable surpluses. However, both directed and incidental fishery impacts would be constrained by the overall exploitation rate ceilings or escapement thresholds for each management unit (Recovery Exploitation Rates and Thresholds, Table 2.3.2). The co-managers expect that directed fishing under Alternative 1 during the ~~2004~~ 2005–2009 fishing seasons would be limited to occasional ceremonial and subsistence fisheries.

Fisheries would also be conducted in a manner that would minimize impacts to the diversity of chinook salmon populations within the Puget Sound Action Area. For example, to minimize potential size, timing, and age-selective effects resulting from terminal fisheries, pulsed (i.e., short-duration) openings would be scheduled over the duration of the run.

Monitoring

Alternative 1 includes monitoring provisions to collect biological data, validate assumptions, and assess the performance of the annual fishing regime. WDFW and the Puget Sound treaty tribes work together cooperatively to conduct the monitoring. The Puget Sound chinook salmon catch in all fisheries, including incidental catch, and fishing effort would be monitored and compared against pre-season expectations. Commercial catch in Washington waters would be recorded on sales receipts (‘tickets’), copies of which would be sent to the Washington Department of Fish and Wildlife and tribal agencies, and recorded in a jointly-maintained database. Recreational catch in some areas in Puget Sound would be estimated in-season by creel surveys. Creel sampling regimes have been developed to meet acceptable standards of variance for weekly catch. For other Puget Sound fishing areas, recreational harvest would be estimated from a sample of catch record cards obtained from all anglers. The recreational fishery baseline sampling program would provide auxiliary estimates of species composition, effort, and catch per unit effort. For this program, the objectives would be to sample 120 fish per sampling group for estimation of species composition, and 100 boats per stratum (i.e., sampling group) for the estimation of catch per unit effort. Post-season comparison to actual catch is used to assess the true effect of regulations, and guides their future application or modification. Collection of scales, otoliths (bones in the head of a fish that indicate age), coded-wire tags, and sex and length data would occur to determine the age and size composition of the local population, and distinguish hatchery- and natural-origin fish.

Chinook escapement surveys in each river system would be implemented to estimate annual escapements, evaluate trends in escapement, and to describe the annual variation in the return timing of chinook populations. Estimates of escapement and fishery exploitation rates would enable reconstruction of the abundance of annual chinook returns and, given the age composition of annual returns, would enable estimation of the abundance produced from a given brood year escapement. After adjustment to account for non-landed fish and natural mortality, these estimates of recruitment would define the productivity of specific populations.

Monitoring would include continued implementation of the coast-wide indicator stock program in Puget Sound, used to assess harvest mortality and distribution. Chinook salmon populations that are part of the indicator stock program include Nooksack River spring, Skagit River spring, Stillaguamish River summer, Green River fall, Nisqually River fall, Skokomish River fall, and Hoko River fall populations. Additional indicator stocks are being developed for Skagit River summer and fall, and Snohomish summer populations. Commercial and recreational catch in all marine fishing areas in Washington would be sampled to recover coded-wire tagged chinook. For commercial fisheries, the objective would be to sample at least 20 percent of the catch in each area, in each week, throughout the fishing season (Johnson 1990). For recreational fisheries, the objective would be to sample 10 percent of the catch in each month/area stratum for Marine Catch Areas 7 through 13 and 20 percent for Marine Catch Areas 4B through 6 (Milward 2003a; Milward 2003b).

Smolt production from several Puget Sound management units would be estimated to provide additional information on the productivity of populations, and to quantify the annual variation in freshwater (i.e., egg-to-smolt) survival. In general, traps are operated through the chinook salmon out-migration period (January–August). These estimates are essential to understanding and predicting the annual recruitment, particularly in large river systems where freshwater survival has shown wide variation.

Enforcement

The Washington Department of Fish and Wildlife and individual Treaty tribes are responsible for regulating harvest of fisheries under their authority, consistent with the principles and procedures set forth in the Puget Sound Salmon Management Plan (1985).

Each tribe exercises authority over enforcement of tribal commercial fishing regulations, whether fisheries occur on or off their reservation. In some cases, enforcement is coordinated among several tribes by a single agency (e.g., the Point-No-Point Treaty Council is entrusted with enforcement authority over Lower Elwha Klallam, Jamestown S'Klallam, and Port Gamble S'Klallam tribal fisheries). Enforcement officers of one tribal agency may be cross-deputized by another tribal agency, where those tribes fish in common areas. Prosecution of violations of tribal regulations occurs through tribal courts and governmental structures. Enforcement officers would patrol all marine and freshwater salmon fisheries under Alternative 1 to enforce regulations and offer community outreach.

Reporting

The co-managers would write an annual report on Puget Sound chinook salmon fisheries management that they would use to inform future harvest management decisions (see Section 7 of the Resource Management Plan in Appendix A), and would provide this report to NMFS annually as part of the application of Limit 6. Annual review builds a remedial response into the pre-season planning process to prevent excessive fishing mortality levels relative to the conservation of a management unit. The report would include:

- A summary of the chronology and conduct of all fisheries within the co-managers' jurisdiction, comparing expected and actual fishing schedules, and landed chinook catch. Significant deviations from the pre-season plan would be highlighted, with a summary of in-season abundance assessments and changes in fishing schedules or regulations.
- Estimates of landed catch of chinook in all fisheries during the management year (May through April) compared with pre-season expectations of catch, including revised estimates of landed catch for the previous management year. The causes of significant discrepancies between expected and actual catch would be examined, with an objective to improving the accuracy of the pre-season projections.
- Results of non-landed mortality studies.
- Comparisons of spawning escapement for all management units to pre-season projections, with detail on individual populations reported, as possible. Escapements would be compared to escapement goals and critical escapement thresholds. Final and detailed estimates of escapement for the previous year would also be tabulated.
- A summary of coded-wire tag sampling rates achieved in the previous year, and a description of biological sampling (i.e., collection of scales, otoliths, and sex and size data) of catch and escapement.
- Annual, adult-equivalent exploitation rates for each management unit as data become available, and comparison of these rates to the preseason expected exploitation rates and ceilings.
- A report describing whether the annual goals of the Pacific Salmon Treaty agreements were achieved.

As part of Alternative 1, the results of the annual reports would be used to revise harvest management objectives and fishery actions to maintain consistency with the current productivity and capacity of the various chinook systems and to improve management accuracy. The primary intent of monitoring, evaluation and reporting is to provide a useful feedback loop to improve understanding of the status and ecology of the salmon populations and fisheries management.

2.3.2 Alternative 2 – Escapement Goal Management

Under Alternative 2, Puget Sound and Strait of Juan de Fuca salmon fisheries would be managed to achieve fixed escapement goals for each Puget Sound chinook management unit. All marine and freshwater areas currently fished[vi] would remain available under Alternative 2, subject to shaping by the co-managers to address conservation or use objectives. Under Alternative 2, fisheries would occur where the abundance of Puget Sound chinook management units passing through those areas were predicted to be in excess of their goals (Table 2.3-3). Although, there would be no general restriction on where the fish could be caught as long as the fisheries management units were meeting their escapement goals, the subsequent analysis in Section 4 demonstrates that, for the abundances expected to occur over the next six years, most fishing would be limited to terminal (freshwater) areas. Terminal areas are defined as locations containing only populations returning to a single river system; for example, the Skagit River. The reason for this is that fisheries in marine areas would encounter fish from a mixture of management units, some of which would not be anticipated to meet their escapement goals. Since fishing cannot occur on management units below their escapement goals under Alternative 2, fisheries in these areas would be closed.

In practice, under Alternative 2, fisheries would be managed to meet or exceed escapement thresholds for the Puget Sound chinook management units. This means that in many years, escapements would be well above their escapement thresholds, although in some years escapements could fall below their goals because of management imprecision. However, the degree to which escapement deviates from the threshold varies from year to year depending on the management decisions and error in forecasted abundance. Therefore, as with Alternative 1, for the purposes of this analysis, fisheries have been designed to harvest all chinook in excess of the escapement goal.

In general, the analysis of Alternative 2 assumes that the terminal fishery structure is the same as that of Alternative 1, and does not introduce any new fisheries that have not occurred in recent years, since this would be highly speculative. For example, non-tribal commercial fisheries do not presently occur in freshwater areas by agreement with the tribes, and due to a resource use decision to prioritize recreational fisheries in freshwater areas by the Washington Department of Fish and Wildlife. In the Strait of Juan de Fuca region, very limited harvest of chinook, coho, and steelhead would occur only in the Hoko River. In the North Puget Sound region, limited chum and steelhead fisheries would occur in

[vi] Not all freshwater areas are currently fished by the co-managers because of ongoing conservation concerns, or due to fisheries in the area being infeasible.

the Nooksack and Skagit Rivers. Available chinook abundance for the Stillaguamish management unit would allow a small chum fishery, moderate chinook, coho and pink fisheries in the Stillaguamish River and a small chum fishery in Tulalip Bay. The Tulalip Bay fishery is the only fishery outside terminal areas under Alternative 2. In the South Puget Sound region, available chinook salmon abundance would allow moderate fisheries for coho and chum salmon, and limited fisheries for pink salmon. In Hood Canal, available chinook salmon abundance would allow moderate fisheries for coho, pink and chum salmon relative to Alternative 1.

Table 2.3-3. Escapement goal objectives used to analyze Alternative 2 based on objectives provided by the co-managers.

Management Unit	Alternative 2 Escapement Goal
Western Strait-Hoko [1]	850
Dungeness Spring	925
Elwha	2,900
Nooksack Spring	4,000[2]
Nooksack/Samish summer-fall [1]	8,900
Skagit Spring	2,000
Skagit Summer/Fall	14,500
Stillaguamish	900[2]
Snohomish	4,600[2]
Tulalip Tribal Hatchery [1]	--
Lake Washington	1,550
Green-Duwamish	5,800
Puyallup	1,200
White Spring	1,000
Nisqually	1,100
Gorst, Grovers, Minter, Chambers & McAllister, Deschutes [1]	9,600
Mid-Canal	750
Skokomish	1,200
Hoodsport H, Dewato, Union, Tahuya tributaries. [1]	1,850

[1] Not defined as an independent population for the listed Puget Sound chinook Evolutionarily Significant Unit. Goals used to assess economic impacts of lost harvest opportunity.

[2] Natural-origin spawners.

Fisheries outside the Puget Sound Action Area, such as those under the jurisdiction of the Pacific Fisheries Management Council, including Marine Catch Area 4B from May to September, would continue to operate under Alternative 2.

Monitoring

With the elimination of almost all marine salmon fisheries under Alternative 2, monitoring programs associated with those fisheries would be eliminated. Monitoring of terminal fisheries, escapement, and smolt production would continue as described under Alternative 1.

Enforcement

With the elimination of almost all marine salmon fisheries, enforcement would be redirected from marine fisheries to terminal salmon fisheries or to other natural resources; such as, shellfish and wildlife.

Reporting

Reporting provisions would be the same as described for Alternative 1.

2.3.3 Alternative 3 – Escapement Goal Management at the Population Level with Terminal Fisheries Only

Alternative 3 is very similar to Alternative 2 except that 1) Puget Sound and Strait of Juan de Fuca salmon fisheries would be managed to meet population-specific escapement goal objectives rather than management unit-specific goals and, 2) salmon fisheries that would harvest listed Puget Sound chinook would not occur within the Puget Sound Action Area outside terminal areas of Puget Sound and the Strait of Juan de Fuca. Alternative 2 had no specific geographical constraints on where fisheries could occur[vii]. Populations are those defined by the Puget Sound Technical Recovery Team (~~NMFS~~ PSTRT 2003). There would be no fishing-related mortality of listed Puget Sound chinook for populations for which abundance was not expected to meet the escapement goal of the population (Table 2.3-4). Data were not available to derive a population-specific escapement goal for the North Lake Washington population because the data are too variable to derive a population dynamic relationship, and the contribution of hatchery strays is unknown. Lacking these data, the escapement goals for the Lake Washington management unit and the Cedar River population were used to represent probable effects of Alternative 3 on the North Lake Washington population. Both the Lake Washington Tributaries and Cedar River populations have the same type of life history and are subject to the same fisheries, so there is no reason to believe based on available information that the North Lake Washington

[vii] Abundance over the next 6 years (2005–2010) is predicted to be below the escapement goal for most populations, effectively constraining fisheries to freshwater areas under the terms of Alternative 2. However, if abundance was predicted to exceed the escapement goals, fisheries could occur in marine as well as freshwater areas under Alternative 2. Under Alternative 3, however, fisheries would be explicitly constrained to freshwater areas.

Tributaries population and the Cedar River population are harvested in different locations or at different rates. Management for all individual populations rather than management units, the constraint to fish only in freshwater areas, the use of escapement goals as management objectives for all populations, and the elimination of harvest on listed chinook salmon populations or management units that do not meet their escapement goal, are the key differences between Alternatives 1, and Alternatives 2 and 3. For example, under Alternative 1, the three Skagit summer/fall chinook salmon populations would be managed for an exploitation rate ceiling. There would be no general restriction on where the fish could be caught as long as the fisheries in total did not exceed the ceiling and there is some level of harvest under all abundance conditions. Under Alternative 2, the three Skagit summer/fall populations would be managed for the management unit escapement goal, and no fishery-related mortality on listed Skagit summer/fall chinook would occur in Puget Sound fisheries when abundance was not expected to meet the escapement goal. Under Alternative 3, the three Skagit summer/fall chinook populations would be managed for individual escapement goals. Fisheries would only occur in terminal areas where and when abundance was anticipated to exceed the escapement goal.

It is important to note that under the Puget Sound Salmon Management Plan (1985), the co-managers established escapement goals only at the management-unit level, and not at the population level, except where there is only one population in the management unit. The Puget Sound Salmon Management Plan (1985) defines a stock (population) as "An anadromous salmonid population of a single population of a species migrating during a particular season to a specific fish production facility and/or to a freshwater system which flows into saltwater" (Puget Sound Salmon Management Plan 1985). The co-managers have interpreted this to mean that the smallest unit of management would be at the level of a river system (i.e., management unit), not tributaries within that river system, and in most instances, information on individual populations is very limited. In order to adopt population-specific management objectives for those management units that include multiple populations, formal agreement would be required between the co-managers. Therefore, the population-specific escapement goals defined under Alternative 3 are not official management objectives, but are used only for the purpose of analyzing this alternative.

Under Alternative 3, terminal fisheries would occur where Puget Sound chinook salmon abundance in excess of the goals were predicted (Table 2.3-4). Although in practice fisheries would be managed to meet or exceed the goals, as with Alternatives 1 and 2, for the purposes of this analysis, fisheries have been designed to harvest all chinook in excess of the escapement goal. In general, as under

Alternative 2, the analysis of Alternative 3 assumes that the terminal fishery structure would be the same as that of Alternative 1, and would not introduce any new fisheries that have not occurred in recent years even with the elimination of marine commercial fishing opportunities. Except for fisheries in Tulalip Bay and the Stillaguamish River, fisheries under Alternative 3 would be identical to those under Alternative 2. In the Strait of Juan de Fuca region, very limited harvest of chinook, coho, and steelhead would occur only in the Hoko River. In the North Puget Sound region, limited chum and steelhead fisheries would occur in the Nooksack and Skagit Rivers. Population abundance for the South Fork Stillaguamish population would not meet its escapement goal and so the Tulalip Bay and Stillaguamish fisheries that would occur under Alternative 2 would not occur under Alternative 3. In the South Puget Sound region, available chinook abundance would allow moderate fisheries for coho and chum salmon, and limited fisheries for pink salmon. In Hood Canal, available chinook abundance would allow moderate fisheries for coho, pink and chum salmon relative to Alternative 1.

Fisheries outside the Puget Sound Action Area, such as those under the jurisdiction of the Pacific Fisheries Management Council, including Marine Catch Area 4B from May to September, would continue to operate under Alternative 3.

Monitoring

With the elimination of marine salmon fisheries under Alternative 3, monitoring programs associated with those fisheries would be eliminated. Monitoring of terminal fisheries, escapement, and smolt production would continue as described under Alternative 1.

Enforcement

Enforcement would be redirected from marine fisheries to terminal salmon fisheries or to other natural resources; such as, shellfish and wildlife.

Reporting

Reporting requirements would be the same as described for Alternative 1.

Table 2.3-4. Escapement goal objectives used to analyze Alternative 3 based on objectives provided by the co-managers.

Management Unit/Population	Alternative 3 Escapement Goal
Western Strait-Hoko [1]	850
Dungeness Spring	925
Elwha	2,900
Nooksack Spring	
North Fork Nooksack	2,000[1]
South Fork Nooksack	2,000[1]
Nooksack/Samish summer-fall [1]	8,900
Skagit Spring	
Upper Sauk	986
Suiattle	574
Upper Cascade	440
Skagit Summer/Fall	
Lower Sauk	1,926
Upper Skagit	8,434
Lower Skagit	4,140
Stillaguamish	
North Fork Stillaguamish	600[5]
South Fork Stillaguamish	300[5]
Snohomish	
Skykomish	3,600[5]
Snoqualmie	1,000[5]
Tulalip Tribal Hatchery [1]	--
Lake Washington	
Cedar	1,200[5]
North Lake Washington tributaries	
Green-Duwamish	5,800
Puyallup	1,200
White Spring	1,000
Nisqually	1,100
Gorst, Grovers, Minter, Chambers & McAllister, Deschutes [2]	9,600
Mid-Canal	750
Skokomish	1,200
Hoodsport H, Dewato, Union, Tahuya tributaries. [2]	1,850

[1] Natural-origin spawners.

[2] Not defined as an independent population for the listed Puget Sound Chinook Evolutionarily Significant Unit. Goals used to assess economic impacts of lost harvest opportunity.

2.3.4 Alternative 4 – No Action/No Authorized Take

Under Alternative 4, fishing-related mortality of listed Puget Sound chinook would be eliminated in salmon fisheries within the Strait of Juan de Fuca and Puget Sound. Therefore, it is assumed that those salmon fisheries within the Puget Sound Action Area that harvested one or more listed Puget Sound chinook consistently from year to year would be closed. This would preclude all salmon fisheries in marine areas and most freshwater fisheries. The only fisheries open under Alternative 4 would be freshwater fisheries for chum from December through January, and freshwater fisheries for steelhead from December through March. This would result in limited chum and/or steelhead fisheries in the Strait of Juan de Fuca tributaries, Nooksack, Skagit, Green, and Skokomish Rivers. It is assumed that the catches of chum and steelhead salmon species would be similar to those observed in recent years (1996-2001).

Fisheries outside the Puget Sound Action Area, such as those under the jurisdiction of the Pacific Fisheries Management Council, including Marine Catch Area 4B from May to September, would continue to operate under Alternative 4.

Monitoring

With the elimination of salmon fisheries under Alternative 4, monitoring programs associated with those fisheries would be eliminated. Core programs like escapement surveys, and smolt production monitoring would continue. Collection of biological data might continue, but in situations of past revenue constraint, have been substantially reduced or eliminated.

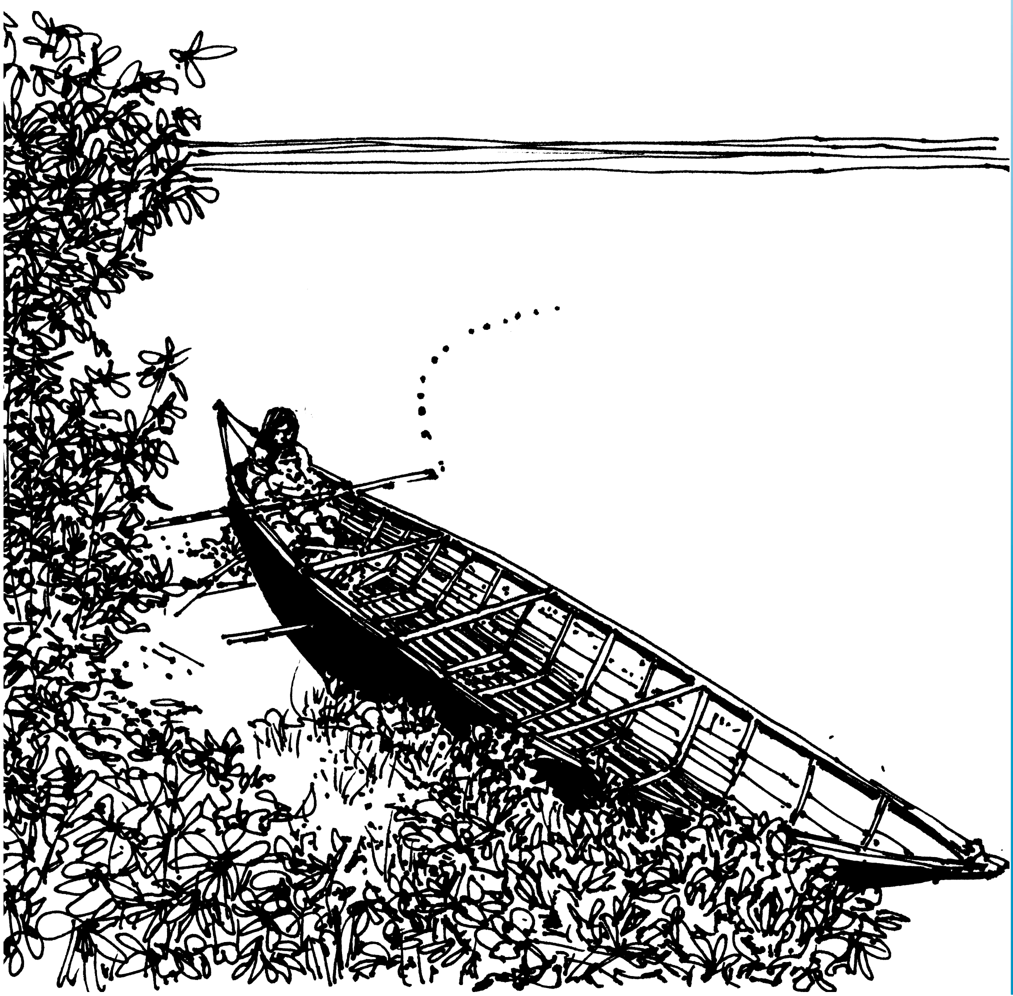
Enforcement

Without fishery regulations to enforce under Alternative 4, the enforcement program for fisheries would be redirected to other natural resources such as shellfish and wildlife. Officers would cite illegal fishing when encountered, but it would be unlikely to be a focused effort.

Reporting

The reporting element would be greatly reduced by the co-managers under Alternative 4, as they would turn their focus to management of other resources. However, it is likely that the reporting of escapement, escapement trends, and some of the other core biological information would continue.

Affected Environment



3

3.0 AFFECTED ENVIRONMENT

3.1 Introduction

This section describes those components of the existing natural, built, and human environment that would be affected by the alternatives under consideration for salmon and steelhead fisheries in Puget Sound and the Strait of Juan de Fuca that take listed Puget Sound chinook. The ESA defines “take” to mean “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct” (ESA section 3, Definitions). Fisheries that do not take listed chinook salmon are not considered in this document. Each of the topics required to be addressed by the National Environmental Policy Act (NEPA) and the Washington State Environmental Policy Act were considered when selecting topics for discussion in this section. The issues discussed in this section have been identified as important aspects of the Affected Environment by ~~NOAA Fisheries~~ NMFS, the co-managers, other federal agencies, and/or public comment. Consistent with guidance from the President’s Council on Environmental Quality (CEQ) for implementing NEPA, this section provides the most detail and discussion on those issues with the greatest potential to be affected by the Proposed Action and alternatives, and only briefly describes those issues that may be marginally affected (CEQ Regulations at 40 CFR 1502.15). To accurately depict existing conditions, the Affected Environment is described in the context of the 1990s and early 2000s, focusing on the 2000–2001 period.

The Affected Environment section begins with a description of the Puget Sound Action Area and its general environmental setting. Subsections within Section 3 discuss various aspects of the natural, built, and human environment that may be affected by the Proposed Action or alternatives, organized as follows:

Section 3 Subsections	Natural Environment	Built Environment	Human Environment
3.3.1 and 3.3.2: Status of salmonid species	X		
3.3.3: Other fishes	X		
3.3.4: Fish habitat	X		
3.3.5 through 3.3.7: Potential ecological effects of current harvest activities	X		
3.4: Tribal treaty rights and trust responsibilities			X
3.5: Non-commercial use of salmonids by Puget Sound tribes			X
3.6: Regional economics of commercial and sport fisheries			X
3.7: Environmental justice			X
3.8.1 through 3.8.3 and 3.8.5: Seabirds, marine mammals, and other wildlife species	X		
3.8.4: Lower trophic-level species	X		
3.9: Land ownership and land use		X	
3.10: Water quality	X		

3.2 Environmental Setting

The Puget Sound Action Area includes all marine waters of the State of Washington east of, and including the Strait of Juan de Fuca. The action area also includes all State of Washington freshwater tributaries of these marine waters east of the Strait of Juan de Fuca, and the freshwater tributaries of the Strait of Juan de Fuca east of, and including the Elwha River drainage.

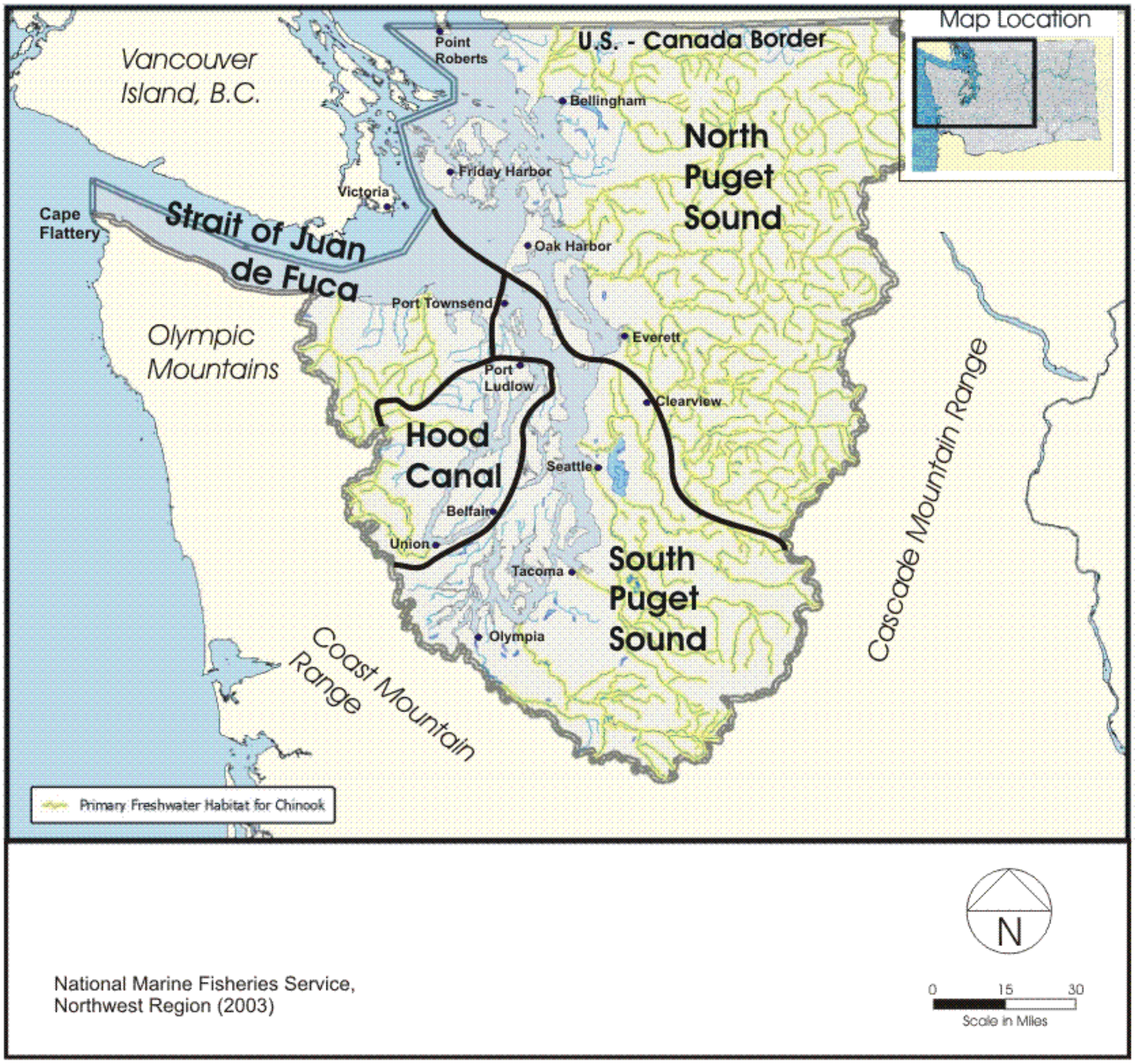
Using definitions found in *Washington Place Names* (Reese 2002), the action area has been divided into four distinct regions: 1) Strait of Juan de Fuca; 2) Hood Canal; 3) South Puget Sound; and 4) North Puget Sound (Figure 3.2-1). There are 12 Washington counties within the action area (Figure 3.2-2).

Strait of Juan de Fuca. This 90-mile long waterway between British Columbia (Canada) and Washington State, with an average width of 13 miles, extends from the Pacific Ocean at Cape Flattery to the vicinity of Port Townsend in the United States and Victoria in British Columbia (see Figure 3.2-1). The action area includes only the waters of the United States. Washington counties Clallam and Jefferson border the south side of the Strait of Juan de Fuca. Major river systems draining into the Strait of Juan de Fuca include the Elwha River and the Dungeness River in Clallam County (Table 3.2-1).

Hood Canal. This saltwater channel extends southwest from the vicinity of Port Ludlow in Jefferson County through Kitsap and Mason counties, to the Great Bend at Union, then northeast to Belfair in Mason County (see Figure 3.2-1). It is an arm of the great inland sea of western Washington. Major freshwater drainages within Hood Canal include the Skokomish, Hamma Hamma, Dosewallips, Duckabush, and the Big and Little Quilcene Rivers (Table 3.2-1).

South Puget Sound. For the purpose of this Environmental Impact Statement, the marine area defined in *Washington Place Names* as Puget Sound is referred to as South Puget Sound. South Puget Sound is an inland, saltwater sound that extends about 53 miles south from Point Wilson near Port Townsend in western Washington (see Figure 3.2-1). It extends southwesterly approximately 30 miles to Budd Inlet, with other branches in Thurston and Mason counties. It does not include Hood Canal, Port Susan, Bellingham Bay or the San Juan Island waterways. Major freshwater drainages that discharge to South Puget Sound are listed in Table 3.2-1.

1 Figure 3.2-1. The Puget Sound Action Area and regions within the action area.



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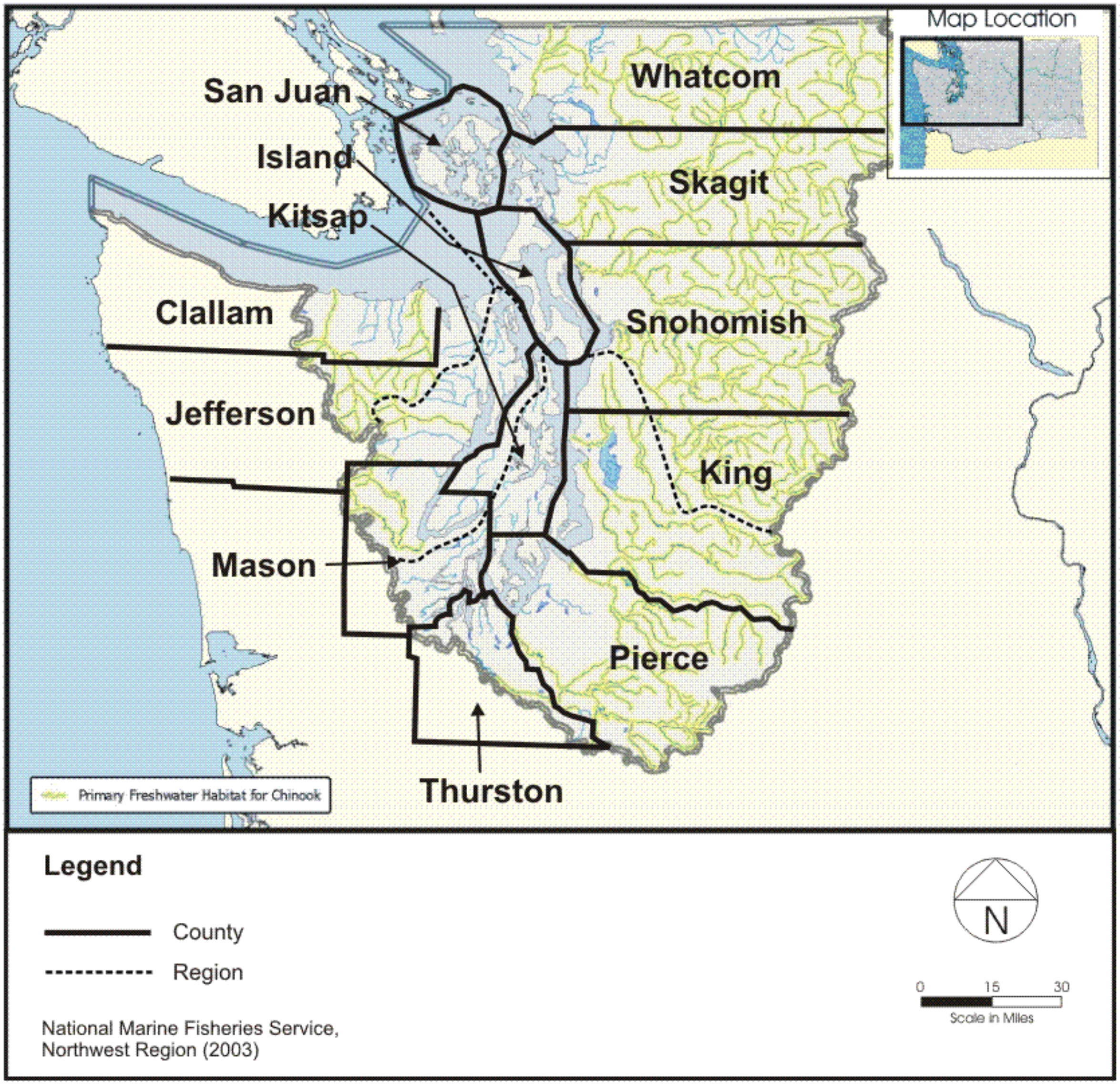
1 Figure 3.2-2. Washington counties within the Puget Sound Action Area.



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North Puget Sound. The northern portion of the action area, including the U.S. marine areas referred to as Port Susan, Bellingham Bay, the Strait of Georgia, the marine waters of the San Juan Islands, and the marine waters of the San Juan Archipelago, are collectively referred to herein as North Puget Sound (Figure 3.2-3). Major drainages that enter North Puget Sound include the Nooksack, Samish, Skagit, Stillaguamish, and Snohomish Rivers (Table 3.2-1).

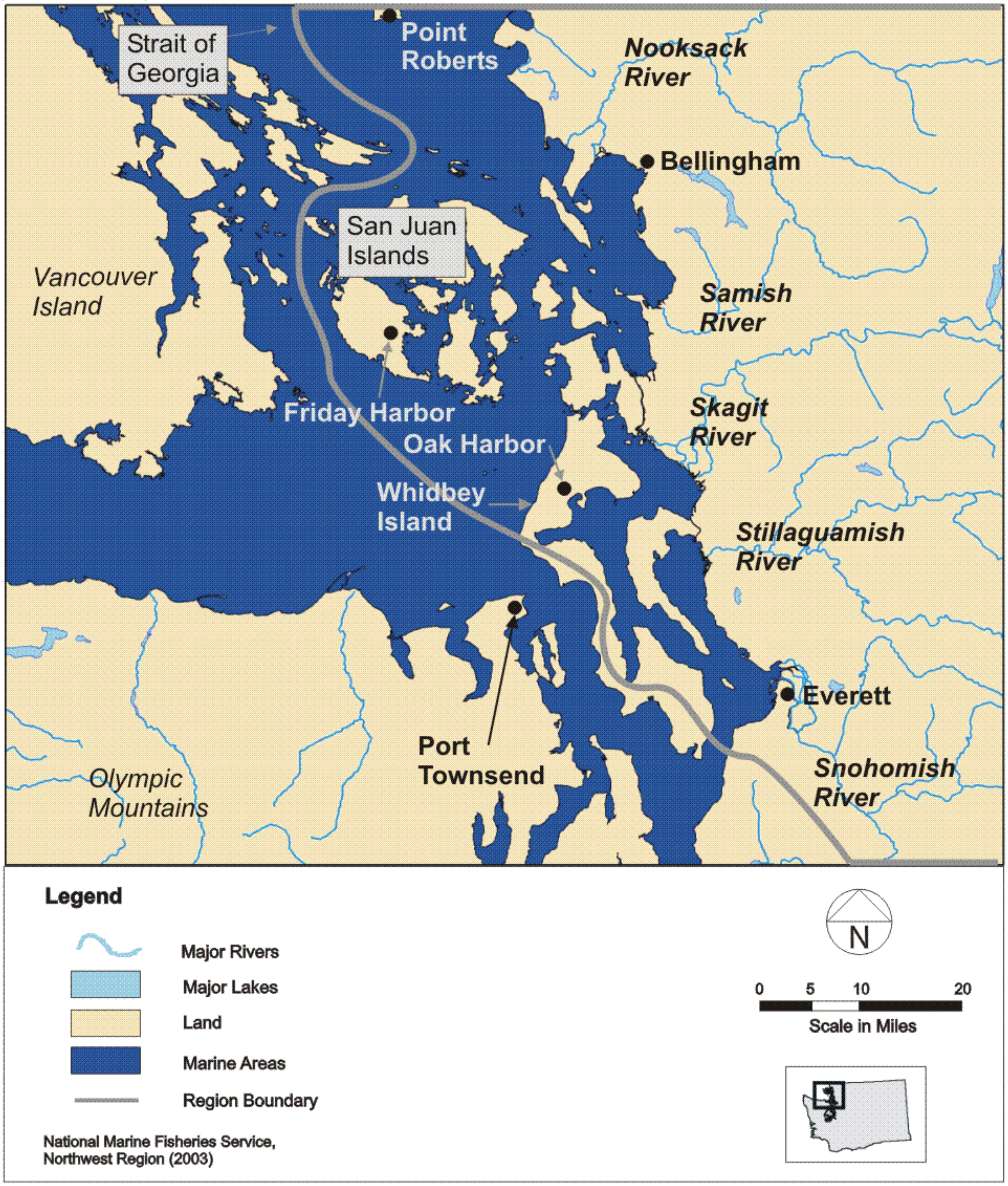
Table 3.2-1. Major river systems within the four regions of the Puget Sound Action Area.

Region	Major River Systems
Strait of Juan de Fuca	Elwha River Dungeness River
Hood Canal	Skokomish River Hamma Hamma River Dosewallips River Duckabush River Big Quilcene River Little Quilcene River
South Puget Sound	Cedar River Green/Duwamish River Puyallup River Nisqually River Deschutes River
North Puget Sound	Nooksack River Samish River Skagit River Stillaguamish River Snohomish River

3.2.1 Physical Description of the Action Area

The Puget Sound Action Area is bounded on the east by the Cascade Mountain Range and on the west by the Olympic Mountains. Its northern part reaches the international boundary between the United States and Canada, and it ends at the base of the low hills of the Coast Mountain Range near Olympia (Figure 3.2-1). The surrounding land mass of the action area includes approximately 13,600 square miles, 20 percent of the total surface land mass within Washington state (66,582 square miles).

1 Figure 3.2-3. The North Puget Sound region of the Puget Sound Action Area.



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Freshwater inflow into Puget Sound, Hood Canal, and the eastern part of the Strait of Juan de Fuca is approximately 900 million gallons per day. The major sources of fresh water are the Skagit and Snohomish Rivers. However, the annual amount of fresh water entering Puget Sound is only 10 to 20 percent of the amount entering the Strait of Georgia. The majority of the fresh water entering the Strait of Georgia is conveyed by the Fraser River drainage, a major drainage in southwestern Canada (Gustafson et al. 2000). The Fraser River enters the Strait of Georgia approximately 10 miles north of the United States border.

The marine surface area of the Puget Sound Action Area is approximately 900 square miles, within 2,000 miles of coastline (Gustafson et al. 2000). The average depth of Puget Sound at mean low tide is 205 feet, The average surface water temperature is 55^{o} F in summer and 45^{o} F in winter (Staubitz et al. 1997). Estuarine circulation in Puget Sound is driven by tides, gravitational forces, and freshwater inflows.

The largest habitat type within the Puget Sound Action Area is kelp beds and eelgrass meadows, which cover almost 400 square miles. Other major habitats include subaerial and intertidal wetlands (68 square miles), and mudflats and sandflats (95 square miles) (Gustafson et al. 2000). The extent of some of these habitats has markedly declined over the last century. Hutchinson (1988) indicated that 58 percent of intertidal habitat in Puget Sound has been lost since European settlement. Four river deltas (the Duwamish, Lummi, Puyallup, and Samish Rivers) have lost more than 92 percent of their intertidal marshes (Simenstad et al. 1982; and Schmitt et al. 1994, as cited in Gustafson et al. 2000). At least 76 percent of the wetlands around Puget Sound have been eliminated, especially in urbanized estuaries. Substantial declines of mudflats and sandflats have also occurred in the deltas of these estuaries (Levings and Thom 1994, as cited in Gustafson et al. 2000).

Geologic history of the area includes repeated advances and retreats of continental ice sheets from Canada. The continental ice sheet reached its maximum advance about 14,000 years ago (Kruckeberg 1991). It was the action of ice and its later melt waters that gave shape to many of the features of the Puget Sound area landscape of today.

Three dominant climate factors influence the weather of Puget Sound. They are 1) the Pacific Ocean, acting as the region’s thermostat and generator of moisture-laden air; 2) the semi-permanent high and low-pressure cells that hover over the North Pacific Ocean that propel the maritime air in the direction of Puget Sound; and 3) the mountains bordering Puget Sound, that regulate the flow of the regional atmosphere. The combined effects of these factors result in a generally predictable climate, described as “maritime;” i.e., mild and wet. Precipitation is mainly in the form of rain, of which more than 75 percent falls between October and March. With the exception of areas within the "rain shadow" of the Olympic Mountains, most areas within the Puget Sound Action Area receive 36 to 52 inches of precipitation per year, with an average of 40.3 inches (Kruckeberg 1991).

3.2.2 Resident Population within the Action Area

The total resident human population of the 12 counties within the action area on April 1, 2000, as reported by the United States Census Bureau, was 3,978,513 (Table 3.2-2). Approximately 67.5 percent of the entire Washington State population of 5,894,121 resided within these 12 counties at that time (United States Census 2000). Most of the population lives near the shores of Puget Sound and in the alluvial valleys of major rivers. American Indian and Alaska Natives represented approximately 1.4 percent of the population.

Table 3.2-2. April 1, 2000 resident population of Puget Sound Action Area counties.

Region	Washington County	April 1, 2000 Resident Population	Percent American Indian and Alaska Native [1]
Strait of Juan de Fuca	Clallam	64,525	5.1%
Hood Canal	Jefferson	25,953	2.3%
	Kitsap	231,969	1.6%
	Mason	49,405	3.7%
South Puget Sound	King	1,737,034	0.9%
	Pierce	700,820	1.4%
	Thurston	207,355	1.5%
North Puget Sound	Snohomish	606,024	1.4%
	Skagit	102,979	1.9%
	Whatcom	166,814	2.8%
	Island	71,558	1.0%
	San Juan	14,077	0.8%
Total	12 Counties	3,978,513	1.4%

[1] The proportionate occurrence of American Indian and Alaska Native populations is noted for purposes of the Environmental Justice analysis of potential impacts to minority populations that have a significant reliance on Puget Sound Chinook salmon. The United States Census 2000 defined American Indian and Alaska Native as a "person having origins in any of the original peoples of North and South America (including Central America), and who maintain tribal affiliation or community attachment" (United States Census 2000).

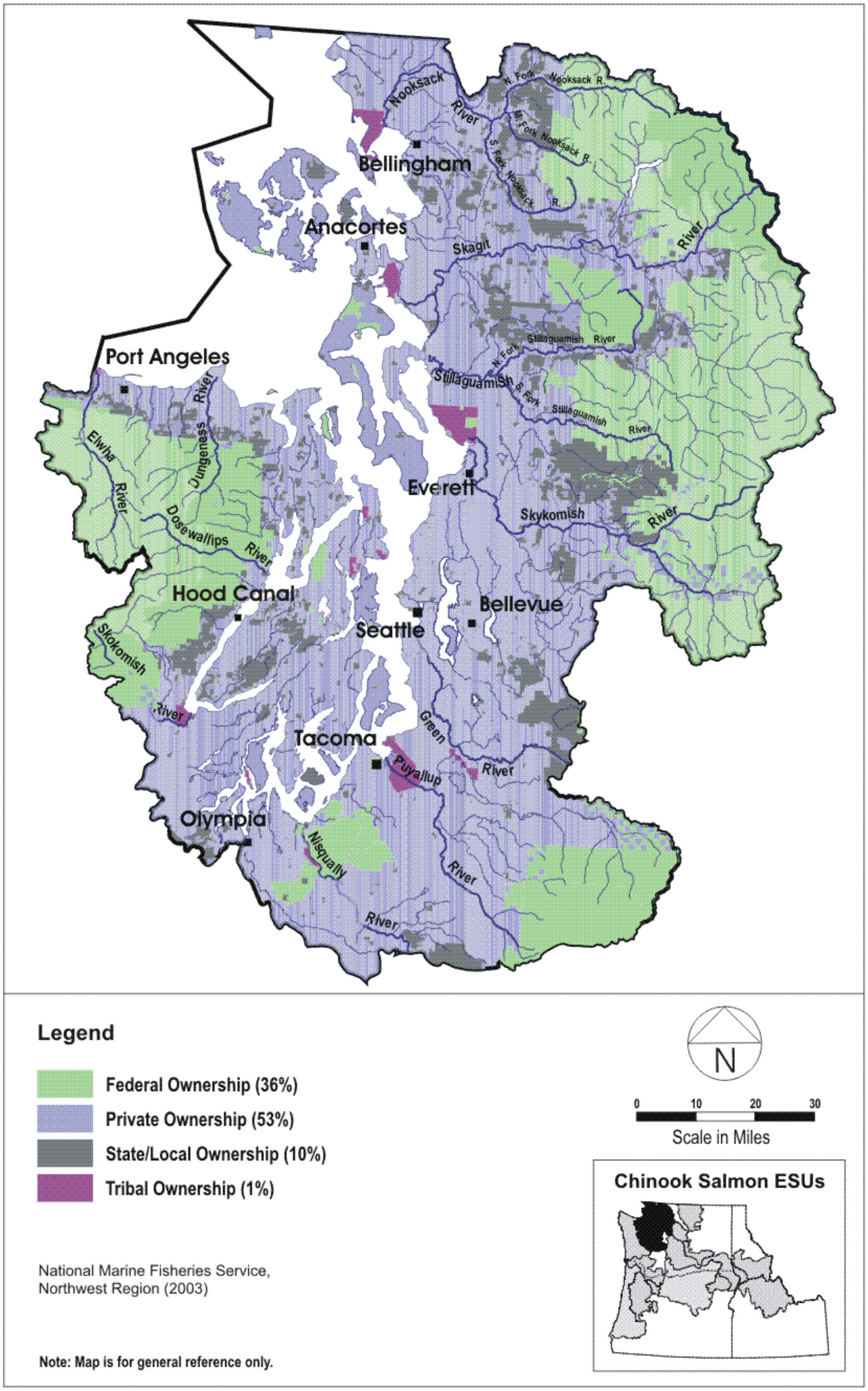
3.2.3 Evolutionarily Significant Units within the Action Area

An Evolutionarily Significant Unit (ESU) is a distinctive group of Pacific salmon or steelhead (National Marine Fisheries Service 2003). The Puget Sound Action Area includes the geographic range of two ESUs: the Puget Sound Chinook ESU, and the Hood Canal Summer-Run Chum ESU.

Puget Sound Chinook Salmon Evolutionarily Significant Unit: The Puget Sound Chinook Salmon Evolutionarily Significant Unit was listed as a threatened species on March 24, 1999 (64 Federal Register 14308). The Puget Sound Action Area includes the entire area of the Puget Sound Chinook Salmon Evolutionarily Significant Unit. The Puget Sound Chinook Salmon Evolutionarily Significant Unit encompasses all runs of chinook salmon within Puget Sound, from the Elwha River on the Olympic Peninsula to the North Fork Nooksack River (Figure 3.2-4).

Chinook salmon are found in most of the rivers within the action area. The Washington Department of Fisheries (WDF et al. 1993) recognized 27 distinct stocks of chinook salmon: eight spring-run, four summer-run, and 15 summer/fall and fall-run stocks. The existence of an additional five spring-run stocks has been disputed among different management agencies (WDF et al. 1993). The Skagit River and its tributaries were historically the predominant system in Puget Sound that supported naturally-spawning populations of Puget Sound chinook salmon (WDF et al. 1993).

Figure 3.2-4. Puget Sound Chinook Salmon Evolutionarily Significant Unit: Land ownership pattern.



The Puget Sound Technical Recovery Team has proposed a more recent analysis of the population structure of chinook salmon within the action area. The Puget Sound Technical Recovery Team is an independent scientific body convened by the National Marine Fisheries Service (NMFS) to develop technical delisting criteria and guidance for salmon delisting in Puget Sound. The Technical Recovery Team has narrowed the earlier population delineation to 22 demographically-independent populations representing the primary historical spawning areas of chinook salmon in Puget Sound (M. Ruckelshaus, chair Puget Sound Technical Recovery Team, personal communications with K. Schultz, NMFS, January 8, 2003). These proposed populations include: North Fork Nooksack River, South Fork Nooksack River, upper Skagit River, lower Sauk River, lower Skagit River, upper Sauk River, Siuattle River, upper Cascade River, North Fork Stillaguamish River, South Fork Stillaguamish River, Skykomish River, Snoqualmie River, Cedar River, north Lake Washington tributaries, Green River, White River, Puyallup River, Nisqually River, Skokomish River, Dosewallips River, Dungeness River, and the Elwha River (Figure 3.2-5).

Chinook salmon (and their progeny) from the following hatchery stocks are also considered part of the listed Puget Sound Chinook Salmon Evolutionarily Significant Unit: Kendall Creek (spring run); North Fork Stillaguamish River (summer run); White River (spring run); Dungeness River (spring run); and Elwha River (fall run).

Hood Canal Summer-Run Chum Salmon Evolutionarily Significant Unit: The Hood Canal Summer-Run Chum Salmon Evolutionarily Significant Unit was listed as a threatened species on March 25, 1999 (64 Federal Register 14570). This Evolutionarily Significant Unit includes summer-run chum salmon populations in Hood Canal and in Discovery Bay and Sequim Bay within the Strait of Juan de Fuca region (Figure 3.2-6). The Hood Canal Summer-Run Chum Salmon Evolutionarily Significant Unit may also include summer-run chum salmon in the Dungeness River, but the existence of that run is uncertain at this time.

Listed species of Puget Sound salmon are discussed in more detail in Subsection 3.3 of this Environmental Impact Statement.

Figure 3.2-5. Proposed demographically-independent populations in the Puget Sound Salmon Evolutionarily Significant Unit.

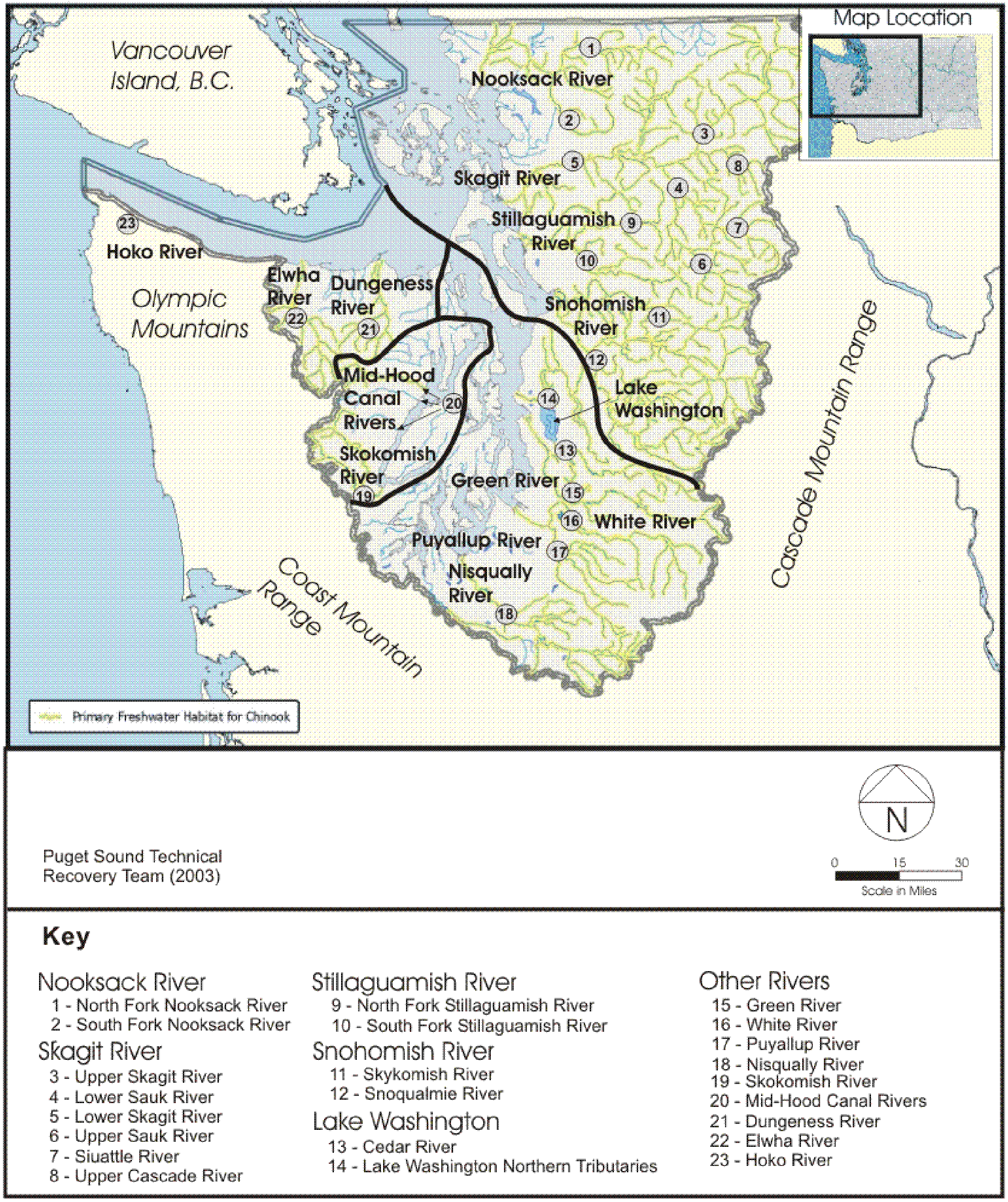
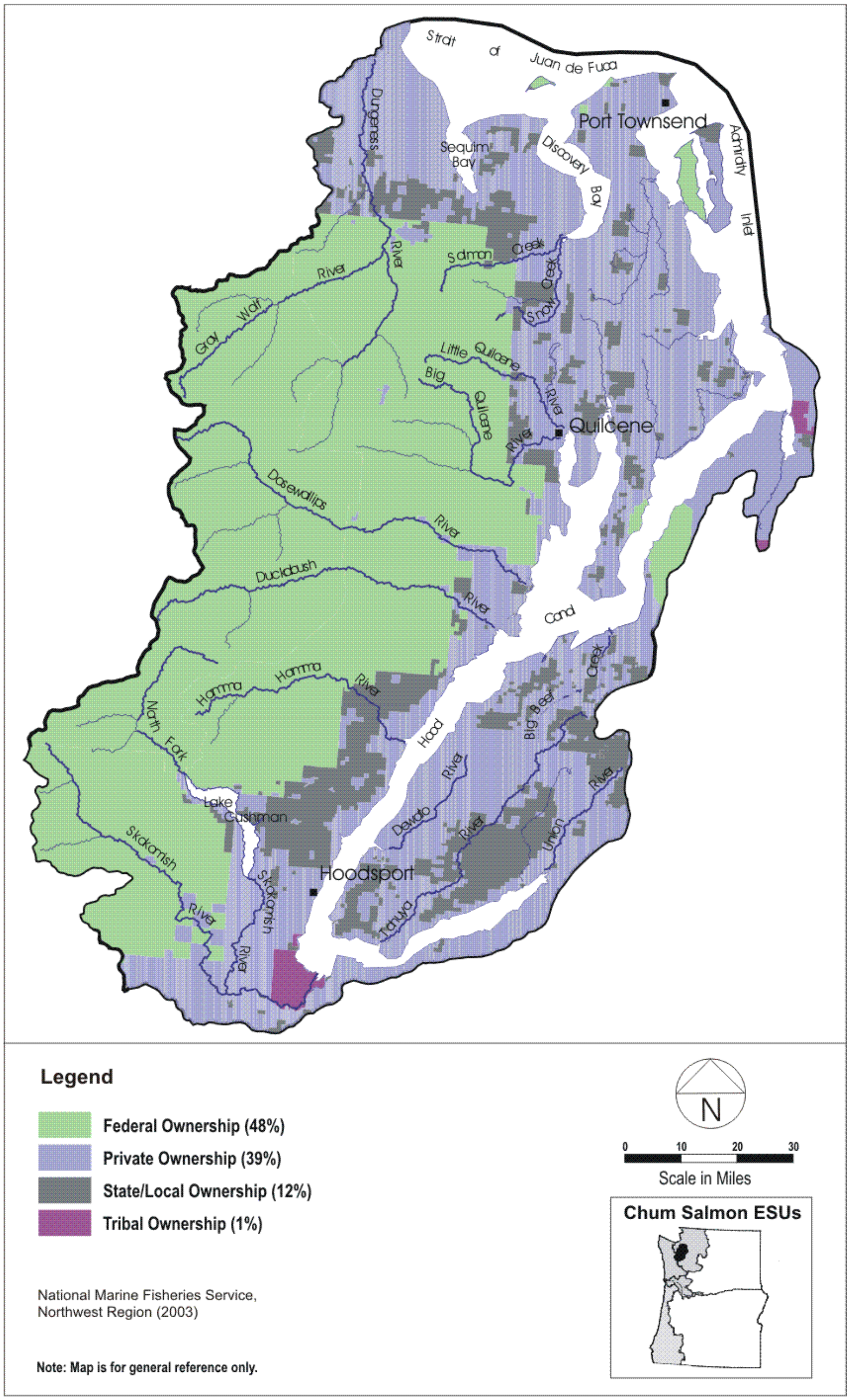


Figure 3.2-6. Hood Canal Summer-Run Chum Salmon Evolutionarily Significant Unit: Land ownership pattern.



3.3 Fish

3.3.1 Threatened and Endangered Species

This section describes the status of salmonid species with particular reference to chinook salmon, the species most likely to be affected by the Proposed Action and its alternatives. All~~ five~~ seven species of Pacific salmon (genus *Oncorhynchus*) chinook, coho, chum, sockeye,~~ and~~ pink, steelhead and cutthroat – are present in the affected environment and are subject to harvest impacts. Two Evolutionarily Significant Units (ESUs) of Pacific salmon indigenous to the affected environment are listed as threatened under the Endangered Species Act (ESA): the Puget Sound Chinook ESU and the Hood Canal summer chum ESU. Chinook and coho salmon from other ESUs, some of which are listed, are infrequently encountered in fisheries covered under the Resource Management Plan (see Subsection 3.3.1.3). Bull trout (*Salvelinus confluentus*) are present in streams and lakes in the affected environment, and possibly in the marine area as well. Puget Sound and Washington coastal bull trout were listed as threatened in 1999 (see Subsection 3.3.1.4.)

General Salmonid Life History

Pacific salmon and steelhead trout belong to the genus *Oncorhynchus* within the family *Salmonidae* that includes anadromous salmon, trout, char, whitefish, and grayling. Except in limited cases where geologic or anthropomorphic events have blocked migration to salt water, all~~ five~~ seven species of Pacific salmon, – chinook, sockeye, coho, chum, and pink – exhibit an anadromous life cycle[i], meaning they spawn in fresh water, mature in the marine environment, and return to fresh water to reproduce and die. Though Pacific salmon species share many general traits, individual populations have adapted to local environmental conditions, and life history strategies are diverse. A general overview of salmonid life history is given here. The reader is referred to Groot and Margolis (1991), and Wydoski and Whitney (2003) for a more in-depth review.

Mature salmon spawn in fresh water, constructing nests called *redds* in stream gravels where fertilized eggs are buried to incubate. ~~All five ~~Most anadromous forms of~~species of~~ salmon species die after spawning. Generally, the young of all salmon species emerge from the gravel in the spring. Newly-emerged salmon are called *fry*. Embryo development rate, the timing of fry emergence, and the subsequent patterns of freshwater rearing and seaward migration are determined primarily by parental spawn timing and water temperature; thus, hydrologic characteristics play an important role in shaping

[i] Sockeye salmon are a general exception because kokanee (a non-anadromous form of sockeye salmon) often share a watershed with an anadromous sockeye population.

salmonid populations. Specific timing and location of freshwater residence and subsequent migration patterns of each of the ~~five~~ seven species and populations within species varies markedly. Actively-feeding riverine juveniles are known as *fingerlings* until they are physiologically ready to migrate to salt water, at which time they are called *smolts*. This transitional life stage is referred to as *smolting*, and may occur in the river or estuary. The term *yearlings* refers to juveniles that remain in their natal stream (*overwinter*) until the following spring before migrating seaward. Juveniles that migrate as fingerlings are often referred to as *sub-yearlings*.

Both pink and chum salmon migrate seaward almost immediately after emerging from the gravel, and thus are less dependent on freshwater habitat than are sockeye, chinook and coho. ~~Sockeye and c~~Coho may spend one or two years in fresh water before migrating to the ocean. Sockeye also may spend up to two years in freshwater before migrating to the ocean, or, where lake access is not available, they may spend a short time rearing in the lower reaches of the river before migrating to sea. The freshwater rearing habits of fingerlings among and within individual chinook populations may vary considerably.

Once at sea, salmon migrate over routes that vary markedly among species and populations. Seaward migration of immature salmon tends to be over a broader temporal and geographic range than streamward migration routes that are generally quite predictable for species and populations.

Table 3.3-1 summarizes differences in key characteristics of ~~the~~ five species, including rearing time in freshwater, early rearing habitats, time spent at sea, age at maturity and size.

Table 3.3-1. Summary of key characteristics of Pacific salmon species.

Characteristic	Chinook	Chum	Coho	Pink	Sockeye
Time rearing in fresh water	1 month to 1 year	Hours to days	Most 1 to 2 years	Hours to days	1 to 2 years
Primary early rearing habitats	Stream, estuary	Estuary	Stream	Estuary	Lake
Years spent at sea	1.5 to 4.5	2.5 to 4.5	0.5 to 1.5	1.5	1.5 to 3.5
Age in years at maturity	2 to 8	2 to 7	2 to 4	2	3 to 8
Average length and weight at maturity	32 ~~5~~ inches 15 ~~35~~ pounds	24 ~~6~~ inches 12 pounds	24 ~~2~~ inches 6 ~~10~~ pounds	16 ~~8~~ inches 4 pounds	20 ~~6~~ inches 6 ~~5~~ pounds

Sources: Canadian Department of Fisheries and Oceans September 2001.
Frank Hawe, Northwest Marine Technologies
Gustafson et al. 1997
Johnson et al. 1997
Hard et al. 1996

3.3.1.1 Puget Sound Chinook

General Life History and Abundance

The Puget Sound Chinook ESU includes runs of chinook salmon from the North Fork Nooksack River in northeast Puget Sound to watersheds in South Puget Sound, Hood Canal and the Dungeness and Elwha Rivers on the Strait of Juan de Fuca (see Figure 3.2-4 in Subsection 3.2). It occupies a central geographic position in the historical range of chinook salmon, which extended from the Ventura River, California to Point Hope, Alaska in North America and in northeastern Asia from Hokkaido, Japan to the Anadyr River in Russia (Healey 1991).

Maturing adults from the Puget Sound Chinook ESU return to their natal streams from early spring to mid-fall, spawning from August though November. The majority of populations in the Puget Sound Chinook ESU migrate to the ocean within their first year following emergence, but important exceptions exist and are noted below. Many Puget Sound chinook rear within Puget Sound marine waters for several months.

Fisheries catch data show the ocean migration range of Puget Sound chinook extends as far north as northern British Columbia and Alaska for some populations. Some apparently rear their entire life within Puget Sound, but most migrate to the ocean and north along the Canadian coast. The majority are caught inside the Strait of Juan de Fuca, the Strait of Georgia, Puget Sound, and off the west coast of Vancouver Island. Less than one percent is caught off the west coasts of Washington and Oregon (~~Washington Department of Fish and Wildlife et al. 1997~~Pacific Fishery Management Council 1992 as cited in S.P. Cramer and Associates 1999). Puget Sound populations show different tendencies to migrate along the west coast of Vancouver Island or through Johnstone Strait and the Strait of Georgia. Catch distribution is discussed in more detail below in the descriptions of individual populations.

Myers et al. (1998) estimated an approximate run size of 690,000 chinook in Puget Sound at the beginning of the 20th century[ii] when hatchery production was negligible, compared to a recent average run size of approximately 240,000, the majority of which is from hatchery production. Cramer et al. (1999) notes the total numbers of chinook produced in Puget Sound dropped in the 1990s to about half the production sustained in the previous two decades. Because of the decrease in total run sizes,

[ii] This estimate, as with other historical estimates, should be viewed with caution. Puget Sound cannery pack probably included a portion of fish landed at Puget Sound ports but originating in Canada and other areas outside Puget Sound, and the estimates of exploitation rates used in run-size expansions are not based on precise data (Myers et al. 1998).

managers regulated fisheries to reduce harvests, thereby maintaining spawning escapements at close to their previous levels.

Recent studies (Hare et al. 1999) suggest marine survival of salmon species fluctuates in roughly 20- to 30-year periods that correspond to broad-scale climate changes. In this century, shifts in the ocean-climate regime occurred in 1925 – to a warm/dry climate; in 1947 – to a cold/wet climate; and in 1977 – to a warm/dry climate. Following the ocean regime shift in 1977, marine survival of Puget Sound hatchery chinook dropped sharply beginning with the 1979 brood, and has remained at less than 50 percent of the early 1970s value until 2000. In 2001, following improved oceanographic conditions, there was a notable increase in escapement within many runs.

Description of Individual Puget Sound Populations

Populations are described here in terms of:

General spawning range	– River or river section
Origin	– Native (to basin)
	– Mixed (native with influence from outside basin, usually from past hatchery transfers
Status	– Healthy, depressed, critical, or unknown
Run timing	– Spring, summer, summer-fall, or fall

Run timing refers to the seasonal period during which mature adults return to rivers, and is generally descriptive of a suite of life-history characteristics that, as a whole, contribute to the diversity of populations. Puget Sound spring-run populations return to natal rivers from early spring to mid-summer, and spawn from late summer to early fall in colder, higher-elevation areas of watersheds where eggs and fry develop more slowly. Puget Sound fall-run populations return to natal streams from late summer to fall and spawn until late fall. Spring-run juveniles tend to reside longer in natal streams before their ocean migration, and to have different ocean migration patterns than do fall runs. As the term implies, spawn-timing characteristics of summer-fall runs are intermediate to spring and fall runs.

In evaluating the effect of the Proposed Action on listed salmonids, the National Marine Fisheries Service (NMFS) uses an approach consistent with concepts developed by the National Oceanic and Atmospheric Administration (NOAA), Northwest Fisheries Science Center, for defining the conservation status of populations and ESUs. These concepts are described in detail in McElhany et al. 2000, incorporated here by reference. These viable salmonid population guidelines describe the importance of abundance levels, productivity, spatial structure, and diversity as indicators of population status. In assessing the affect of an action, these guidelines help to stratify the ESU adequately to represent its unique population characteristics (National Marine Fisheries Service 2000).

The most direct biological effect of the Proposed Action or its alternatives is expected to be changes in the abundance (spawning escapement) of certain populations within the ESU. Consequently, measures of abundance and description of the geographic and temporal distribution of populations – which determine their vulnerability to fisheries – are key in NMFS' evaluation and are emphasized in this discussion. Habitat characteristics, though important over the long term in shaping life history characteristics, are expected to be minimally affected or unaffected by the Proposed Action of fishing regime management. Therefore, habitat characteristics are treated briefly here, and described in more detail in Appendix C. Appendix C also includes further detail on life history characteristics of each of the populations.

Freshwater habitat-related activities having the greatest impact on Puget Sound Chinook salmon generally fall into three major categories: modifications to flow regimes from the operation of dams and water withdrawals which affect juvenile outmigration and adult return migration; degraded water quality and reduced and degraded incubation and rearing habitats that reduce abundance and productivity; and fluctuations in natural conditions. The relative effect of each impact category to the ESU, and to each population within the ESU, differs. Habitat restoration actions are expected to improve abundance, productivity, diversity and spatial distribution by restoring degraded habitat towards proper function (NMFS 1996a) and protecting habitats that are currently properly functioning. However, in most cases, it will be a decade or more before the effects are demonstrable. Information on habitat-related effects has been described in detail in various watershed plans (NCRT 2001; ~~SB~~SRTC 1999; www.sharedsalmonstrategy.org), limiting factor investigations (http://salmon.scc.wa.gov/reports/index.html) and general reports (Bishop and Morgan 1996; Myers *et al.* 1998; PSSRG 1997; WCSBRT 2003). The reader is referred to those documents for detailed information. The major effects have been summarized in this subsection by major basin and in Appendix B-1 of the DEIS.

Dams constructed for hydropower generation, irrigation or flood control have substantially affected Chinook salmon populations in several river systems. The construction and operation of dams have blocked access to spawning and rearing habitat, changed flow patterns, resulted in elevated temperatures and stranding of juvenile migrants and degraded downstream spawning and rearing habitat by reducing recruitment of spawning gravel to downstream areas.

Water quality in streams throughout Puget Sound has been degraded by human activities such as dams and diversion structures, water withdrawals, farming and grazing, road construction, timber harvest, mining, and urbanization. Within the area encompassed by the Puget Sound Chinook ESU, over 1,300 streams and river segments and lakes do not meet Federally approved, state and Tribal water quality standards and are now listed as water quality limited under Section 303(d) of the Clean Water Act (DOE 2004). Tributary water quality problems contribute to poor water quality where sediment and contaminants from the tributaries settle in mainstem reaches and the estuary.

Highway culverts that are not designed for fish passage can block upstream migration. Migrating fish are also diverted into unscreened or inadequately screened water conveyances or turbines, resulting in unnecessary mortality. Whereas many fish-passage improvements have been made in recent years, manmade structures continue to block migrations or kill fish in some areas.

Land ownership has played a part in habitat and land use changes. While there is substantial habitat degradation across all ownerships, in general, habitat in many Federally managed headwater stream sections is in better condition than in the largely non-Federal lower portions of tributaries (Doppelt *et al.* 1993; Frissell 1993; Henjum *et al.* 1994). In the past, valley bottoms were among the most productive fish habitats (NCRT 2001; ~~SB~~SRTC 1999; Spence *et al.* 1996; Stanford and Ward 1992). Today, agricultural and urban land development and water withdrawals have substantially altered the habitat for fish and wildlife. Streams in these areas typically have high water temperatures, sedimentation problems, low flows, simplified stream channels, and reduced riparian vegetation (Bishop and Morgan 1996; NCRT 2001; PSSRG 1997; ~~SB~~SRTC 1999). For example, hydro-modification in the Skagit River system has resulted in a loss of 64 percent of its distributary sloughs and 45 percent of side channel sloughs (Bishop and Morgan 1996; PSSRG 1997).

Salmon abundance is substantially affected by changes in estuarine and marine environments as well as changes in freshwater environments. For example, large scale climatic regimes, such as El NiZo, cause changes in ocean productivity. Much of the Pacific coast was subject to a series of very dry years during the first part of the 1990s. In more recent years, severe flooding has adversely affected some stocks. For example, flood events in 1990 and 1995 may have contributed to the low productivity of the 1990 and 1995 brood years for the Nooksack early and some of the Skagit spring and summer/fall Chinook salmon populations.

Salmon and steelhead are exposed to high rates of natural predation, particularly during freshwater rearing and migration stages. Ocean predation may also contribute to natural mortality, although the levels of predation are largely unknown. In general, salmonids are prey for pelagic fishes, birds, and marine mammals, including harbor seals, sea lions, and killer whales. There have been recent concerns that rebounding seal and sea lion populations, following their protection under the Marine Mammal Protection Act of 1972, have resulted in substantial mortality for salmonids.

Recent evidence suggests that marine survival of salmon species fluctuates in response to 20-30 year long periods of either above or below average survival that is driven by long-term cycles of climatic conditions and ocean productivity (Beamish and Bouillon 1993; Beamish *et al.* 1999; Cramer *et al.* 1999; Hare *et al.* 1999). This phenomenon has been referred to as the Pacific Decadal Oscillation (PDO) (Mantua *et al.* 1997). Poor ocean conditions that affect the productivity of Northwest salmonid populations appear to have been an important contributor to the decline of many populations prior to listing. The mechanism whereby stocks are affected is not well understood. The pattern of response to these changing ocean conditions has differed among stocks, presumably due to differences in their ocean timing and distribution. It is presumed that survival is driven largely by events occurring between ocean entry and recruitment to a sub-adult life stage. The survival and recovery of these species will depend on their ability to persist through periods of low ocean survival when stocks may depend on better quality freshwater habitat and be aided by lower relative harvest rates.

In accord with the viable salmonid population guidelines, NMFS considers the effect an action may have on both the *critical threshold level* of abundance and the *viable population abundance level*. The critical threshold represents a boundary below which the risk of extinction increases substantially. The viable population threshold is a higher abundance level that would generally indicate recovery or a point beyond which ESA protection is no longer required (McElhany et al. 2000; and NMFS 2000). Because NMFS and the co-managers most commonly use measures of spawning escapement (i.e., the number of sexually-mature adults returning to spawning grounds) to express abundance, these threshold levels are referred to as the *Critical Escapement Threshold* (CET), and *Viable Escapement Threshold* (VET) as determined under current environmental conditions. NMFS has quantified specific critical escapement thresholds for 14 of the populations, and specific viable escapement thresholds for 10 of the populations described here (Table 3.3.2). It should be noted that specific viable escapement thresholds are estimates based on current habitat conditions, and do not necessarily reflect a level beyond which ESA protection is no longer warranted. In other cases, NMFS relies on general guidelines developed by the Northwest Fisheries Science Center (McElhany et al. 2000), and escapement goals developed by the co-managers to define acceptable levels of spawner abundance.

The metric for evaluating salmon fishery impacts for chinook populations originating within the Puget Sound Action Area is *exploitation rate* – i.e., fisheries-related mortality expressed as the estimated proportion of the total population(s) taken in various fisheries. For chinook salmon, this is more specifically defined as the proportion of the total abundance of all age classes of fish from a given population or management unit present before fishing began in a given management year. For other species, exploitation rate is more simply calculated as catch or fishing mortality divided by catch plus escapement. In evaluating impacts of fisheries on the ESU, NMFS uses the concept of *rebuilding exploitation rates* developed consistent with the concepts of the Viable Salmonid Population guidelines. In general terms, a rebuilding exploitation rate (RER) is the level of exploitation that would result in a low probability that the proposed harvest action will endanger the population, and a relatively high probability that it will not impede recovery (McElhany et al. 2000; and NMFS 2000).

Table 3.3-2. Critical escapement thresholds, viable escapement thresholds, and rebuilding exploitation rates determined by NMFS for Puget Sound chinook populations.

	Critical Escapement Threshold	Viable Escapement Threshold	Rebuilding Exploitation Rate
Nooksack River Spring			0.12
North Fork	400	700	
South Fork			
Skagit River Summer-Fall			
Lower Skagit	251	2,182	0.49
Lower Sauk	200	681	0.51
Upper Skagit	967	7,454	0.60
Skagit River Spring			
Upper Cascade	170		
Upper Sauk	130	330	0.38
Suiattle	170	400	0.41
Stillaguamish River Summer-Fall			
North Fork	300	552	0.32
South Fork	200	300	0.24
Snohomish River Summer-Fall			
Skykomish	1,650	3,500	0.18
Snoqualmie	400		
Green-Duwamish River	835	5,523	0.53

Source: NMFS 2000 and NMFS 2003.

The Fishery Regulation Assessment Model (FRAM) provides estimates of total or fishery-specific exploitation rates for chinook management units, Chinook Validation File, for December 2002 provided by the Northwest Indian Fisheries Commission (Fishery Regulation Assessment Model, December 2002). This model is briefly described in Appendix C. The exploitation rates include the number of fish actually harvested and an estimated number of fish that die as a result of being captured and released, or sustain some other form of injury from fishing gear (see *incidental catch* in the glossary and Appendix C).

The distribution of fishery impacts among the major fisheries is also described for populations. These estimates are based on information from the coded-wire tag database. In this system, a portion of salmon reared in hatcheries throughout the affected environment are implanted with minute tags bearing relevant information about their origin. A portion of these tags are recovered through monitoring programs in the fisheries, at hatcheries, and on spawning grounds. Impacts of fisheries on naturally-spawning fish (that for the most part are not tagged) are estimated based on impacts of hatchery-tagged *indicator populations* released in areas frequented by the natural runs. Unless otherwise noted, estimates of harvest impacts reported in this section are from *The Pacific Salmon Commission Joint Chinook Technical Committee Report Annual Exploitation Rate and Model Calibration Report, TC-Chinook 02-3* (Pacific Salmon Commission, October 2002). The status of populations is qualitatively described as *critical*, *depressed* or *healthy* – taking into account many life history and habitat factors, but particularly trends in spawning escapement – a convention used by the co-managers.

Included in the Puget Sound Chinook ESU are 22 populations (Puget Sound Technical Recovery Team, April 8, 2004~~2~~) grouped by the co-managers into 15 management units, corresponding to watersheds throughout the ESU. The co-managers have classed the populations as Category 1, 2 or 3 on the basis of the history of salmon in the area, the current characteristics of the population, and the influence of hatchery production. Category 1 populations are genetically unique and indigenous to watersheds of Puget Sound. Category 2 populations are located in watersheds where indigenous populations may no longer exist, but where sustainable populations existed in the past and where the habitat can still support self-sustaining, natural populations). Category 3 populations are generally found in small tributaries that may now have some natural spawning, but historically never had independent, self-sustaining populations of chinook salmon.

Management decisions embodied in the Proposed Action consider Category 1 and 2 populations because those have been identified as areas that have or historically had independent self-sustaining, natural chinook populations. The status of these populations varies from healthy to critical. The population delineation proposed by the Puget Sound Technical Recovery Team and incorporated by NMFS in this document contains only Category 1 and 2 populations.

Chinook salmon populations have been grouped into four regions of the Puget Sound Action Area: North Puget Sound, South Puget Sound, Hood Canal, and the Strait of Juan de Fuca (see Figure 3.2-1 in Subsection 3.2).

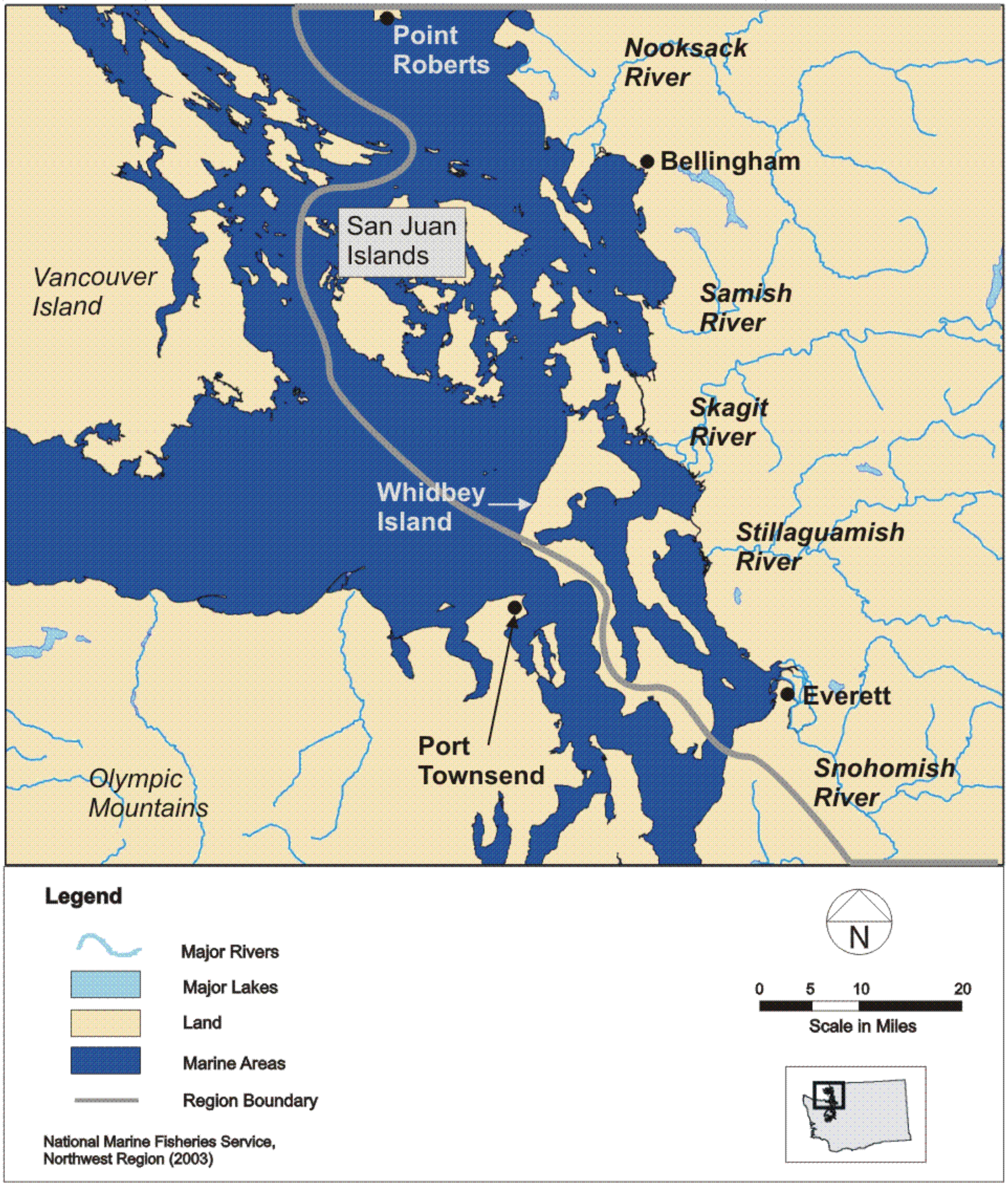
North Puget Sound

River systems in the North Puget Sound region include the Nooksack, Samish, Skagit, Stillaguamish and Snohomish (see Figure 3.3-1). These four watersheds contain 12 distinct chinook populations (Puget Sound Technical Recovery Team 2004~~1~~). These drainages are hydrologically diverse, and support populations with diverse run timing and life history strategies, including five of Puget Sound's seven spring chinook runs and three of its five summer-run populations.

Nooksack River. The Nooksack River enters northern Puget Sound just north of the City of Bellingham, and drains approximately an 800-square-mile area of the Cascade and Puget Lowland ecoregions. Its main tributaries are the North Fork, Middle Fork and South Fork.

The North Fork, a turbid, glacial stream, is somewhat colder than the South Fork, which is generally low and clear at the time of spawning migrations. These tributaries have developed genetically distinct, Category 1, spring-run populations. Both populations spawn in the upper reaches and tributaries of their respective streams (the North Fork population also spawns in the Middle Fork. The North Fork population spawns from mid-July through September in roughly 50 miles of spawning area, and the South Fork population spawns from the end of July through the first week of October over approximately 40 miles of spawning territory (Myers et al. 1998; and Cramer et al. 1999).

1 Figure 3.3-1. North Puget Sound Region.



2

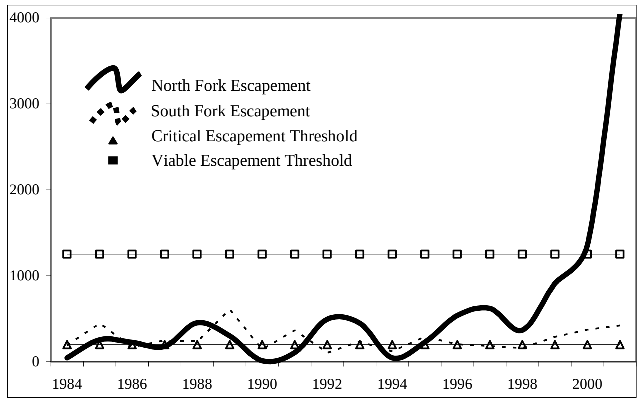
The status of the Nooksack early chinook populations is considered critical, due to chronically low returns and poor freshwater survival. The critical escapement threshold is 400 spawning adults, and the viable escapement threshold 700 spawning adults for the combined populations (~~Puget Sound Technical Recovery Team, July 22, 2003~~Nooksack Rebuilding Exploitation Rate Workgroup 2003). The North Fork population is more abundant than that in the South Fork, and benefits from the hatchery supplementation program, but the natural productivity of both populations is critically depressed (Puget Sound Indian Tribes and Washington Department of Fish and Wildlife 2003). Escapement to the North Fork was below 500 fish in all but two years from 1984 through 1998. Spawning escapement was 911 fish in 1999, 1,357 in 2000, and 4,057 in 2001. The marked increase in 2001 was partly due to the diversion of a large number of male chinook that returned to the hatchery (personal communication with Susan Bishop, NMFS Sustainable Fisheries Division, January 13, 2003). The annual spawning escapement to the South Fork varied from 103 to 606 fish between 1984 and 2001, and the overall trend in escapement during this period has remained flat. Escapement from 1998 through 2001 averaged 310 fish (Figure 3.3-2) (~~Puget Sound Technical Recovery Team, in preparation~~NMFS 2003b). Terminal harvest rates have declined, but the recruits per natural-origin spawner for both populations have consistently remained below one recruit per pair of spawners (NMFS 2003b).

NMFS determined the rebuilding exploitation rate to be 12 percent for both populations (Nooksack Rebuilding Exploitation Rate Working Group 2003). The total fisheries exploitation rate on both populations averaged 36 percent from 1983 through 1996, and 18 percent from 1996 through 2000. Because the Nooksack River is located relatively close to the border between the United States and Canada, and Nooksack early-run chinook tend to migrate northward, the majority of harvest mortality occurs within British Columbia, which accounted for 73 percent of fishery mortality from 1997 through 2000 (Fishery Regulation Assessment Model, December 2002). Southern U.S. fisheries accounted for 26 percent of mortality during this period, and Alaska fisheries 1 percent. Puget Sound fisheries that impact this population are commercial net fisheries in northeastern Puget Sound (Marine Catch Areas 7 and 7A), Bellingham Bay and the Nooksack River (3 percent), and Puget Sound sport fisheries (18 percent) (Figure 3.3-2) (Pacific Salmon Commission, October 2002).

Figure 3.3-2. Spawning escapement, fishing exploitation rate, and geographic distribution of fishing mortality for Nooksack River spring chinook.

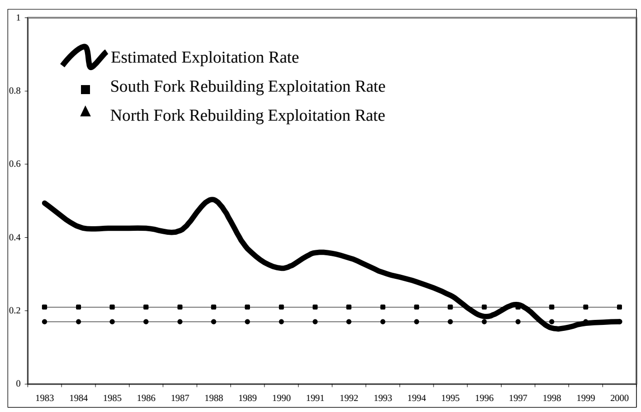
Spawning Escapement and Escapement Goal for Nooksack River Spring Chinook

Estimated escapement of naturally-spawning adults compared to NMFS' Critical and Viable Escapement



Estimated Fishing Exploitation Rate on Nooksack River Spring Chinook

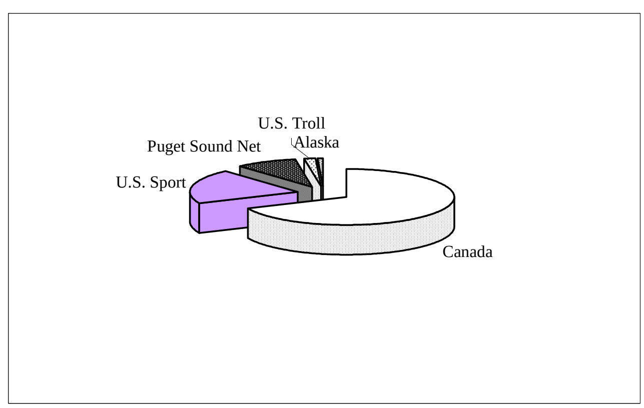
Estimated exploitation rate based on Fishery Regulations Assessment Model compared to NMFS' Recovery



Geographic Distribution of Fishing Mortality on Nooksack River Spring Chinook

Distribution of fishing mortality based on coded-wire tag recoveries of Nooksack spring chinook indicator

Alaska	**1%**
Canada	**73%**
Puget Sound Net	**3%**
U.S. Sport	**18%**
U.S. Troll	**1%**



Sources: Puget Sound Technical Recovery Team (in progress), Northwest Indian Fisheries Commission, and Pacific Salmon Commission December 2002.

A hatchery program on the North Fork Nooksack River at Kendall Creek, operated since 1988, produces early-run juveniles, a proportion of which are released at acclimation sites in the upper North Fork Nooksack River. Annual releases of 1.0 million spring-run juveniles accounted for about 6 percent of chinook salmon released in Puget Sound between 1991 and 2000. Releases in 2001 were 1.65 million. (Pacific States Marine Fisheries Commission, December 2002). The spring-run releases are supplemental to natural production, are believed to reduce the immediate extinction risks associated with very low natural returns, and are therefore listed under the ESA. Between 1991 and 2001, hatchery-origin spawning adults accounted for an estimated 59 percent of naturally-spawning chinook in the North Fork. The supplementation program, located at the Skookum Creek facility in the South Fork, was discontinued after 1992. Hatchery-origin adults made up 31 percent of natural-spawners in the South Fork during the same period, indicating that a substantial amount of straying may exist (Puget Sound Technical Recovery Team, *in preparation*).

Skagit River. The Skagit River watershed, the largest in Puget Sound, drains an area of more than 1,600 square miles. Chinook salmon spawn in approximately 270 miles of the Skagit River and its tributaries, the largest of which are the Baker and the Sauk Rivers. The Puget Sound Technical Recovery Team has identified six populations in the Skagit River system, including spring populations in the upper Cascade, Sauk, and Suiattle Rivers; summer populations in the lower Sauk and upper Skagit; and a fall-timed population in the lower Skagit River (Puget Sound Technical Recovery Team, ~~April 8, 2002~~2004). All are Category 1 populations.

Summer-Fall Populations. The lower Sauk summer-run chinook spawn primarily from the mouth of the Sauk River to Rivermile 21 – separate from the upper Sauk spring spawning areas above Rivermile 32. The lower mainstem Skagit River fall population spawns downstream of the mouth of the Sauk River. The upper mainstem Skagit and lower Sauk River summer populations spawn from September through early October. Lower river fall population spawning lasts through October. Age at spawning is primarily 4 years, with significant numbers of Age-3 and Age-5 fish, as well. Most summer-fall chinook smolts emigrate from the river as fingerlings, though considerable variability has been observed in the timing of downstream migration and residence in the estuary prior to entry into marine waters (Hayman et al. 1996).

The annual spawning escapement for the lower Skagit River fall population has remained well above the NMFS critical threshold of 250 fish from 1971 to the present. From 1971 through 1996, the average annual escapement was 2,507. However, escapement declined steadily from the 1970s to the mid-

1990s. Escapement averaged 1,540 from 1997 through 2001, well below NMFS' viable escapement threshold of 2,182 adult spawners. The most recent 3-year period has shown an increasing trend in escapement.

The critical threshold for the Lower Sauk River summer population is 200 adults, and the viable escapement threshold is 681. Adult spawning escapement averaged 892 from 1971 through 1996, after which returns fell to levels well below the viable escapement threshold through much of the 1990s. The geometric mean of escapements from 1997 through 2001 was 480, representing a moderate increase over the previous 5-year mean.

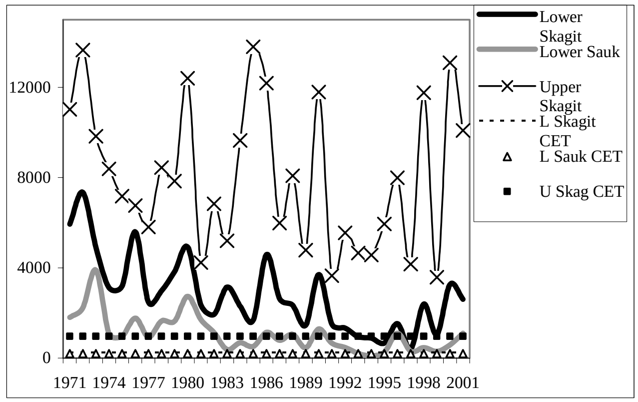
NMFS' critical threshold for the Upper Skagit summer population is 967, and the viable escapement threshold 7,454. There was a downward trend in spawning escapement from the early 1970s to the early-1990s for the Upper Skagit River summer population. Since then, there has been an increasing trend in spawning escapement, with the geometric mean for this period rising to 7,467 fish compared to 5,618 over the previous 5-year period (Figure 3.3-3). Exceptionally strong escapements were observed in three of the four latest return years (Puget Sound Technical Recovery Team, *in preparation*).

NMFS has set rebuilding exploitation rates of 49 percent for the Lower Skagit River population, 51 percent for the Lower Sauk River population and 60 percent for the Upper Skagit River population (NMFS 2000). Total fishery exploitation rates on the Skagit and Sauk River summer and fall populations are estimated to have averaged 60 percent from 1983 through 1996, and 29 percent from 1997 through 2000 (Fishery Regulation Assessment Model, December 2002). Since coded-wire tag data from Skagit River summer-fall chinook is insufficient, fishery impact distribution estimates are based on recoveries of the nearby Samish River fall-run chinook stock. Canadian fisheries accounted for 43 percent of mortality from 1997 through 2000, Washington fisheries approximately 55 percent, and Alaska fisheries approximately 2 percent. Puget Sound net fisheries accounted for 40 percent of fishing mortality, and sport fisheries 13 percent during this period (Figure 3.3-3) (Pacific Salmon Commission, October 2002).

Figure 3.3-3. Spawning escapement, fishing exploitation rate, and geographic distribution of fishing mortality for Skagit River summer-fall chinook.

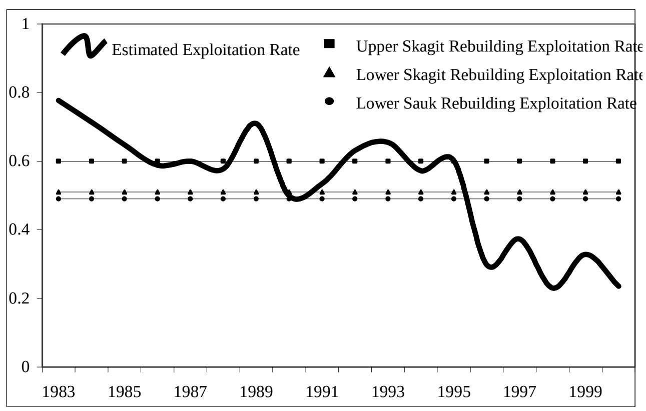
Spawning Escapement and Escapement Goal for Skagit River Summer-Fall Chinook

Estimated escapement of naturally-spawning adults compared to NMFS' Critical and Viable Escapement



Estimated Exploitation Rate on Skagit River Summer-Fall Chinook

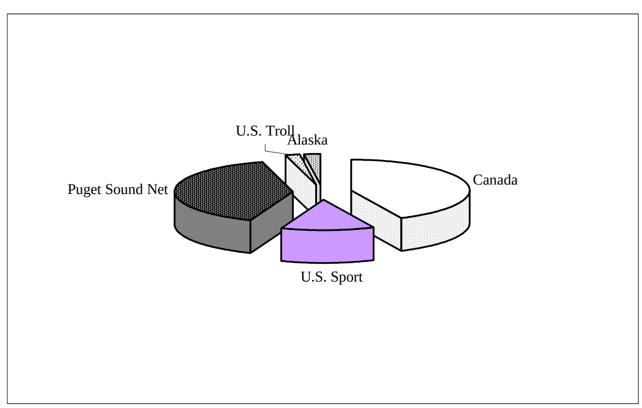
Estimated exploitation rate based on Fishery Regulations Assessment Model compared to NMFS' Recovery



Geographic Distribution of Fishing Mortality on Skagit River Summer-Fall Chinook

Distribution of fishing mortality based on coded-wire tag recoveries from Samish fall chinook indicator stock

Alaska	2%
Canada	43%
Puget Sound Net	40%
U.S. Sport	13%
U.S. Troll	2%



Sources: Puget Sound Technical Recovery Team (in progress), Northwest Indian Fisheries Commission, and Pacific Salmon Commission December 2002.

A hatchery at Marblemount produces spring, summer, and fall-run chinook. From 1990 through 2001, approximately 0.6 million fall-run and 0.4 million summer-run juveniles were released in the Skagit River. In 2001, approximately 0.2 million summer and 0.2 million fall juveniles were released as indicator stocks for the coded-wire tag program. The contribution of hatchery-origin fish to natural spawning has been estimated at less than 1 percent on the lower Skagit and lower Sauk Rivers, and 2 percent in the upper Skagit (Pacific States Marine Fisheries Commission December 2002; and Puget Sound Technical Recovery Team, *in preparation*).

Spring Populations. Spring-run chinook begin entering the Skagit River system in April, and spawn from late July through early September. The upper Sauk River population spawns in the mainstem, the Whitechuck River, and tributary streams. The Suiattle spring chinook population spawns in the mainstem and several tributaries. The upper Cascade spring chinook population is spatially separated from summer-run chinook in the lower Cascade River. The latter population is part of the upper Skagit River summer chinook population.

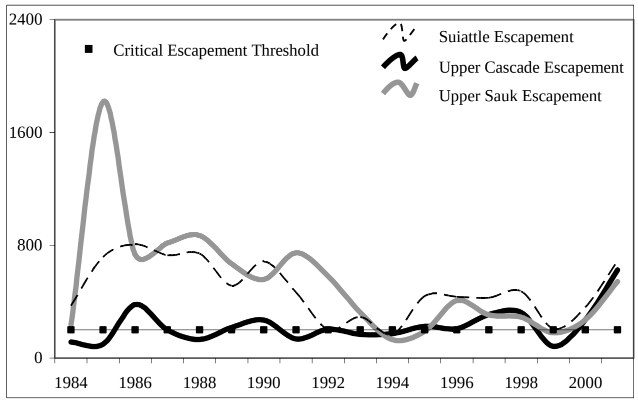
NMFS determined the critical escapement threshold for the Upper Cascade spring population to be 170, the Upper Sauk 130, and the Suiattle 170 adults (~~Puget Sound Technical Recovery Team, July 22, 2003~~Skagit Rebuilding Exploitation Rate Workgroup 2003). Viable escapement thresholds for the Upper Sauk and Suiattle have been set at 330 and 400 adults, respectively. A viable escapement threshold has not been determined for the Upper Cascade population. All three populations had downward trends in escapement from the early 1980s to the early 1990s. From 1984 through 1996, the geometric mean of escapement was 248 for the Upper Cascade, 361 for the Upper Sauk, and 378 for the Suiattle. In recent years, there has been an increasing trend in escapement. From 1997 through 2001, the geometric mean of escapement was 269 for the Upper Cascade population, 298 for the Upper Sauk population, and 401 for the Suiattle spring chinook population. The geometric mean of the commingled escapement for these three populations was 978 for this period, compared to 799 from 1992–1996 (Figure 3.3-4) (Puget Sound Technical Recovery Team, *in preparation*).

NMFS determined the rebuilding exploitation rate for the Upper Sauk to be 38 percent and for the Suiattle, 41 percent. A rebuilding exploitation rate has not been determined for the Upper Cascade population (Skagit Rebuilding Exploitation Rate Working Group 2003). From 1983 through 1996, the average annual exploitation rate was 58 percent. From 1997 through 2000, the annual exploitation rate averaged 31 percent (Fishery Regulation Assessment Model, December 2002). Fifty-three percent of fishing mortality occurred in Canadian waters, 45 percent in U.S. waters. Puget Sound sport fisheries accounted for approximately 42 percent of fishing mortality, and Puget Sound net fisheries 3 percent (Figure 3.3-4) (Pacific Salmon Commission, October 2002).

Figure 3.3-4. Spawning escapement, fishing exploitation rate, and geographic distribution of fishing mortality for Skagit River spring chinook.

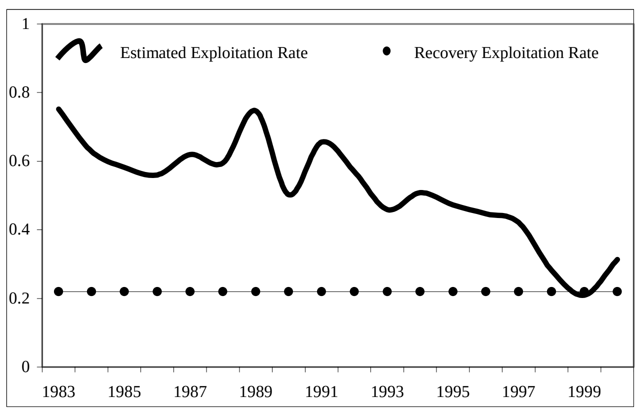
Spawning Escapement and Escapement Goals for Skagit River Spring Chinook

Estimated escapement of naturally-spawning adults compared to NMFS' VSP Guidelines Critical Escapement



Estimated Exploitation Rate and Goals for Skagit River Spring Chinook

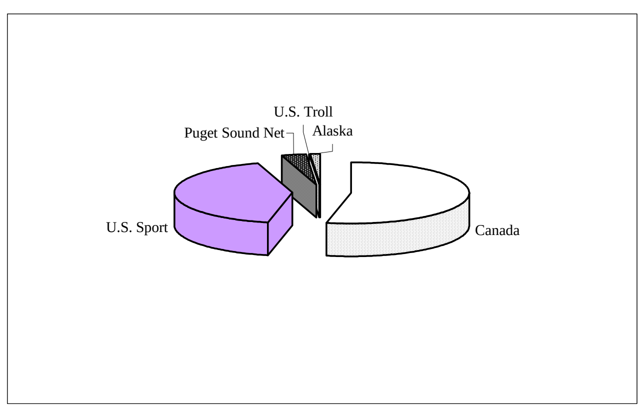
Estimated exploitation rate based on Fishery Regulations Assessment Model compared to NMFS' Recovery



Geographic Distribution of Fishing Mortality on Skagit River Spring Chinook

Distribution of fishing mortality based on coded-wire tag recoveries of Skagit spring chinook indicator stock

Alaska	1%
Canada	53%
Puget Sound Net	3%
U.S. Sport	42%
U.S. Troll	0%



Sources: Puget Sound Technical Recovery Team (in progress), Northwest Indian Fisheries Commission, and Pacific Salmon Commission December 2002.

From 1991 through 2000, approximately 0.4 million spring chinook juveniles were released annually in the Skagit River system, primarily in the Upper Cascade. Releases in 2001 were 0.42 million. These releases serve primarily as an indicator stock for the coded-wire tag program. Less than 1 percent of adults on the spawning grounds are estimated to be of hatchery origin (Pacific States Marine Fisheries Commission, December 2002; and Puget Sound Technical Recovery Team, *in preparation*).

Stillaguamish River. The North Fork Stillaguamish River is fed primarily by non-glacial sources in the Cascade Mountain foothills, flowing for most of its length through the Puget Lowland ecoregion. Its main tributaries are Squire Creek, Boulder River and Deer Creek. The South Fork Stillaguamish, which rises in the Cascades east of Fall City, has similar topography.

NMFS determined the North Fork Stillaguamish summer runs and South Fork Stillaguamish fall runs were distinct populations, based on genetic characteristics, spawn timing, and spawning distribution. Both are classified as Category 1 populations. The North Fork Stillaguamish River population, a composite of natural and hatchery-origin supplemental production, spawns primarily in the upper mainstem and tributaries above Rivermile 14. The South Fork population spawns in the mainstem, Pilchuck Creek, and lower Canyon Creek (Washington Department of Fisheries, et al. 1993).

North Fork Stillaguamish adults enter the river from May through August. Spawning begins in late August, peaks in mid-September, and continues past mid-October. The South Fork Stillaguamish chinook enter the river in August and September, and spawning peaks in early to mid-October. The age composition of mature North Fork Stillaguamish summer chinook, based on scales collected from 1985 through 1991, was as follows: 4.9 percent Age 2, 31.9 percent Age 3, 54.7 percent Age 4, and 8.5 percent Age 5. Ninety-five percent of juvenile Stillaguamish summer chinook emigrate as fingerlings (Washington Department of Fisheries et al. 1993).

The critical escapement threshold is 300 for the North Fork Stillaguamish and 200 for the South Fork. The viable escapement threshold is 552 for the North Fork and 300 for the South Fork. The estimated annual escapement (geometric mean) from 1974 through 1996 was 740 (range 309 to 1,403) in the North Fork, and 207 (range 65 to 283) in the South Fork. The estimated annual escapement (geometric mean) from 1997 through 2001 was 1,087 (range 845 to 1,403) in the North Fork, and 250 (range 226 to 283) in the South Fork (Figure 3.3-5). From 1974 through 1991, there was a declining trend in escapement to the North Fork. Since then, there has been an increasing trend. Consequently, the geometric mean of escapement from 1997 through 2001 is similar to that of the mid-1970s. There has been no significant trend in escapement in the South Fork Stillaguamish River over this period, and the geometric for the most recent 5 years is similar to that of the early 1970s. NMFS determined the rebuilding exploitation rate to be 32 percent for the North Fork population, and 24 percent for the South Fork population (NMFS 2000; and McElhany et al. 2000). From 1983 to 1996, the total exploitation rate on these populations was 47 percent, and from 1997 through 2000, 23 percent (Fishery Regulation Assessment Model, December 2002). From 1997 through 2000, approximately 18 percent of fishing-related mortality occurred in Alaska, 50 percent in Canada, 29 percent in Washington sport fisheries, and 3 percent in Puget Sound net fisheries (Figure 3.3-5) (Pacific Salmon Commission, October 2002).

From 1991 through 2000, releases of chinook in the North Fork Stillaguamish system were less than 0.2 million juveniles annually. Releases in 2001 were 0.39 million. The supplementation program, which collects broodstock from the North Fork spawning escapement, was initiated in 1986 to rebuild the North Fork Stillaguamish population. It is considered essential to the recovery of the population, so these fish are also listed. Hatchery-origin adults comprised 32 percent of natural spawners in the North Fork from 1990 through 2001. Straying of hatchery fish in the South Fork has not been quantified (Pacific States Marine Fisheries Commission, December 2002; and Puget Sound Technical Recovery Team, *in preparation*).

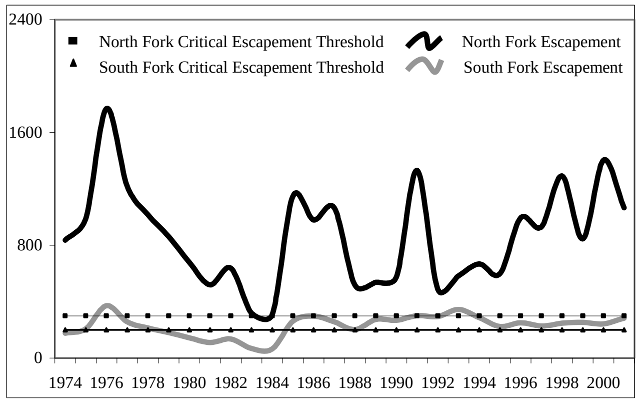
<u>Snohomish River</u>. The Puget Sound Technical Recovery Team has identified two populations in the Snohomish River system: Skykomish River chinook and Snoqualmie River chinook. They are both Category 1 populations (Figure 3.3-6).

Skykomish Chinook. The Skykomish population includes summer/fall-timed fish spawning in the Snohomish mainstem, the mainstem Skykomish, Sultan River, Bridal Veil Creek and the North and South Fork of the Skykomish River. A Category 2 population spawning in the Wallace River originates primarily from the hatchery located there, and is genetically similar to other chinook in the Skykomish River system (Puget Sound Technical Recovery Team 2004~~1~~). Since the 1950s, spawning distribution of summer chinook has shifted upstream. That is, a much larger proportion of summer chinook currently spawn higher in the drainage, between Sultan and the forks of the Skykomish River, than in previous decades (Snohomish Basin Salmonid Technical Recovery Committee 1999). Summer chinook enter fresh water from May through July, spawning primarily in September. Fall chinook spawn from late September through October.

Figure 3.3-5. Spawning escapement, fishing exploitation rate, and geographic distribution of fishing mortality for Stillaguamish River summer-fall chinook.

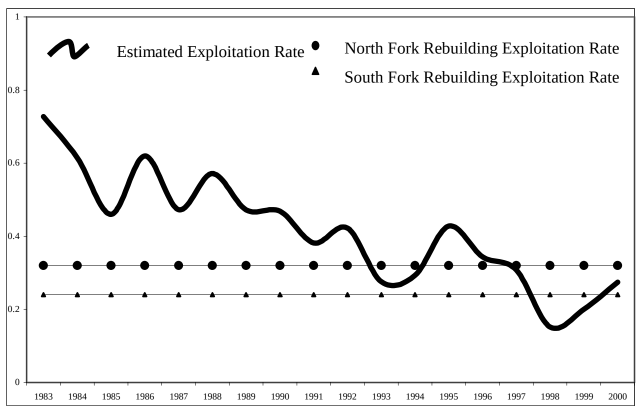
Spawning Escapement and Escapement Goals for Stillaguamish River Summer-Fall Chinook

Estimated escapement of naturally-spawning adults compared to NMFS' Critical Escapement Threshold



Estimated Exploitation Rate and Goals for Stillaguamish River Summer-Fall Chinook

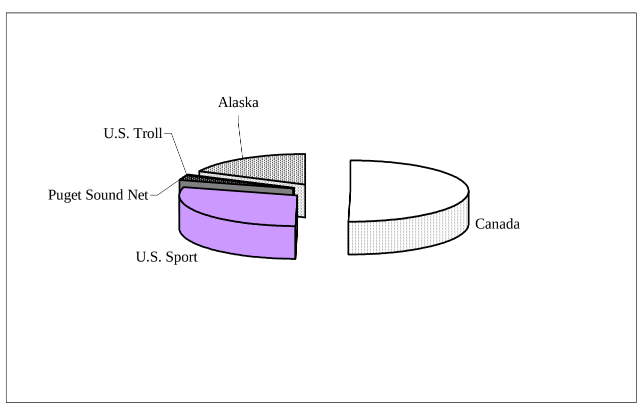
Estimated exploitation rate based on Fishery Regulations Assessment Model compared to NMFS' Recovery



Geographic Distribution of Fishing Mortality on Stillaguamish River Summer-Fall Chinook

Distribution of fishing mortality based on coded-wire tag recoveries of Stillaguamish chinook indicator stock

Alaska	18%
Canada	50%
U.S. (Puget Sound) Net	3%
U.S. Sport	29%
U.S. Troll	0%

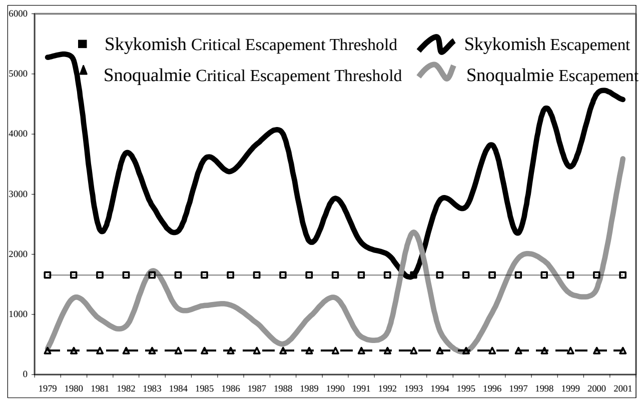


Sources: Puget Sound Technical Recovery Team (in progress), Northwest Indian Fisheries Commission, and Pacific Salmon Commission December 2002.

Figure 3.3-6. Spawning escapement, fishing exploitation rate, and geographic distribution of fishing mortality for Snohomish River summer-fall chinook.

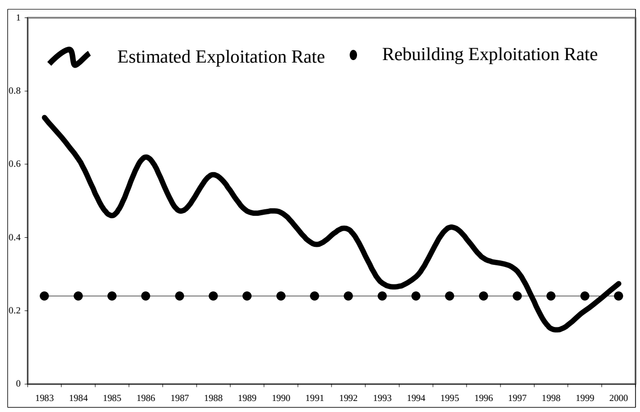
Spawning Escapement and Escapement Goals for Snohomish River Summer-Fall Chinook

Estimated escapement of naturally-spawning adults compared to NMFS' Critical Escapement Thresholds



Estimated Fishing Exploitation Rate on Snohomish River Summer-Fall Chinook

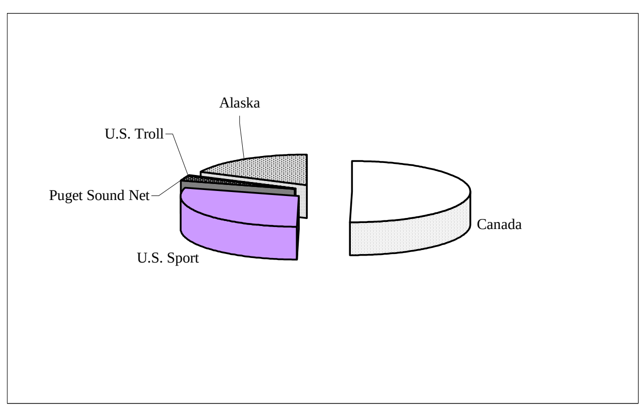
Estimated exploitation rate based on Fishery Regulations Assessment Model compared to NMFS' Recovery



Geographic Distribution of Fishing Mortality on Snohomish Summer-Fall Chinook

Distribution of fishing mortality based on coded-wire tag recoveries of Stillaguamish summer-fall chinook

Alaska	18%
Canada	50%
Puget Sound Net	3%
U.S. Sport	29%
U.S. Troll	0%



Sources: Puget Sound Technical Recovery Team (in progress), Northwest Indian Fisheries Commission, and Pacific Salmon Commission December 2002.

NMFS determined the critical escapement threshold for the Skykomish River population to be 1,653, and the viable escapement threshold as 3,500 spawning adults (personal communication e-mail from Susan Bishop, NMFS Sustainable Fisheries Division, January 14~~2~~, 2003). The geometric mean of annual spawning escapement of the Skykomish River population was 3,023 from 1979 through 1996 (range 1,653 to 5,277). Escapement trended downward from the late 1970s to the mid-1990s, after which it has increased. From 1997 through 2001, the geometric mean of annual escapement was 3,775 (range 2,335 to 4,665) (Figure 3.3-6).

Snoqualmie Chinook. The Snoqualmie River chinook salmon population spawns in the Sultan and Snoqualmie Rivers and their tributaries from September through November.

Limited data show the Snoqualmie River fall chinook spawning population to have a somewhat larger component (28 percent) of Age-5 fish than most other Puget Sound fall populations, with Age-3 and Age-4 fish comprising 20 percent and 46 percent, respectively, of returns (Washington Department of Fish and Wildlife 1995, cited in Myers et al. 1998). Both summer and fall runs appear to have a relatively high percentage of fish that migrate to sea as yearlings.

The critical escapement threshold for the Snoqualmie River is 400. The viable escapement threshold has not yet been determined (65 Federal Register 42433). The trend in escapement for the Snoqualmie River population was relatively flat from the late 1970s to the mid-1990s. The geometric mean of annual escapement was 905 (range 385 to 2,366) from 1979 through 1996. In recent years, escapement has shown an increasing trend. The geometric mean of escapement from 1997 through 2001 was 1,907 (range 1,344 to 3,589), which is above the generic viable escapement threshold of 1,250. Spawning escapement to the Skykomish River showed a marked declining trend from the late 1970s until 1993, and a substantial increasing trend since then. Spawning escapement to the Snoqualmie River showed a declining trend from the late 1970s until 1996, but has shown an increasing trend since then (Figure 3.3-6).

The NMFS rebuilding exploitation rate for both the Skykomish and Snoqualmie River summer-fall populations is 18 percent (NMFS 2003c).[iii] Because juveniles from the Snohomish system were not consistently tagged, estimates of exploitation rates and distribution of fishing-related mortality for both the Skykomish and Snoqualmie River populations are based on coded-wire tag recoveries of Stillaguamish River fingerlings, which are believed to have a similar pattern of ocean migration and

[iii] The RER has recently been revised. It was 32% in 2001 and 2002.

timing (personal communication with Will Beattie, Conservation Planning Coordinator, Northwest Indian Fisheries Commission, January 12, 2003). The average exploitation rate from 1983 through 1996 was 57 percent, and from 1997 through 2001: 27 percent (Fishery Regulation Assessment Model, December 2002). Based on the same coded-wire tag data from Stillaguamish River chinook fingerlings, from 1997 through 2000, approximately 18 percent of fishing-related mortality on the Skykomish and Snoqualmie populations occurred in Alaska, 50 percent in Canada, 29 percent in Washington sport fisheries, and 3 percent in Puget Sound net fisheries (Pacific Salmon Commission, October 2002). The portion of fishery impacts in Canada has decreased in recent years (it was 59% from 1984 through 1995), owing to fishery restrictions (Figure 3.3-6).

An average of 1.6 million juvenile chinook were released into the Snohomish River system each year between 1991 and 2000, or 3.2 percent of Puget Sound releases. Fall-run fish accounted for approximately 40 percent of releases, summer-run 57 percent, and spring-run – released only in 1997 and 1998 – 3 percent. Virtually all fall and summer-run juveniles were produced in and released from the Wallace River hatchery on the Skykomish River. In 2001, 1.72 million summer-run juveniles were released. Fall-run hatchery production originally utilized the Green-Duwamish River stock. These hatchery fish stray to other areas in the Skykomish River, and may mix with summer chinook (Washington Department of Fisheries et al. 1993). From 1990 through 2001, an estimated 41 percent of naturally-spawning chinook in the Skykomish River and 23 percent of naturally-spawning chinook in the Snoqualmie River were of hatchery origin (Pacific States Marine Fisheries Commission, December 2002; and Puget Sound Technical Recovery Team, *in preparation*). Broodstock collection was changed beginning with the 1997 brood year to exclude fall chinook, and thus reduce the influence of out-of-basin populations on production (Puget Sound Indian Tribes and Washington Department of Fish and Wildlife 2003). Hatchery production of spring, summer, and fall chinook also occurs at the Tulalip Hatchery.

South Puget Sound

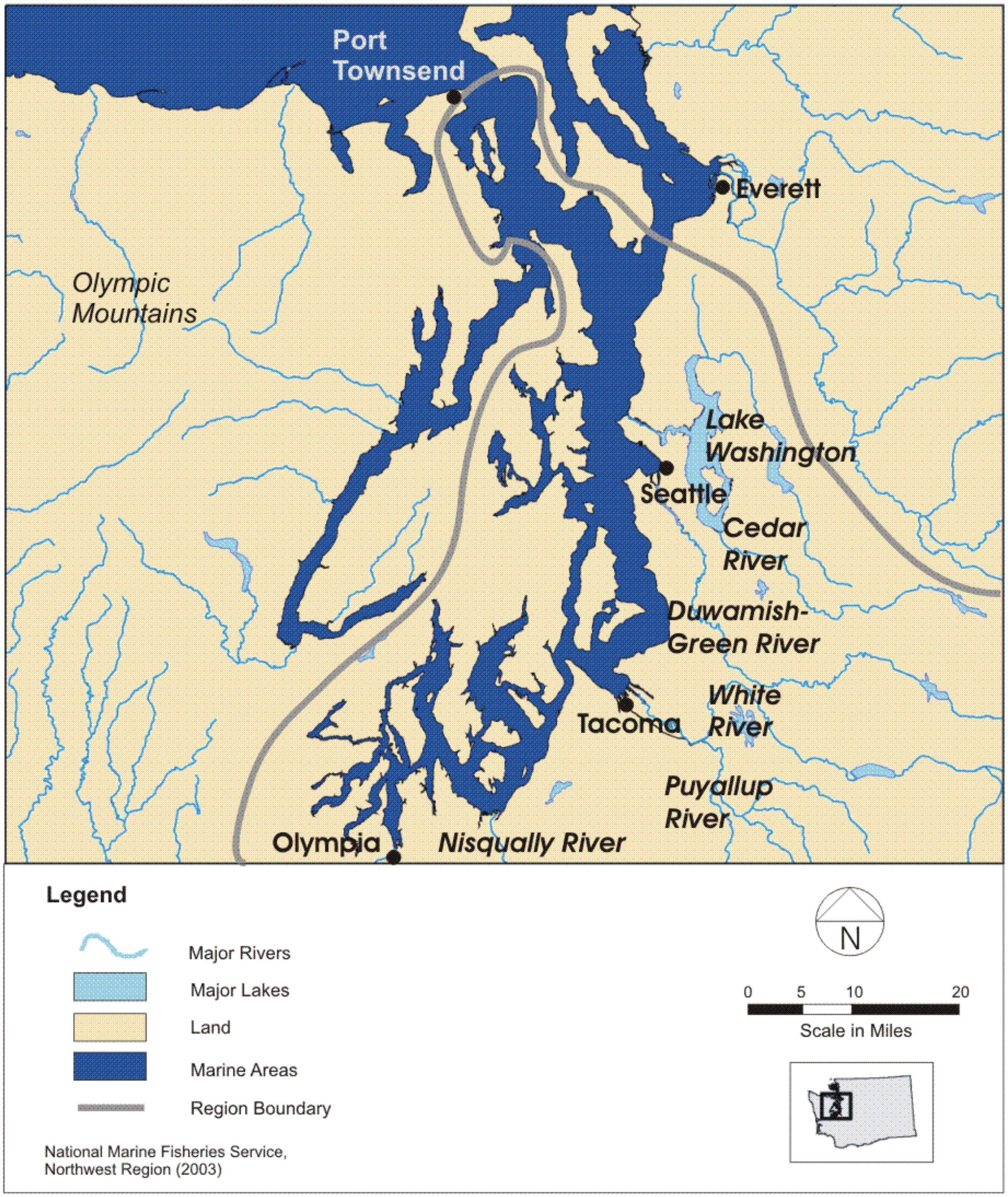
The southern region of the Puget Sound Action Area contains four major chinook-bearing watersheds. These are, from north to south, the Lake Washington, Green-Duwamish, Puyallup and Nisqually watersheds (see Figure 3.3-7). The Puyallup and Nisqually are glacially-influenced rivers originating from the glaciers of Mt. Rainier and surrounding foothills. The lower reaches of all these system flow through lowland areas that have been developed for agricultural, residential, urban or industrial use. There are also several smaller but important chinook-bearing streams in South Puget Sound and Hood Canal. The Puget Sound Technical Recovery Team has identified six populations in this region.

Numerous hatcheries in this area account for the majority of chinook salmon produced in Puget Sound. Hatchery transfers have affected most populations.

Lake Washington Watershed. The Puget Sound Technical Recovery Team identified two summer-fall chinook populations within the Lake Washington watershed: the Sammamish River, a Category 2 population, and Cedar River, a Category 1 population (Puget Sound Technical Recovery Team ~~July 22, 2003~~2004). The Sammamish basin includes the Sammamish River, Swamp, North, Bear, Little Bear, and Issaquah Creeks. Historically, Chinook salmon also spawned in other smaller tributaries to Lake Washington such as May and Kelsey Creeks. Genetic samples from chinook in Bear/Cottage Creek are similar to those from Issaquah Creek, site of the Issaquah hatchery. It is not known whether this results from recent or historical intermingling among fish from these basins. Cedar River chinook may be genetically distinct, but closely related to those in the Green River (Washington Department of Fisheries et al. 1993). Until 1916, the Cedar River drained into the Green River, and from 1952 through 1964, Green River chinook were planted in the Cedar, so a close relationship is not surprising. Plants of hatchery fish were made to most other tributaries to the Lake Washington basin from the Issaquah and Green River hatcheries, from 1952 to at least the early 1990s. Passage to the upper watershed had been eliminated at the turn of the century with the construction of the Landsburg Dam. In 2003, 100 years later, passage was restored as part of a Habitat Conservation Plan, opening up 17 miles of additional, good quality habitat to chinook, coho, and steelhead salmon returning to the Cedar River watershed.

Chinook salmon enter Lake Washington drainages from late May through early November. Spawning is usually complete by the end of November. Chinook spawning in the Cedar River is concentrated between Rivermile 4.0 and 19.0. Most Cedar River chinook emigrate to Lake Washington prior to April as fry, but some rear in the river and migrate to Puget Sound between May and July. The Lake Washington populations have a protracted smolt out-migration, with a large percentage of the run out-migrating after July 1.

1 Figure 3.3-7. South Puget Sound Region.



2

NMFS is currently evaluating critical or viable escapement thresholds for the Lake Washington populations, but will not complete its analysis prior to completion of this Environmental Impact Statement. An interim, generic critical escapement threshold of 200 spawning adults and an interim, generic viable escapement threshold of 1,200 adults has been set by NMFS (NMFS ~~Memorandum~~ 2003a).The co-managers derived an escapement goal of 350 for the North Lake Washington Tributaries population based on patterns of escapement within the Lake Washington watershed. Actual escapements have been below this level in the majority of years since 1983, but have shown an increasing trend since 1997. The geometric mean of spawning escapement was 251 (range 33 to 544) from 1983 through 1996, and 251 from 1997 through 2001 (range 67 to 537). The co-managers' goal for the Cedar River population is 1,200, and actual escapements have been consistently below this since 1974. The geometric mean of spawning escapement was 576 (range 156 to 1,540) from 1983 through 1996, and 297 from 1997 through 2000 (range 120 to 810) (Figure 3.3-8) (Puget Sound Indian Tribes and Washington Department of Fish and Wildlife 2003; and Puget Sound Technical Recovery Team, *in preparation*).

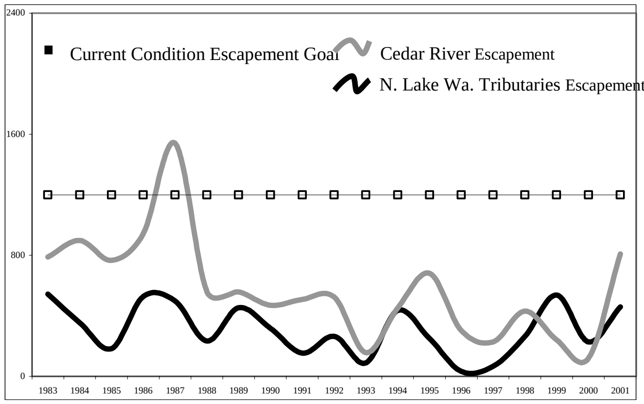
The total exploitation rate for chinook salmon returning to the Lake Washington watershed was 67 percent from 1983 through 1996, and 26 percent from 1997 through 2000 (Fishery Regulation Assessment Model, December 2002). Due to a lack of coded-wire tag data for Lake Washington chinook salmon populations, harvest distribution has been inferred from coded-wire tag data from the South Puget Sound fall fingerling indicator stock (comprised of releases from the Green River and Grovers Creek on the Kitsap Peninsula), which have a similar life history and genetic heritage. Consequently, the reader is referred to the discussion of harvest distribution for the Green-Duwamish River population. However, fisheries in Lake Washington have been limited to incidental harvest of chinook in fisheries targeted on other species, so the proportion of catch in the Lake Washington runs terminal area is much lower than for the Green River (Figure 3.3-8).

Releases of fall-run chinook salmon in the Lake Washington system accounted for about 5 percent of all Puget Sound releases from 1991 through 2000, or about 2.6 million fish per year. Eighty-seven percent of releases came from the Issaquah Creek hatchery, and 7 percent originated from the University of Washington hatchery in Seattle. Releases in 2001 were 2.2 million. There were no releases of chinook salmon in the Cedar River system (Pacific States Marine Fisheries Commission, December 2002). The hatchery stock used in the Issaquah hatchery originated from the Green-Duwamish River basin. Hatchery contribution to natural spawning has not been quantified, although there appears to be little straying of Issaquah Creek adults to the Cedar River (Puget Sound Technical Recovery Team, *in preparation*).

Figure 3.3-8. Spawning escapement, fishing exploitation rate, and geographic distribution of fishing mortality for Lake Washington summer-fall chinook.

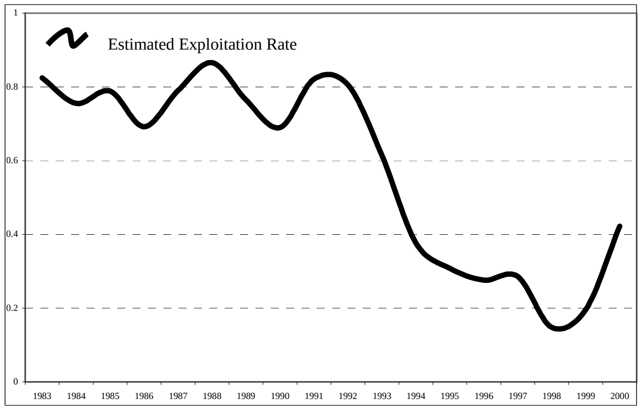
Spawning Escapement and Escapement Goals for Lake Washington Summer-Fall Chinook

Estimated escapement of naturally-spawning adults compared to current condition escapement goal.



Estimated Exploitation Rate for Lake Washington Summer-Fall Chinook

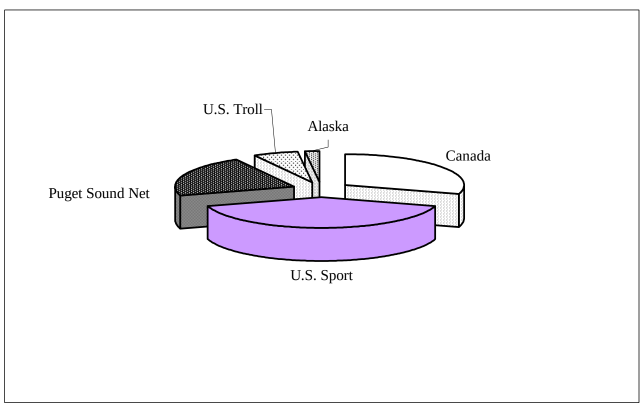
Estimated exploitation rate based on Fishery Regulations Assessment Model.



Geographic Distribution of Fishing Mortality on Lake Washington Summer-Fall Chinook

Distribution of fishing mortality based on coded-wire tag recoveries of Southern Puget Sound Indicator Stock

Alaska	**2%**
Canada	**30%**
Puget Sound Net	**22%**
U.S. Sport	**41%**
U.S. Troll	**6%**



Sources: Puget Sound Technical Recovery Team (in progress), Northwest Indian Fisheries Commission, and Pacific Salmon Commission December 2002.

Green-Duwamish River Chinook. Fall chinook spawn in the mainstem Green River and in two major tributaries – Soos Creek and Newaukum Creek. The Puget Sound Technical Recovery Team has determined that Green River chinook comprise a single population (Puget Sound Technical Recovery Team 2004~~1~~). It is considered a Category 1 population.

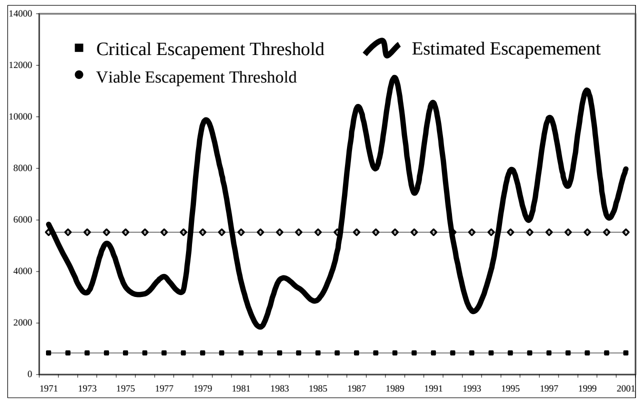
Spawning in the mainstem Green River occurs from Rivermile 26.7 to Rivermile 61 where the first of two dams operated by the City of Tacoma blocks spawning access. Chinook begin entering the Green River in July, and spawn from mid-September through October. Nearly all juveniles migrate seaward during their first year. Age-4 fish comprise 62 percent of adult returns, with Age-3 and Age-5 fish comprising 26 percent and 11 percent, respectively (Washington Department of Fisheries et al. 1993; and Washington Department of Fish and Wildlife 1995, cited in Myers et al. 1998).

NMFS has determined the critical escapement threshold of Green-Duwamish River chinook population to be 835 adult spawners, and the viable escapement threshold to be 5,523 adult spawners. The co-managers' escapement goal is 5,800 natural spawners (NMFS 2000). From 1971 through 2001, escapements have exceeded the viable escapement threshold in 15 of 31 years, and the long-term trend in escapement has been positive. The geometric mean of annual spawning escapement from 1971 through 1996 was 4,892 (range 1,840 to 11,515). The geometric mean of spawning escapement from 1997 through 2001 was 8,306 (range 6,170 to 11,025) (Figure 3.3-9) (Puget Sound Technical Recovery Team, *in preparation*).

Figure 3.3-9. Spawning escapement, fishing exploitation rate, and geographic distribution of fishing mortality for Green-Duwamish River summer-fall chinook.

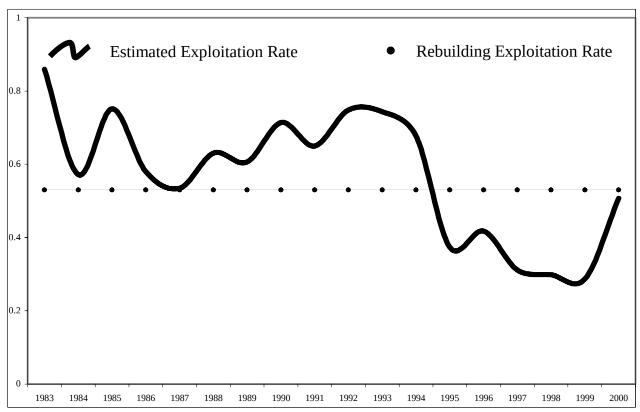
Spawning Escapement and Escapement Goals for Green-Duwamish River Summer-Fall Chinook

Estimated escapement of naturally-spawning adults compared to NMFS' critical and viable escapement thresholds



Estimated Exploitation Rate for Green-Duwamish River Summer-Fall Chinook

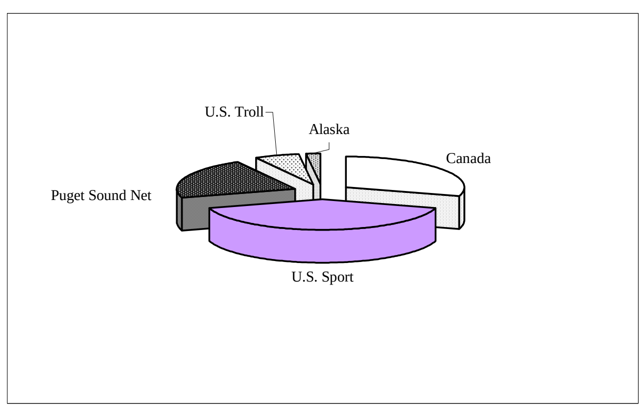
Estimated exploitation rate compared to NMFS' recovery exploitation rate. Estimated exploitation rate based on Fishery Regulations Assessment Model.



Geographic Distribution of Fishing Mortality on Green-Duwamish River Summer-Fall Chinook

Distribution of fishing mortality based on coded-wire tag recoveries of Southern Puget Sound Indicator Stock

Alaska	2%
Canada	30%
Puget Sound Net	22%
U.S. Sport	41%
U.S. Troll	6%



Sources: Puget Sound Technical Recovery Team (in progress), Northwest Indian Fisheries Commission, and Pacific Salmon Commission December 2002.

The NMFS rebuilding exploitation rate on the Green River population is 53 percent (NMFS 2000). Harvest mortality distribution for Green River chinook is estimated from recoveries of the South Puget Sound fingerling indicator stock mentioned previously. Total exploitation on this population fell from levels above 80 percent in the early 1980s, to levels below 40 percent in the 1990s. The average exploitation rate from 1983 through 1996 was 63 percent, while the average from 1997 through 2000 was 35 percent (Fishery Regulation Assessment Model, December 2002). From 1997 through 2001, Canadian fisheries accounted for 30 percent of fishing-related mortality, U.S. sport fisheries 41 percent, Puget Sound net fisheries 22 percent, U.S. troll fisheries 6 percent, and Alaska fisheries 2 percent (Figure 3.3-9) (Pacific Salmon Commission, October 2002).

The Green-Duwamish River system, with its large hatchery at Soos Creek, accounts for about 12 percent of Puget Sound hatchery chinook releases, with annual releases of 6.4 million juveniles from 1990 through 2001 (Pacific States Marine Fisheries Commission, December 2002). About 72 percent of the juveniles were released from the Soos Creek facility, with smaller releases throughout the system. Releases in 2001 were 4.2 million. From 1990 through 2001, hatchery-origin adults are estimated to have accounted for 71 percent of naturally-spawning chinook in the system (Puget Sound Technical Recovery Team, *in preparation*). Green River chinook stocks were transferred extensively to watersheds throughout Puget Sound, beginning in the 1950s (Myers et al. 1998).

Puyallup River. The Puyallup River is glacially-influenced as a result of its origin on the north slope of Mt. Rainier. The Puyallup River watershed also includes the Cascade foothills. The lower reaches of the Puyallup River flow through agricultural, residential, urban and industrial areas. Fall chinook salmon account for the vast majority of chinook returning to the Puyallup River system, but the White River – a main tributary – contains a spring-run population.

White River Spring Chinook. The Puget Sound Technical Recovery Team has identified the spring-timed chinook in the White River as a single, genetically distinct, Category 1 population, and the only spring chinook population in South Puget Sound (Puget Sound Technical Recovery Team 2004~~1~~).

Mud Mountain Dam at Rivermile 23.4 limits upstream adult migration. A portion of White River spring chinook spawn below the dam, though habitat suitability is constrained by the flow regime. Natural-origin adult fish are trapped at a diversion dam below Mud Mountain Dam and transported into the upper watershed, above Mud Mountain Dam, where they spawn in the West Fork of the White River and tributaries. Spring chinook enter the Puyallup River from May through mid-September, and spawn from mid-September through October.

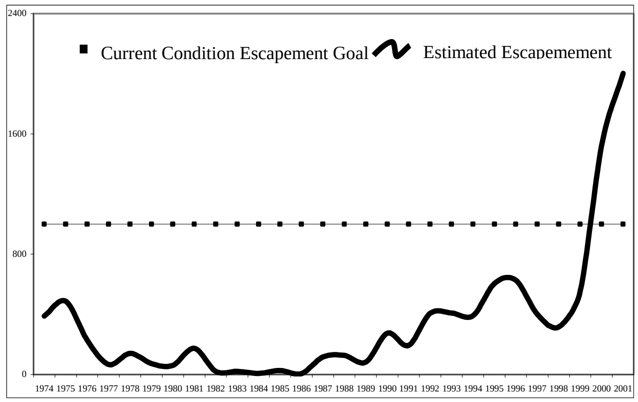
The status of White River spring chinook is critical because of chronically low escapements and the population's reliance on the hatchery supplementation program. NMFS is currently evaluating critical and viable escapement thresholds for the White River population, but will not complete its analysis prior to completion of this Environmental Impact Statement. In the interim, NMFS has established generic critical and viable escapement thresholds of 200 and 1,000 spawning adults, respectively. The co-managers' escapement goal is to allow at least 1,000 natural-origin adults to spawn upstream of Mud Mountain Dam, based on an assessment of available spawning habitat within the White River watershed and comparisons with similar systems in other areas (WDFW et al. 1996). Escapement of White River chinook may have exceeded 5,000 in the early 1940s (Puget Sound Indian Tribes and Washington Department of Fish and Wildlife 2003), but abundance had been reduced to critical levels in the 1970s by migration blockages, alteration of the flow regime, and degradation of spawning and rearing habitat. The geometric mean of annual spawning escapement was 115 (range 6 to 628) from 1974 through 1996, and 735 (range 316 to 2,002) from 1997 through 2001 (Figure 3.3-10) (Puget Sound Technical Recovery Team, *in preparation*). Spawning escapement has shown a substantial increasing trend since the late 1980s. However, later-timed summer-fall chinook have recently been returning to the White River in increasing numbers, which has confounded the counts of spring chinook (personal communication with Bruce Sanford, Washington Department of Fish and Wildlife, April 2, 2003). The population may not be currently viable in the absence of supplementation (NMFS 2000).

Increased fishery restrictions have all but eliminated impacts to this population in fisheries outside Puget Sound, and more conservative management in Washington waters lowered the overall exploitation rate from more than 38 percent between 1983 and 1996, to 22 percent between 1997 and 2000 (Fishery Regulation Assessment Model, December 2002). Nearly all fishery impacts on White River spring chinook occur in Puget Sound, primarily in recreational fisheries, which currently account for 91 percent of the harvest of this stock (Figure 3.3-10). This is due in part to release of yearling smolts from the White River and Hupp Spring hatcheries, which are believed to have a greater tendency to rear in Puget Sound, and in part due to intentional management of commercial fisheries to avoid impacts on all spring chinook (personal communication with Susan Bishop, NMFS Sustainable Fisheries Division, January 5, 2003). Juveniles released at older ages are thought to spend more time in Puget Sound.

Figure 3.3-10. Spawning escapement, fishing exploitation rate, and geographic distribution of fishing mortality for White River spring chinook.

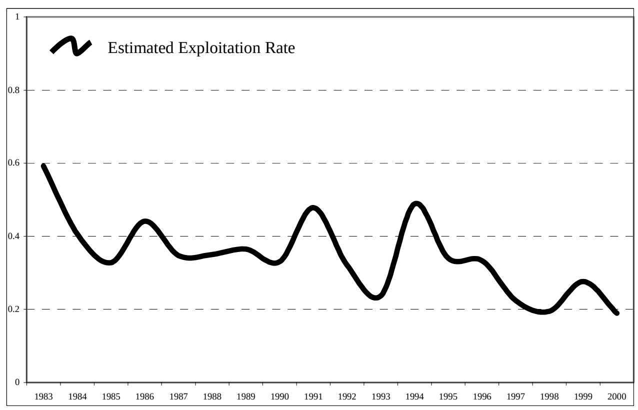
Spawning Escapement and Escapement Goals for White River Spring Chinook

Estimated escapement of naturally-spawning adults compared to current condition escapement goal



Estimated Exploitation Rate for White River Spring Chinook

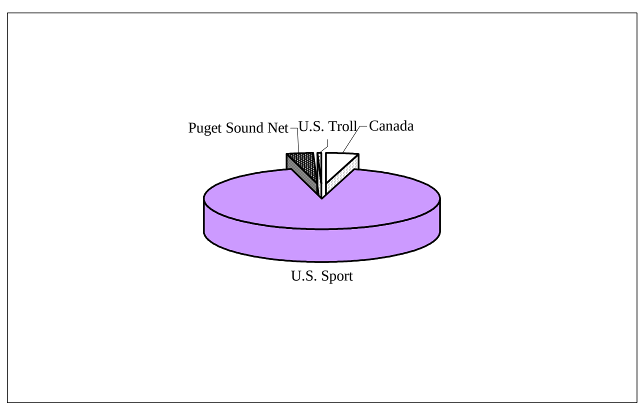
Estimated exploitation rate based on Fishery Regulations Assessment Model



Geographic Distribution of Fishing Mortality on White River Spring Chinook

Distribution of fishing mortality based on coded-wire tag recoveries of White River spring chinook indicator stock

Alaska	**0%**
Canada	**4%**
Puget Sound Net	**4%**
U.S. Sport	**91%**
U.S. Troll	**1%**



Sources: Puget Sound Technical Recovery Team (in progress), Northwest Indian Fisheries Commission, and Pacific Salmon Commission December 2002.

A hatchery supplementation program was begun in the mid-1980s to stabilize and rebuild White River spring chinook. Broodstock is trapped at the Buckley diversion dam on the White River. Unmarked[iv] fish in excess of hatchery needs are transported above Mud Mountain Dam to spawn to rebuild the naturally-spawning population. From 1991 through 2000, annual releases of approximately 0.8 million juvenile spring chinook comprised about 1.6 percent of the total annual chinook releases in Puget Sound. Releases in 2001 were 0.4 million (Pacific States Marine Fisheries Commission, December 2002). Some hatchery fingerlings are released from upstream rearing ponds. Fish from the White River hatchery supplementation program are considered essential to recovery of the population, and are therefore listed.

Puyallup River Fall Chinook. The Puget Sound Technical Recovery Team (2001) has identified a single fall-timed chinook population in the Puyallup River (Puget Sound Technical Recovery Team 2004~~1~~). Because hatchery programs have introduced non-native stocks, primarily of Green River origin, into this system, Puyallup chinook are considered a Category 2 population. Puyallup fall chinook are genetically similar to Green River chinook (Puget Sound Technical Recovery Team 2004~~1~~).

Puyallup River fall chinook spawn primarily in South Prairie Creek (a tributary of the Carbon River), the Puyallup River mainstem,Voights' Creek, and Kapowsin Creek. Adult passage has occurred at Electron Dam, at Rivermile 41.7, since 2001. A remnant native component may persist in South Prairie Creek. Adults begin entering the Puyallup River in late July, and spawning occurs from mid-September through mid-November. Spawning adults are 76 percent Age-4 fish, 16 percent, Age 3, and 6 percent Age 5. An estimated 97 percent of smolts emigrate as fingerlings after a few months of freshwater rearing (Washington Department of Fisheries et al. 1993, cited in Myers et al. 1998).

NMFS is currently evaluating critical and viable escapement thresholds for the Puyallup River fall chinook salmon population, but will not complete its analysis prior to completion of this Environmental Impact Statement. In the interim, NMFS has adopted a generic critical escapement threshold of 200 and a generic viable escapement threshold of 1,250 spawning adults (NMFS Memorandum 2003). Until recently, the natural-spawning escapement goal for Puyallup River fall chinook was 3,250; however, the system was managed primarily to achieve hatchery escapement, and the natural escapement goal was seldom met (NMFS 2000; and Puget Sound Technical Recovery Team, *in preparation*). The co-

[iv] Denotes fish thought to be of natural-origin, although they could also be unmarked hatchery fish from facilities other than the White River Hatchery.

managers are currently updating the system goal. Until then, the co-managers' escapement goal is to insure that at least 500 chinook spawn in South Prairie Creek (Puget Sound Indian Tribes and Washington Department of Fish and Wildlife 2003). This index of escapement is believed to represent adequate seeding of the entire system. The estimated geometric mean of annual spawning escapement was 1,437 from 1971 through 1996 (range 518 to 3,515), and 2,039 from 1997 through 2001 (range 1,193 to 4,995) (Figure 3.3-11) (Puget Sound Technical Recovery Team, *in preparation*).

Total exploitation rate for this population averaged 72 percent from 1983 through 1996, and 60 percent from 1997 through 2000 (Fishery Regulation Assessment Model, December 2002). Because a hatchery indicator stock has not been developed in the Puyallup River, the South Puget Sound fall fingerling indicator stock provides the most relevant description of Puyallup River chinook harvest distribution (Puget Sound Indian Tribes and Washington Department of Fish and Wildlife 2003).

Annual hatchery releases of 2.5 million fall chinook in the Puyallup River accounted for approximately 4 percent of Puget Sound chinook releases from 1991 through 2000. Releases in 2001 were 1.61 million. Hatcheries operated by the Washington Department of Fish and Wildlife at Voights' Creek and the Puyallup Tribe at Diru Creek account for about 78 percent and 21 percent of releases, respectively. No estimates have been made of hatchery-contribution to natural spawning.

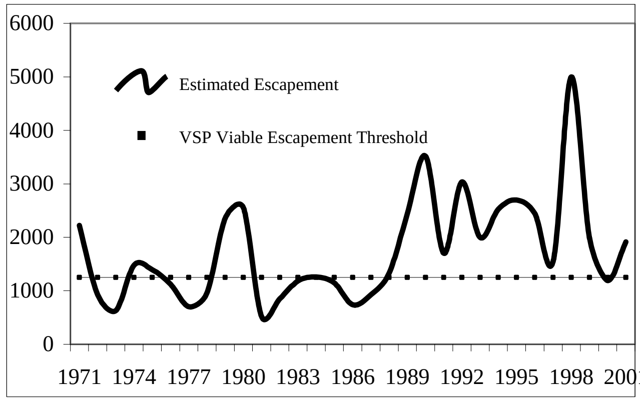
Nisqually River Chinook. The Puget Sound Technical Recovery Team identified one fall-timed chinook population in the Nisqually River watershed (Puget Sound Technical Recovery Team 2004~~1~~). It is a Category 2 population. A partially glacier-fed system, the Nisqually River flows for most of its length through the Puget Lowland ecoregion. Nisqually chinook spawn in the mainstem and numerous side channels and tributaries from Rivermile 3 to Rivermile 42 where La Grande Dam blocks further access. Adult chinook enter the Nisqually River system from July through September, and spawning activity continues through November. Juveniles typically spend 2 to 6 months in fresh water before beginning their seaward migration. Forty-five percent of adults are thought to mature at Age 3, and 31 percent at Age 4 (Washington Department of Fisheries et al. 1993; and Washington Department of Fish and Wildlife 1995, cited in Myers et al. 1998).

Native spring and fall chinook populations have been extirpated from the Nisqually River system, primarily as a result of blocked passage at the Centralia diversion, dewatering of mainstem spawning areas by hydroelectric operations, a toxic copper ore spill associated with a railroad trestle failure, and other habitat degradation (Nisqually Chinook Recovery Team 2001).

Figure 3.3-11. Spawning escapement, fishing exploitation rate, and geographic distribution of fishing mortality for Puyallup River fall chinook.

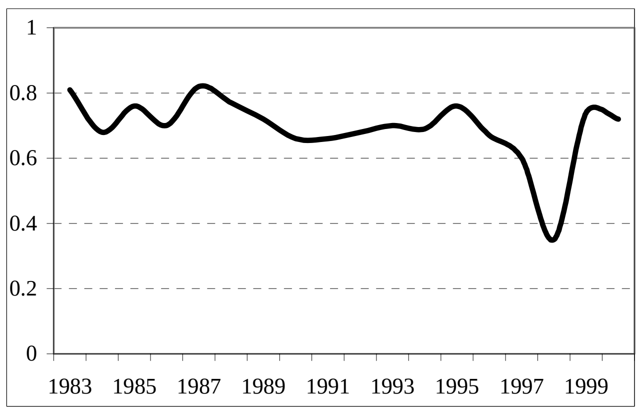
Spawning Escapement and Escapement Goal for Puyallup River Fall Chinook

Estimated escapement of naturally-spawning adults compared to NMFS' VSP Guidelines Viable Escapement



Estimated Fishing Exploitation Rate on Puyallup River Fall Chinook

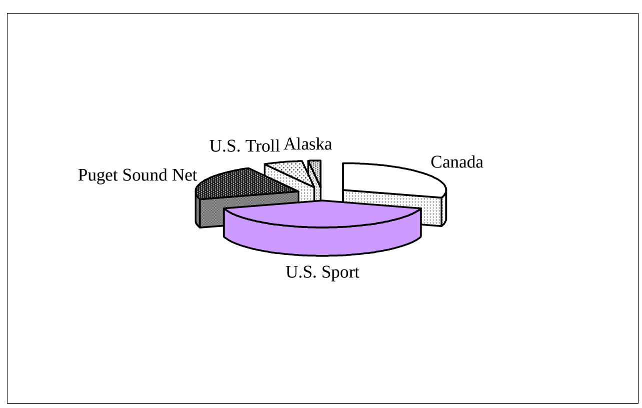
Estimated exploitation rate based on Fishery Regulations Assessment Model



Geographic Distribution of Fishing Mortality on Puyallup River Fall Chinook

Distribution of fishing mortality based on coded-wire tag recoveries of southern Puget Sound indicator stock

Alaska	2%
Canada	30%
Puget Sound Net	22%
U.S. Sport	40%
U.S. Troll	6%



Sources: Puget Sound Technical Recovery Team (in progress), Northwest Indian Fisheries Commission, and Pacific Salmon Commission December 2002.

Prior to 2001, the Nisqually River was managed to achieve egg-take goals for the hatchery enhancement program. NMFS is currently evaluating critical or viable escapement thresholds for the Nisqually River chinook population, but will not complete its analysis prior to completion of this Environmental Impact Statement. In the interim, NMFS has adopted a generic critical escapement threshold of 200 and a generic viable escapement threshold of 1,100 spawning adults (NMFS Memorandum 2003). In 2001, the system began to be managed primarily for natural spawning escapement. The co-managers' previous natural escapement goal of 900, which was met or exceeded in 48 percent of the years between 1979 and 1999, was increased to 1,100 in 2000 based on an assessment of available habitat (Puget Sound Indian Tribes and Washington Department of Fish and Wildlife 2003). The trend in escapement from 1979 through 2001 has been slightly upward. The geometric mean of escapement was 637 (range 85 to 2,332) from 1979 through 1996, and 883 from 1997 through 2000 (range 340 to 1,399) (Figure 3.3-12) (Puget Sound Technical Recovery Team, *in preparation*).

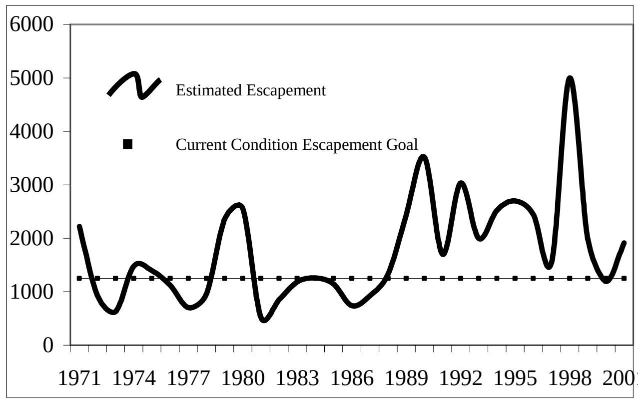
Based on coded-wire tag data, the exploitation rate on Nisqually River chinook averaged 83 percent from 1983 through 1996, and 68 percent from 1997 through 2001. From 1997 through 2000, 14 percent of harvest mortality occurred in Canada, 38 percent in U.S. sport fisheries, 45 percent in Puget Sound net fisheries, and 3 percent in U.S. troll fisheries. These numbers reflect decreasing harvest impacts in Canadian fisheries; from 1982 through 1995, Canadian fisheries, U.S. sport fisheries, and U.S. net fisheries each accounted for roughly 30 percent of harvest mortality (Figure 3.3-12) (Pacific Salmon Commission, October 2002).

The Kalama Creek and Clear Creek hatcheries operated by the Nisqually Tribe released approximately 2.9 million fall chinook annually (about 6 percent of total Puget Sound chinook releases) from 1991 through 2000. Releases in 2001 were 3.28 million (Pacific States Marine Fisheries Commission, December 2002). The hatchery stocks were derived from Puyallup and Green River fall-runs, and preliminary studies show hatchery and naturally-spawning populations are genetically similar (Puget Sound Indian Tribes and Washington Department of Fish and Wildlife 2003; and Washington Department of Fisheries et al. 1993, cited in Puget Sound Technical Recovery Team, April 8, 2002).

Figure 3.3-12. Spawning escapement, fishing exploitation rate and geographic distribution of fishing mortality for Nisqually River fall chinook.

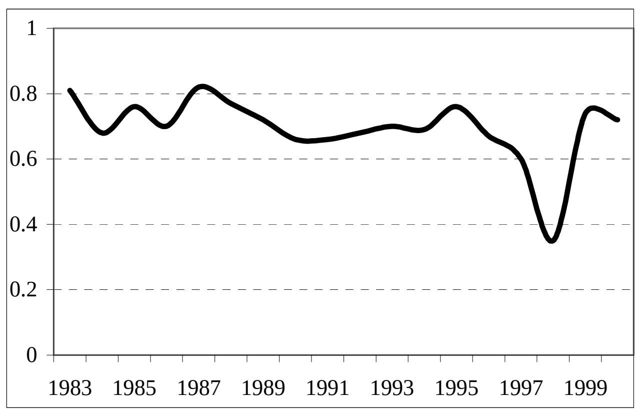
Spawning Escapement and Escapement Goal for Nisqually River Fall Chinook

Estimated escapement of naturally-spawning adults compared to current condition escapement goal



Estimated Fishing Exploitation Rate on Nisqually River Fall Chinook

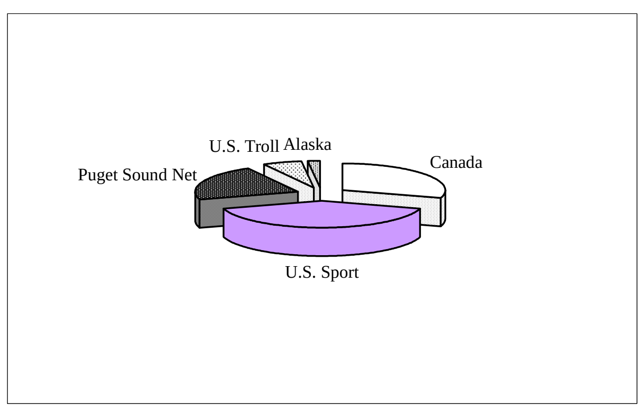
Estimated exploitation rate based on Fishery Regulations Assessment Model



Geographic Distribution of Fishing Mortality on Nisqually River Fall Chinook

Distribution of fishing mortality based on coded-wire tag recoveries of southern Puget Sound indicator stock

Alaska	2%
Canada	30%
Puget Sound Net	22%
U.S. Sport	40%
U.S. Troll	6%



Sources: Puget Sound Technical Recovery Team (in progress), Northwest Indian Fisheries Commission, and Pacific Salmon Commission December 2002.

Hood Canal

Skokomish River Chinook. The Puget Sound Technical Recovery Team identified one chinook population in the Skokomish River, one of two identified in Hood Canal. The Skokomish River enters Hood Canal at its southern end; thus, its chinook salmon population is spatially separated from rivers in the mid-Hood Canal management unit (see Figure 3.3-7). Historically, the Skokomish River supported the largest natural chinook run in Hood Canal. Presently, spawning takes place in the Skokomish River mainstem up to the confluence with the South and North Forks, in the South Fork of the Skokomish River, and in the North Fork to where Cushman Dam blocks higher access.

Skokomish River chinook are a composite of natural- and hatchery-origin fish that are genetically indistinguishable. The co-managers classify Skokomish summer-fall chinook as a Category 2 population. A small, self-sustaining population of landlocked chinook is present in Lake Cushman, upstream of the dams.

Chinook salmon enter the Skokomish River starting in late July, with the majority of the run entering from mid-August to mid-September, and spawning from mid-September through October. Peak spawning occurs during mid-October. Adults mature primarily at Age 3 (33%), and Age 4 (43%). Juveniles emigrate primarily during the spring and early summer of their first year (Lestelle and Weller 1994).

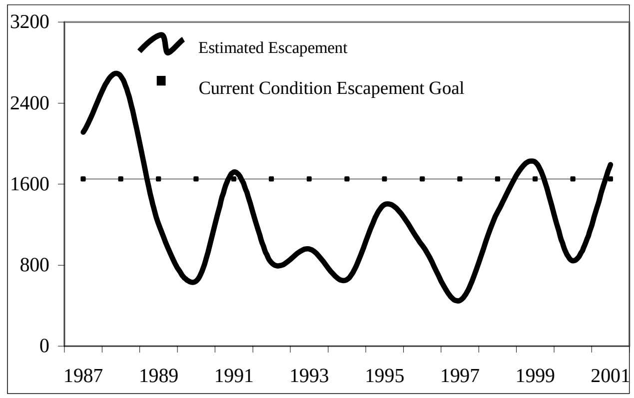
NMFS is currently evaluating critical or viable escapement thresholds for the Skokomish River population, but will not complete its analysis prior to completion of this Environmental Impact Statement. In the interim, NMFS has adopted a generic critical escapement threshold of 200 and a generic viable escapement threshold of 1,250 spawning adults (NMFS~~ Memorandum~~ 2003a). From 1987 (the earliest year for which data are available) through 2001, natural-spawning escapement ranged from 452 to 2,666. While there has been a downward trend in escapement over this period, it has been relatively small. The most recent 5-year geometric mean of escapement was 1,105, compared to 937 from 1992 through 1996, and 1,496 from 1987 through 1991.

The overall exploitation rate for all Hood Canal summer-fall chinook salmon averaged 69 percent from 1983 through 1996, and 39 percent from 1997 through 2000 (Fishery Regulation Assessment Model, December 2002). Coded-wire tag recoveries (from the George Adams hatchery indicator stock) indicate Canadian fisheries accounted for 37 percent of harvest mortality, U.S. sport fisheries 45 percent, U.S. net fisheries 7 percent, and U.S. troll fisheries 9 percent from 1997 through 2000. This represents a substantial change from harvest distribution between 1982 and 1995, when Puget Sound net fisheries accounted for 28 percent of harvest mortality, U.S. sport fisheries 31 percent, and Canadian fisheries 33 percent (Figure 3.3-13) (Pacific Salmon Commission, October 2002).

Figure 3.3-13. Spawning escapement, fishing exploitation rate, and geographic distribution of fishing mortality for Skokomish River fall chinook.

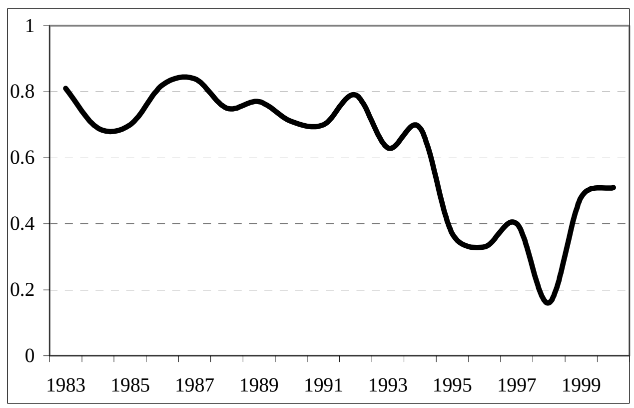
Spawning Escapement and Escapement Goal for Skokomish River Fall Chinook

Estimated escapement of naturally-spawning adults compared to current condition escapement goal



Estimated Fishing Exploitation Rate on Skokomish River Fall Chinook

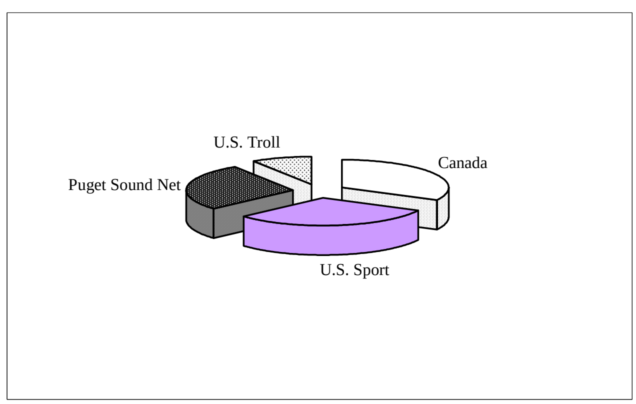
Estimated exploitation rate based on Fishery Regulations Assessment Model and George Adams Hatchery indicator



Geographic Distribution of Fishing Mortality on Skokomish River Fall Chinook

Distribution of fishing mortality based on coded-wire tag recoveries based on George Adams Hatchery indicator stock

Alaska	0%
Canada	37%
Puget Sound Net	7%
U.S. Sport	45%
U.S. Troll	9%



Sources: Puget Sound Technical Recovery Team (in progress), Northwest Indian Fisheries Commission, and Pacific Salmon Commission December 2002.

Fall-timed chinook, originally derived from Green River broodstock, are reared at the George Adams Hatchery on the Skokomish River. Approximately 0.4 million fall chinook (less than one percent of total Puget Sound releases) were released each year between 1991 and 2000 in the Skokomish River system. Additional production at Hoodsport Hatchery, which utilizes George Adams Hatchery broodstock, also enhances local fisheries. The contribution of hatchery-origin fish to natural spawning escapement in the Skokomish River is not known.

Mid-Hood Canal Fall Chinook. The Puget Sound Technical Recovery Team determined that summer-fall chinook salmon from the Dosewalips, Duckabush, and Hamma Hamma Rivers constitute an independent chinook population within Hood Canal (Puget Sound Technical Recovery Team, July 22, 2003), but noted that the degree to which chinook salmon spawning in these rivers were historically demographically linked is not clear. Chinook spawn mostly in the lower reaches of the Dosewalips, because falls and cascades above Rivermile 14 are only passable in high flow years. Genetic data are not expected to be informative in reconstructing the historical Dosewalips River chinook population structure or that of other streams tributary to Hood Canal, since many of the chinook spawning in Hood Canal appear be genetically similar to hatchery-origin chinook derived from Green River-origin broodstock (Puget Sound Technical Recovery Team~~, July 22, 2003~~ 2004).

Current chinook spawner surveys are typically limited to the lower reaches of each stream. In the Dosewalips River, the areas surveyed are transit areas and do not include all spawning areas; upper reaches have been occasionally surveyed since 1998. Prior to 1986, no reliable estimates are available because all escapement estimates for these rivers were made by extrapolation from the Skokomish River (Puget Sound Indian Tribes and Washington Department of Fish and Wildlife 2003). Escapement estimates have averaged 46 since 1998. Escapement estimates have varied so markedly in the Dosewalips River, that there is no apparent trend. Aggregate escapement to the three mid-Hood Canal rivers has averaged 452 since 1998. Aggregate escapement showed a marked increase subsequent to 1997. Aggregate escapement to the three mid-Hood Canal rivers has averaged 452 since 1998. The generic critical escapement threshold and viable escapement threshold for the Mid-Hood Canal population is 200 and 1,250 adults, respectively. Lack of coded-wire tag data makes direct assessment of harvest distribution and exploitation rates impossible. Managers assume marine harvest distribution of Mid-Hood Canal chinook similar to that of chinook from George Adams Hatchery; however, the terminal-area exploitation rate is lower because chinook fisheries are confined to southern Hood Canal and the Skokomish River.

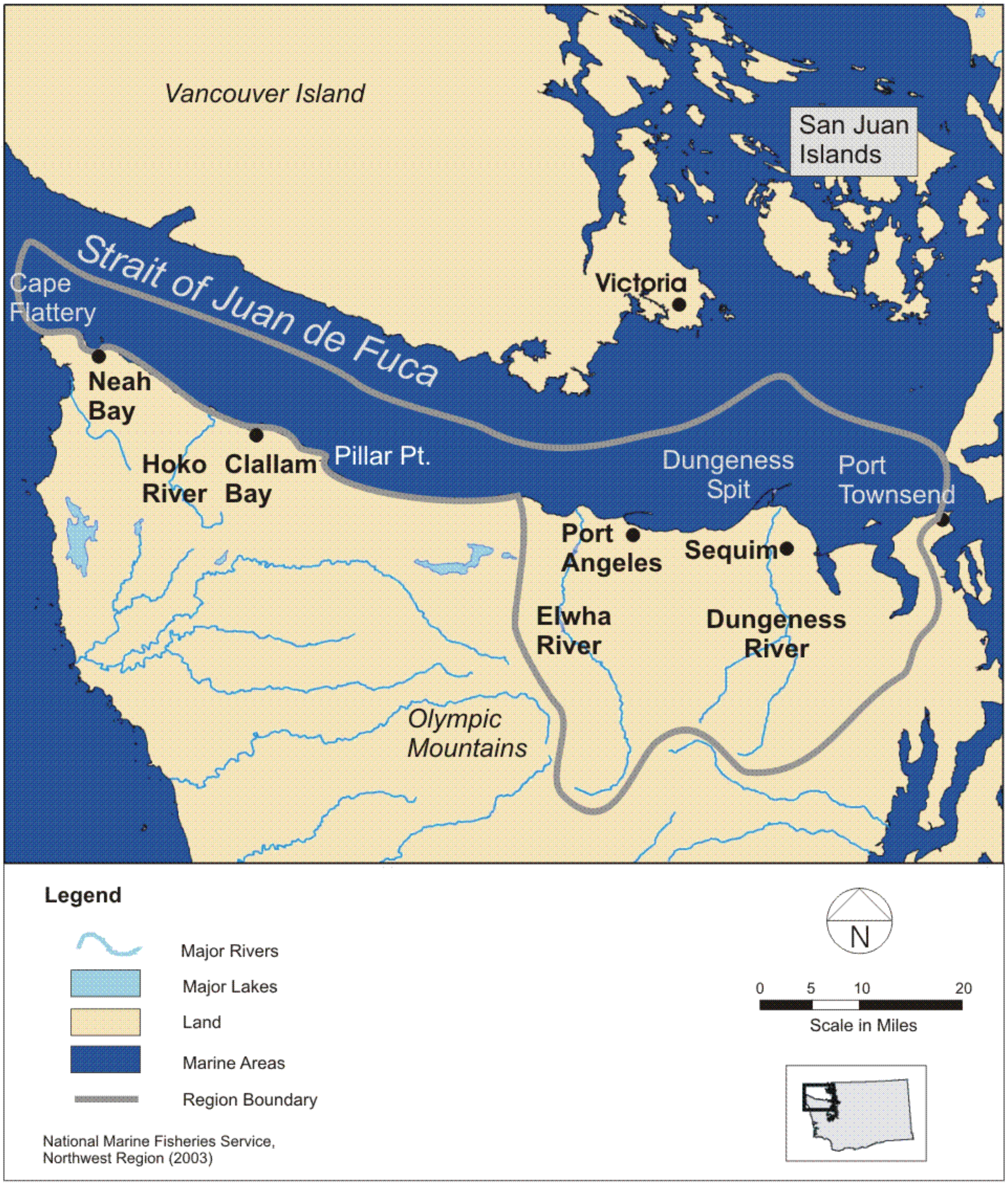
Annual Hood Canal hatchery releases of 2.8 million fall-run and 169,000 spring-run juveniles accounted for 6 percent of Puget Sound chinook released between 1991 and 2000. Spring chinook releases, which decreased steadily each year since 1991, were discontinued in 1997. Releases of fall chinook in 2001 totaled 3.3 million. Fall chinook are reared at numerous satellite locations throughout this area, but the great majority originate and are released from the Hoodsport facility (79%), and the Enetai hatchery (8%). The hatchery population is of mixed origin, with significant influence from transplants from South Puget Sound facilities.

Strait of Juan de Fuca Region

The two chinook-bearing streams in this area, the Dungeness and Elwha Rivers, both originate in the Olympic Mountain Range. The Dungeness River enters the Strait of Juan de Fuca in the vicinity of Sequim. The Elwha River enters the Strait of Juan de Fuca west of Port Angeles (see Figure 3.3-14).

Dungeness River. A native-origin, spring-summer chinook run spawns in the Dungeness River to Rivermile 18.9, where a falls just above the mouth of Gold Creek blocks further access, and in the Graywolf River, a major tributary. The Dungeness spring-summer chinook run is considered distinct from other Strait of Juan de Fuca populations based on spawn timing and geographic distribution (Puget Sound Technical Recovery Team, ~~April 8, 2002~~2004), and is classified as a Category 1 population.

Figure 3.3-14. Strait of Juan de Fuca Region.



Mature chinook salmon enter the Dungeness River from early summer through September, and spawn from August through mid-October (Washington Department of Fisheries et al. 1993). More than 95 percent of Dungeness River juvenile chinook migrate to sea during their first year (Washington Department of Fisheries et al. 1993; Smith and Sele 1995; and Washington Department of Fish and Wildlife 1995, cited in Myers et al. 1998). Sixty-three percent of adults mature at Age 4, 25 percent at Age 5, and 10 percent at Age 3 (Point-No-Point Treaty Tribes 1995; and Washington Department of Fish and Wildlife 1995, cited in Myers et al. 1998).

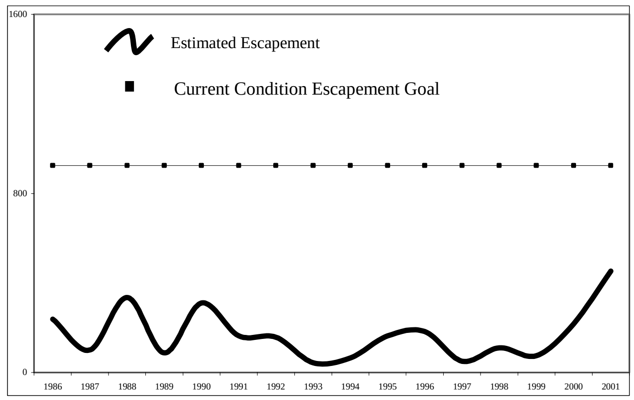
The Dungeness River spring-summer chinook population is classified as critical due to chronically-low spawning escapement levels (NMFS 2000; and Washington Department of Fisheries et al. 1993). NMFS has not yet determined critical or viable escapement thresholds for this population. The co-managers have set an escapement goal of 925 spawners based on an assessment of current suitable habitat and capacity (Smith and Sele 1994), which NMFS has adopted as the interim viable escapement threshold. NMFS has determined the critical escapement threshold to be 500 spawning adults (NMFS ~~Memorandum~~ 2003a). Escapement has remained mostly below 250 spawners since 1986. The geometric mean of escapements was 142 (range 43 to 331) from 1986 through 1996, and 132 from 1997 through 2001 (range 50 to 453). The trend in escapement from 1986 to the present has been relatively flat, although there has been a marked increase in escapement since 1997 (Figure 3.3-15) (Puget Sound Technical Recovery Team, *in preparation*). Elwha River-tagged fingerlings offer the best available description of harvest distribution for Dungeness River chinook.

A captive broodstock program was implemented on the Dungeness River in 1996, with a goal of increasing the number of naturally-spawning fish. Approximately 1.5 million spring chinook salmon reared at the Dungeness hatchery were released annually into the Graywolf and Dungeness Rivers between 1996 and 2000. Releases in 2001 totaled 2.1 million. The contribution of hatchery fish to natural spawning is unknown, but believed to be substantial (Pacific States Marine Fisheries Commission, December 2002; and NMFS 2000).

Figure 3.3-15. Spawning escapement, fishing exploitation rate, and geographic distribution of fishing mortality for Dungeness River spring chinook.

Spawning Escapement and Escapement Goal for Dungeness River Spring Chinook

Estimated escapement of naturally-spawning adults compared to current condition escapement goal.



Estimated Fishing Exploitation Rate on Dungeness River Spring Chinook

Extremely small population size makes estimates problematic.

NOT AVAILABLE

Geographic Distribution of Fishing Mortality on Dungeness River Fall Chinook

Extremely small population size makes estimates problematic.

Alaska
Canada
Puget Sound Net
U.S. Sport
U.S. Troll

NOT AVAILABLE

Sources: Puget Sound Technical Recovery Team (in progress), Northwest Indian Fisheries Commission, and Pacific Salmon Commission December 2002.

Elwha River Chinook. The Elwha population is the westernmost population of the Puget Sound ESU, with genetic and life history traits more similar to coastal chinook populations than other Puget Sound populations (Myers et al. 1998; and Puget Sound Technical Recovery Team 2004~~1~~). The Puget Sound Technical Recovery Team identified one fall-timed chinook population in the Elwha River. It is of native-origin, supported by hatchery supplementation, and is classed as a Category 1 population.

Adult chinook enter the Elwha River from June through early September. Spawning begins in late August, and peaks in late September to October (Washington Department of Fisheries et al. 1993). Elwha River chinook mature primarily at Age 4 (57%), with Age-3 and Age-5 fish comprising 13 percent and 29 percent, respectively, of annual returns (Myers et al. 1998). Naturally-produced juveniles emigrate primarily in their first year.

The degraded condition of currently usable habitat in the 5-mile reach below the Elwha Dam precludes a self-sustaining natural population. Prior to dam construction in the early 1900s, the Elwha basin contained as much as 70 miles of spawning habitat. Recovery of the population depends on restoring access to high quality habitat in the upper Elwha basin.

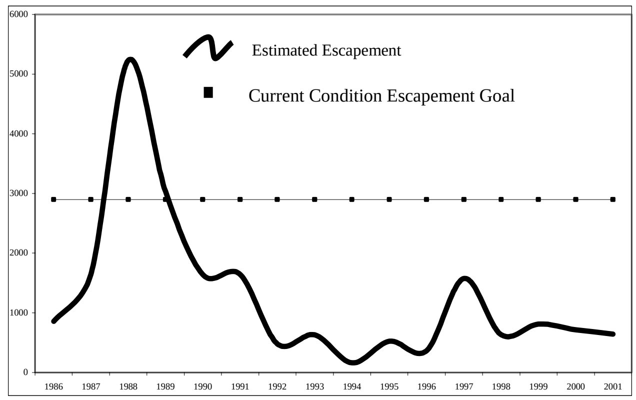
NMFS is currently evaluating critical or viable escapement thresholds for the Elwha River chinook population, but will not complete its analysis prior to completion of this Environmental Impact Statement. NMFS has determined an interim critical escapement threshold of 1,000 spawning adults and an interim viable escapement threshold of 2,900 adults for this population (NMFS ~~Memorandum~~ 2003a).There has been a declining trend in escapement since the mid-1980s. The co-managers' nominal escapement goal of 2,900, which is a composite of 500 natural spawners and 2,400 adults for broodstock needs, was exceeded only twice between 1986 and 2001. The geometric mean of escapements was 950 from 1986 through 1996 (range 163 to 5,228), and 821 from 1997 through 2001 (range 633 to 1,578). Despite an apparent increasing trend in escapement since 1994, the overall trend in escapement has been downward (Figure 3.3-16).

The Elwha River chinook migrate to northern British Columbia and Southeast Alaska. Coded-wire tag data from 1991 through 1996, showed British Columbia accounted for 54 percent of harvest mortality, Alaska 10 percent, Washington sport fisheries 21 percent, Washington troll fisheries 5 percent, and Puget Sound net fisheries 9 percent (Figure 3.3-16) (Pacific Salmon Commission data cited in NMFS 2000).

Figure 3.3-16. Spawning escapement, fishing exploitation rate, and geographic distribution of fishing mortality for Elwha River summer-fall chinook.

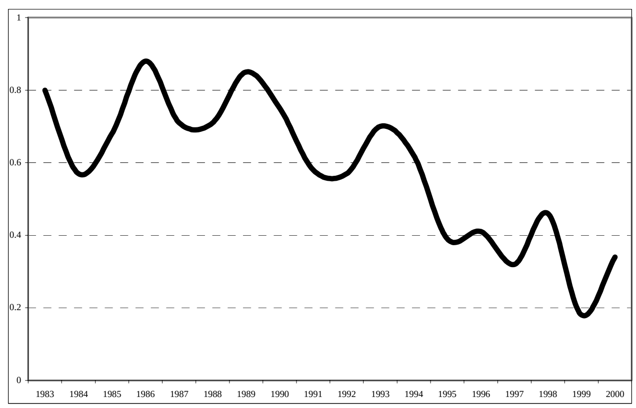
Spawning Escapement and Escapement Goal for Elwha River Summer-Fall Chinook

Estimated escapement of naturally-spawning adults compared to current condition escapement goal



Estimated Fishing Exploitation Rate on Elwha River Summer-Fall Chinook

Distribution of fishing mortality based on coded-wire tag recoveries of Hoko River-Strait of Juan de Fuca indicator stock



Geographic Distribution of Fishing Mortality of Elwha River Summer-Fall Chinook

Estimates problematic

Alaska
Canada
Puget Sound Net
U.S. Sport
U.S. Troll

NOT AVAILABLE

Sources: Puget Sound Technical Recovery Team (in progress), Northwest Indian Fisheries Commission, and Pacific Salmon Commission December 2002.

Approximately 2.5 million fall chinook fingerlings from the Elwha hatchery were released each year from 1991 through 2000. Releases in 2001 were 2.6 million. The hatchery uses the native Elwha River population, and now no longer releases yearling smolts. Chinook produced at the Elwha hatchery are considered essential to run recovery, and thus are included in the listed ESU. The contribution of hatchery straying to natural spawning is unknown (Pacific States Marine Fisheries Commission, December 2002; Puget Sound Technical Recovery Team, *in preparation*; and NMFS 2000).

3.3.1.2 Hood Canal and Strait of Juan de Fuca Chum Salmon (*Oncorhynchus keta*)

NMFS listed the Hood Canal summer chum ESU as threatened in 1999. This ESU includes summer-run populations in Hood Canal and the eastern Strait of Juan de Fuca. Populations within this ESU exhibit considerable diversity in life-history features.

General Life History

Summer chum spawning occurs from late August through late October, generally within the lowest 1 to 2 miles of the river systems in which they occur. Summer chum fry emerge from stream gravels between February and the last week of May, and immediately begin migrating to estuarine areas. Following a brief residence in the estuarine zone, chum fry migrate seaward, returning 2 to 4 years later along a southerly migration path parallel to the coastlines of southeast Alaska and British Columbia. Summer chum mature primarily at 3 and 4 years of age, and a few return at Age 5. They enter the Strait of Juan de Fuca from the first week of July through September, and Hood Canal from early August through the end of September.

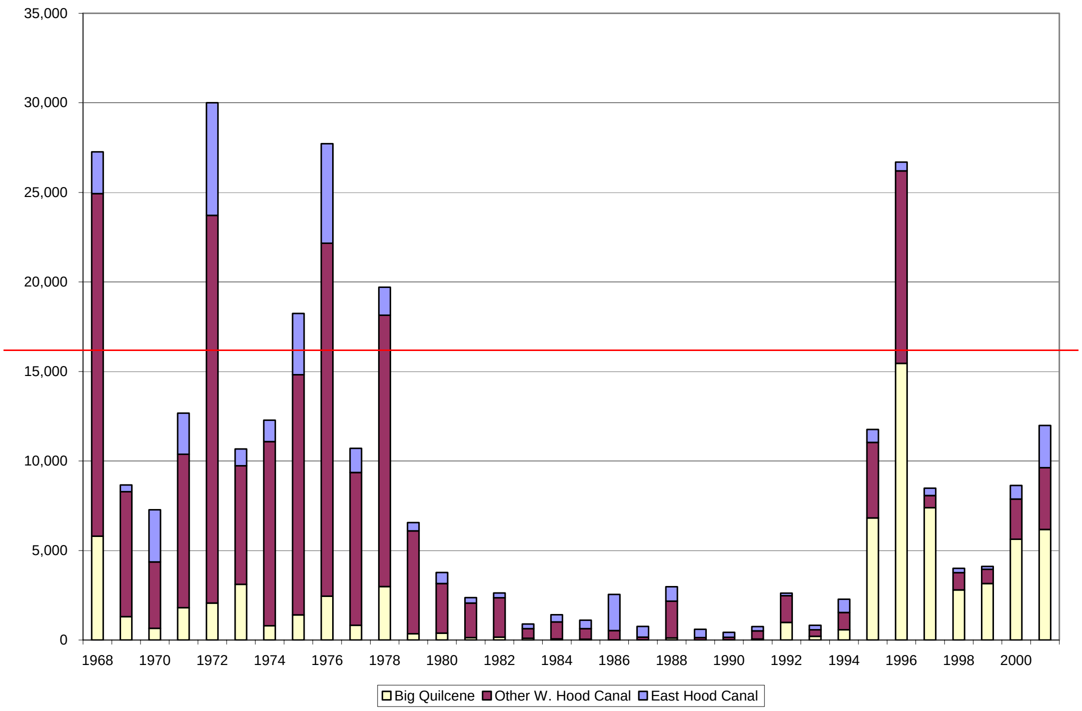
Population Structure

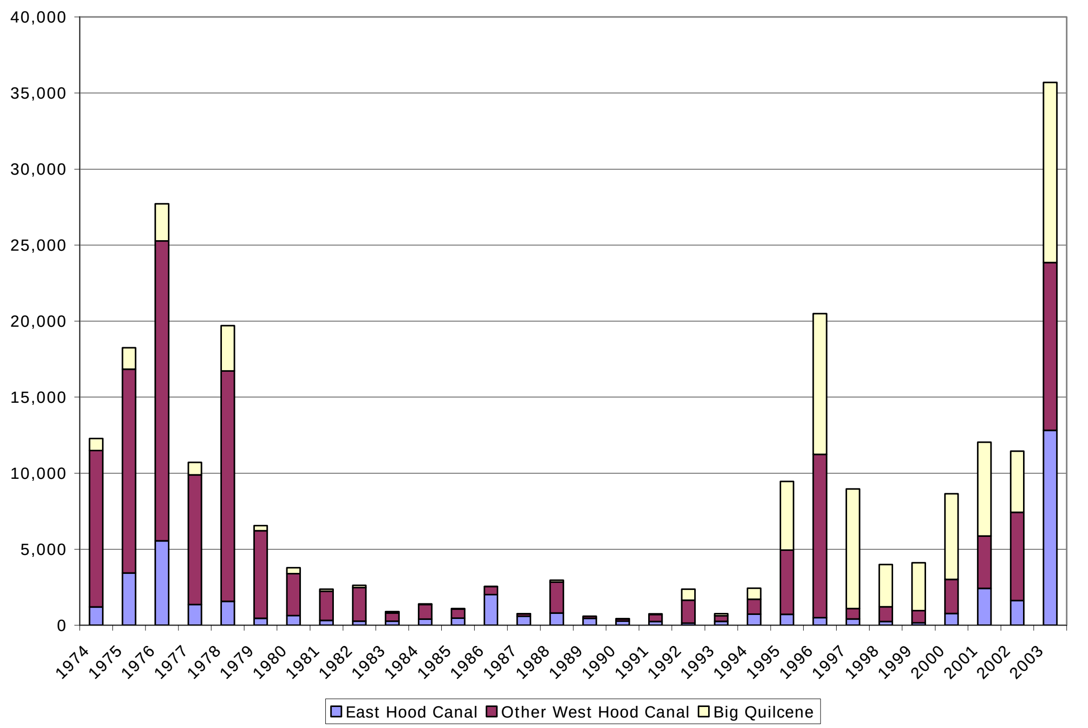
The Hood Canal Summer-Run ESU includes 16 summer-run populations in Hood Canal and the eastern Strait of Juan de Fuca, including seven populations that have become extinct. It is likely that summer chum were historically distributed among additional streams within the region. These early-timed populations are genetically distinct from fall and winter chum salmon (Washington Department of Fish and Wildlife and the Point-No-Point Treaty Tribes 2000).

Of the 16 populations of summer chum identified to have existed in the Hood Canal summer-run chum ESU, seven are considered ~~*functionally extinct*~~ extinct: Skokomish River, Finch Creek, Anderson Creek, Big Beef Creek, Dewatto River, Tahuya River and Chimacum Creek (Washington Department of Fish and Wildlife and the Point-No-Point Treaty Tribes 2000). A summary of the status of Hood Canal and Strait of Juan de Fuca native summer chum populations is shown in Table 3.3-3. Summer chum are occasionally observed in other Hood Canal drainages, including the Skokomish River, that once supported a large summer chum population (see Figure 3.3-7). A re-introduction program began on the Tahuya River in 2000 and the Dewatto River appears to be undergoing natural re-colonization. Summer chum salmon populations in the eastern Strait of Juan de Fuca occur in Snow and Salmon Creeks and in Jimmycomelately Creek. The populations in Chimacum Creek and Big Beef Creek were extirpated, but were re-introduced in 1996. An unknown number of summer chum salmon return to the Dungeness River.

The average spawning escapement of summer chum in Hood Canal from 1968 through 1972 was 22,706 fish. By 1989, spawning escapement had reached its historical low of 519. Annual escapements began to increase in 1993, with escapements from 1998 through 2003~~1~~ averaging~~at 7,829~~ 9,425 (geometric mean). Escapement has been strongest in northern Hood Canal river systems, particularly on the west side of Hood Canal, including the Big Quilcene River, where a hatchery supplementation program is operated. Escapement in ~~1995~~ 2003 was more than 23~~1~~,000 fish in ~~northern~~ western Hood Canal. Streams on the east side of Hood Canal continued to have poor or no escapement except for Big Beef Creek, where a hatchery supplementation program is also operated (Figure 3.3-17) (Washington Department of Fish and Wildlife and the Point-No-Point Treaty Tribes 2000; Washington Department of Fish and Wildlife and the Point No Point Treaty Tribes 2003~~0~~).

Figure 3.3-17. Summer chum salmon spawning escapement to the Big Quilcene, other west Hood Canal streams, and east Hood Canal streams, 1968–2001.

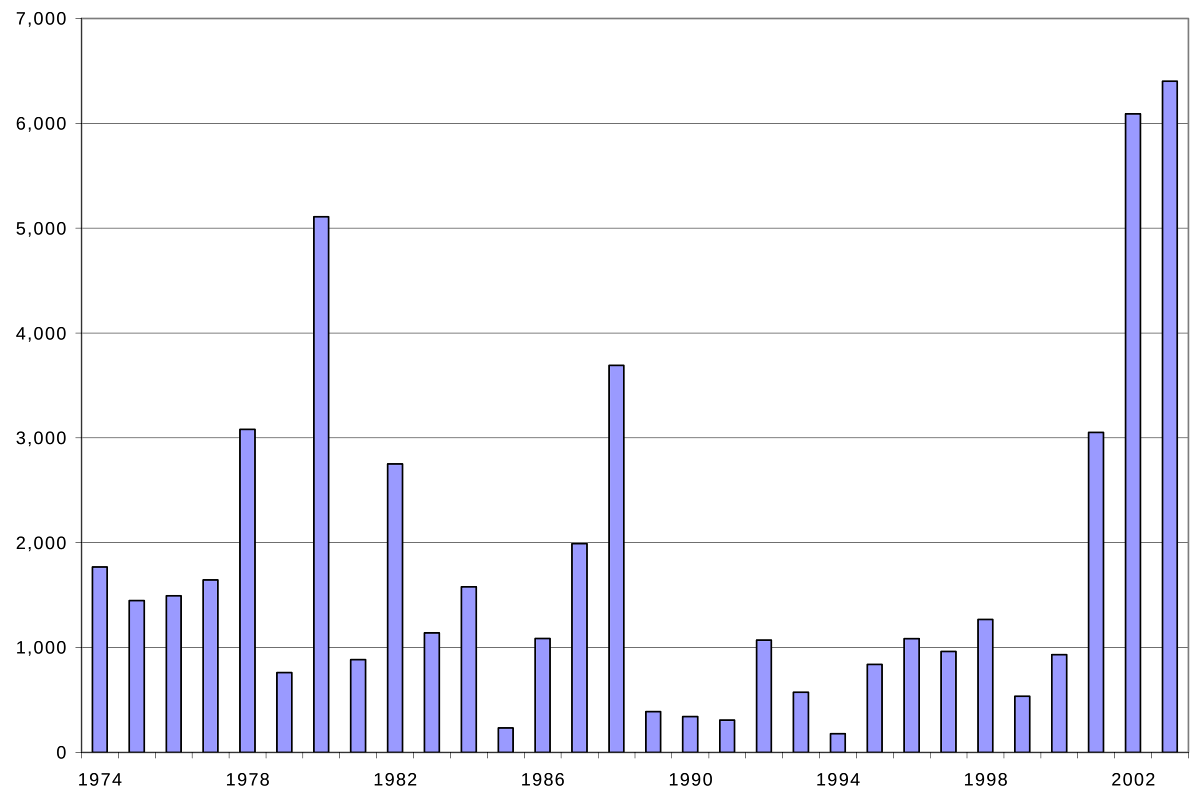




Source: Washington Department of Fish and Wildlife and the Point-No-Point Treaty Tribes 2000; Washington Department of Fish and Wildlife and the Point No Point Treaty Tribes 2003~~0~~.

Summer chum escapements in the Strait of Juan de Fuca (Snow, Salmon, and Jimmycomelately Creeks) averaged 1,401 fish from 1974 through 1977, and ~~1,332~~ 2,270 from 1998 through 2003~~1~~ (geometric mean) (see Figure 3.3-18). (Washington Department of Fish and Wildlife and the Point-No-Point Treaty Tribes 2000; Washington Department of Fish and Wildlife and the Point No Point Treaty Tribes 2003~~0~~).

Figure 3.3-18. Summer chum salmon spawning escapement to Strait of Juan de Fuca streams, 1971–2001.



Source: Washington Department of Fish and Wildlife and the Point-No-Point Treaty Tribes 2000; Washington Department of Fish and Wildlife and the Point-No-Point Treaty Tribes 200~~0~~3.

Table 3.3-3. Summary of status of Hood Canal and Strait of Juan de Fuca native summer chum salmon populations.

Population	Status	Population	Status
Union	Healthy	Dungeness	Unknown
Hamma Hamma	Depressed	Big Beef	Extinct [1]~~Re-introduced~~
Duckabush	Depressed	Anderson	Extinct
Dosewalips	Depressed	Dewatto	Extinct
Big / Little Quilcene	Depressed	Tahuya	Extinct[1]~~Extinct~~
Snow / Salmon~~Quilcene~~	~~Critical~~Depressed	Skokomish	Extinct
Lilliwaup ~~Snow / Salmon~~	Critical	Finch	Extinct
Jimmycomelately~~Lilliwaup~~	Critical	Chimacum	Extinct[1] ~~Re-introduced~~
~~Jimmycomelately~~	~~Critical~~		

[1] These populations have re-introduction programs.

Source: Washington Department of Fish and Wildlife and the Point-No-Point Treaty Tribes 2000.

Table 3.3-4. Summary of environmental and harvest-related factors ~~impacting~~ contributing to the decline of Hood Canal and Strait of Juan de Fuca summer chum populations in the 1970s and 1980s.

Factor		Hood Canal	Strait of Juan de Fuca
Climate	Ocean Conditions	Undetermined	Undetermined
	Estuarine Conditions	Undetermined	Undetermined
	Freshwater Conditions	Moderate	Major
Ecological Interactions	Wild fall chum	Low	Low
	Hatchery fall chum	Low	Low
	Other salmonids (including hatchery)	Moderate	Low
	Marine fish	Low	Low
	Birds	Low	Low
	Marine mammals	Low	Low
Habitat	Cumulative impacts	Major	Major
Harvest	Canadian pre-terminal	Low	Moderate
	U.S. pre-terminal	Low	Low
	Terminal	Major	Low

Source: Washington Department of Fish and Wildlife and the Point-No-Point Treaty Tribes 2000.

Decline of the Hood Canal summer chum ESU has been attributed to a combination of high fishery exploitation rates, shifts in climatic conditions that have changed patterns and intensity of precipitation (thus altering stream flows), and the cumulative effects of habitat degradation (Washington Department of Fish and Wildlife and the Point-No-Point Treaty Tribes 2000; and Johnson et al. 1997 cited in NMFS 2000). The co-managers have ranked the relative importance of the~~se~~ factors responsible for the decline of ~~for~~ Hood Canal and Strait of Juan de Fuca summer chum salmon during the late 1970s and early 1980s.

Catch Distribution

Summer chum salmon are taken incidentally in Canadian and U.S. net fisheries targeting coho and sockeye salmon. They are taken occasionally in troll fisheries off the west coast of Vancouver Island, and infrequently by trollers or sport fishermen off the Pacific Coast and in the U.S. portion of the Strait of Juan de Fuca (Washington Department of Fish and Wildlife and the Point-No-Point Treaty Tribes 2000).

Historically, summer chum salmon were not a primary fishery target in Hood Canal since fisheries were focused on chinook, coho and fall chum salmon. However, because summer chum run timing overlaps that of chinook and coho salmon in many areas, they are caught in fisheries targeting these species. Prior to 1974, Hood Canal was designated a commercial salmon fishing preserve, and the only commercial fisheries permitted on Hood Canal were on the Skokomish reservation (Washington Department of Fisheries et al. 1973, in Johnson et al. 1997). When commercial fisheries were opened on Hood Canal in 1974, incidental harvest of chum increased rapidly, rising to 50 to 80 percent by the late 1980s in most parts of Hood Canal, and as high as 90 percent in Marine Catch Area 12A during the 1980s. In 1992, after fishery restrictions were put in place to protect summer chum, exploitation rates in Hood Canal were reduced to an average of 2.5 percent (Washington Department of Fish and Wildlife and the Point-No-Point Treaty Tribes 2000). Restrictions in Canadian fisheries that intercept summer chum also contributed to the decline in exploitation.

Hatchery Production

Hatchery programs have operated at the Quilcene National Fish Hatchery since 1992, rearing the local population to supplement production in the Quilcene River and the Little Quilcene River, and for re-introduction into Big Beef Creek. Supplementation programs also operate on Lilliwaup Creek, the Union River, the Hamma Hamma River, Salmon Creek, Chimacum Creek, and Jimmycomelately Creek.

3.3.1.3 Listed Columbia River Chinook Salmon

Small numbers of chinook from Columbia River ESUs may be taken in fisheries in Puget Sound and the Strait of Juan de Fuca. These include the Lower Columbia River, Upper Willamette River Spring-run, Upper Columbia Summer-Fall-run and Snake River Fall-run ESUs. Of these, the Lower Columbia, Willamette Spring and Snake River Fall ESUs are listed as threatened.

The exploitation rates on these populations in Puget Sound fisheries between 1984 and 1994 are all believed to have been less than 1.0 percent; 0.6 percent for the Snake River fall ESU, 0.48 to 0.59 percent for the Lower Columbia River ESU, and 0.21 percent for the Willamette Spring ESU (personal communication via e-mail from Dell Simmons, NMFS, to Susan Bishop, NMFS Sustainable Fisheries Division, December 2002).

3.3.1.4 Bull Trout (*Salvelinus confluentus*)

Puget Sound and Washington coastal bull trout populations were listed as threatened in November 1999 by the U.S. Fish and Wildlife Service (USFWS). At the same time, USFWS issued a 4(d) rule exempting from take prohibitions fishing activities taking place at that time (U.S. Federal Register, Volume 64 No. 210, November 1, 1999; proposed special rule: *Salvelinus confluentus*).

The bull trout is a char endemic to western North America that exhibits a number of life-history forms. The stream-resident form lives out its life in small headwater streams. The fluvial form lives as an adult in large rivers but spawns in small tributary streams, sometimes attaining large size. The lacustrine-ad fluvial form spawns in tributary streams but lives as an adult in lakes. It grows to a large size and usually reaches sexual maturity in about its fifth year. Little is known about the bull trout's marine life history (MacPhail and Baxter 1996). However, Kraemer (2003) found that bull trout from the Skagit system commonly switched between fluvial and anadromous forms.

Bull trout are declining in numbers throughout their range, especially at the southern edges of their distribution where a number of populations have become extinct (including streams in the Willamette River system, Oregon, and the McLeod River, California) (MacPhail and Baxter 1996).

The 1998 bull trout/Dolly Varden population inventory identified 80 populations in Washington. All bull trout/Dolly Varden populations in Washington are maintained by wild production. Of the 80 populations identified, 14 (18%) are healthy, 2 (3%) are depressed, 6 (8%) are critical, and the status of 58 populations (72%) is unknown. For a detailed inventory of the status of Puget Sound bull trout populations, the reader is referred to the 1998 addendum to the *Washington Salmon and Steelhead Stock Inventory* (SASSI) report, incorporated here by reference.

Char are occasionally caught in sport and commercial fisheries in Puget Sound, as well as in in-river net fisheries. These char are (apparently) bull trout. They are common in nearshore marine areas of Puget Sound from Everett north, and would be vulnerable to beach seine and set net fisheries. Salmon test fisheries in the Skagit River catch char, especially during the spring. Post-spawning adults may be taken in coho and chum fisheries. Char, including bull trout, are routinely caught in Skagit Bay while test seining for juvenile chinook. In marine waters, the char behave much like sea-run cutthroat, spending most of their time in shallow water (10 feet or less). Bull trout are quite commonly caught in local sport fisheries in both Port Susan and Skagit Bay, especially along northern Whidbey Island, Camano Island, and the mainland from Edmonds north (personal communication via e-mail from Curt Kraemer, Washington Department of Fish and Wildlife, May 2002 and April 2003).

3.3.1.5 Listed Columbia River Chum Salmon

In March of 1999, the National Marine Fisheries Service (NMFS) listed the Columbia River chum salmon ESU as a threatened. Johnson et al. (1997) apparently found no documented instances of Columbia River chum salmon being caught in Puget Sound fisheries. Using the presence of Washington coastal fall chum in Puget Sound catches as a surrogate for Columbia River fall chum, NMFS concluded the average annual catch of Columbia River fall chum in northern Puget Sound fisheries would range from 0 to 21 fish, and that it was unlikely that Columbia River fall ~~chinook~~ chum would be encountered in terminal area fisheries inside Puget Sound (NMFS 2000).

3.3.2 Unlisted Salmonids

3.3.2.1 Puget Sound and Olympic Peninsula Coho Salmon (*O. kisutch*)

General Life History

Coho salmon were historically distributed along the Pacific coast from Chamula Bay, Mexico (Miller and Lea 1972), to Point Hope, Alaska, through the Aleutians, and from the Anadyr River, USSR, south to Hokkaido, Japan (Scott and Crossman 1973). The Puget Sound and Washington Coastal ESUs are geographically intermediate in the coho's range.

More than 95 percent of coho salmon in Washington, Oregon, and California mature in their third year of life after rearing up to 15 months in fresh water and approximately 16 months in the ocean.

Juvenile coho prefer low-velocity stream habitats such as pools and backwaters. Coho usually migrate downstream as yearlings, after which they may reside in estuaries for a few months (Drucker 1972; and Crone and Bond 1976).

Regional Population Aggregates

The Puget Sound/Strait of Georgia Coho ESU includes populations from drainages of Puget Sound and Hood Canal, the Olympic Peninsula east of Salt Creek, and the Strait of Georgia from the east side of Vancouver Island (north to and including Campbell River) and the British Columbia mainland (north to and including Powell River), excluding the upper Fraser River above Hope. Coho salmon from this region differ genetically from those from the Columbia River and the Oregon and California coastal regions. Differences between coho salmon from the Puget Sound ESU and populations from the Olympic Peninsula are more modest (Weitkamp, et al. 1995).

Washington Department of Fisheries et al. (1993) identified 40 coho populations within the boundaries identified by NMFS for the Puget Sound ESU (Washington Department of Fisheries et al. 1993). While the majority of the populations were sustained by wild spawning, only three of these populations (Sumas/Chilliwack, Skagit, and Deer Creek [Stillaguamish River]) were determined to be of native origin. The rest were classed as being of mixed, non-native or unknown origin. However, natural production is predominant in the Skagit, Stillaguamish, and Snohomish River systems, and comprises a significant proportion of production in all other management units (Weitkamp et al. 1995).

<u>Status and Abundance Trends</u>. NMFS (Weitkamp *et al.* 1995) noted that while coho salmon within the Puget Sound ESU were abundant and, with some exceptions, run sizes and natural spawning escapements generally stable, there are substantial risks to whatever native production remains. The Puget Sound Coho ESU remains a candidate species for listing under the federal Endangered Species Act.

In summarizing assessments of Puget Sound coho salmon population status from four reviews, Weitkamp et al. (1995) aggregated populations into 15 watersheds and reported considerable variability in the status of populations from individual tributaries within these watersheds; in many cases, status ranged from healthy to depressed (Table 3.3-5).

Table 3.3-5. Summary of assessments of population status of Puget Sound coho salmon.

Population		WDF et al. 1993		
	Nehlsen et al. 1991 [1]	Origin [2]	Prod. Type [3]	Status [4]
North Puget Sound/ Strait of Georgia		N, M, U	W	U
Nooksack River	A+	M	C	U
Samish River		M	C	H
Skagit River		N, U	C	D, U
Stillaguamish River		N, M	W	D, U
Snohomish River		M, X	W, C	H, D
Lake Washington		M	C	H,D
Puyallup River		M	C	H, D
Nisqually River		M	C	H
South Puget Sound minor drainages	A (Chambers Creek)	M, X	W, C	
Hood Canal		M	W, C	H, D
Strait of Juan de Fuca minor drainages	A (Lyre River)	M	C	D
Dungeness River		M	C	D
Elwha River	A	M	C	H

Source: Weitkamp et al. 1995.
[1] A+ possibly extinct; A high risk; B moderate risk; C special concern; X extinct.
[2] N–native; M–mixed; X–non-native; U–unknown. [3] W–wild; C–composite.
[4] H–healthy; D–depressed; C–critical; U–unknown.

The co-managers group Puget Sound coho populations into six management units and further divide these into wild and hatchery components. From 1991 through 2000, the annual run size of Puget-Sound coho populations entering Puget Sound was 669,000, of which 44 percent was naturally spawning. The management units, and the portion of the wild coho run for which they account, are: Hood Canal (11%), Nooksack-Samish (6%), Strait of Juan de Fuca (2%), Skagit (8%), Southern Puget Sound (35%) and Stillaguamish-Snohomish (37%) (Table 3.3-6) (Pacific Fisheries~~y~~ Management Council, Ocean Salmon Fisheries review, 2001).

Table 3.3-6. Summary of run size and escapement trends for Puget Sound wild coho population groups, 1981 through 2000.

Population Group	Wild Run (000s)	Hatchery Run (000s)	Wild Escapement Trend (1981 through 2000)	Wild Run Size Entering Puget Sound
Hood Canal	902	893	Marked Increase	Slight Increase
Nooksack-Samish	473	2301	Slight Increase	Marked Decrease
Strait of Juan de Fuca	166	289	Steep Increase	Slight Increase
Skagit River	660	374	Marked Increase	Slight Increase
South Puget Sound	2866	7156	Marked Decrease	Steep Decrease
Stillaguamish-Snohomish	3027	1146	Slight Increase	Substantial Decrease
Combined Wild Populations	8093	1146	Moderate Increase	Marked Decrease

Source: Based on data from Pacific Fisheries Management Council Ocean Salmon Review for 2000, Table B-41.

An analysis of trends in run size and escapement for the wild-spawning components of the six Puget Sound coho management units shows increases in escapement have come about primarily from a reduction in Puget Sound fisheries, allowing more fish to reach spawning grounds even though total run sizes entering Puget Sound decreased. Natural spawning increased for five of the management units: Hood Canal, Nooksack-Samish, Strait of Juan de Fuca, Skagit, and Stillaguamish-Snohomish, but runs entering Puget Sound showed slight to marked decreases for three of the populations, including the Stillaguamish-Snohomish group and the southern Puget Sound group that together account for 72 percent of the total Puget Sound wild coho run (Table 3.3-6) (Pacific Fishery Management Council Ocean Salmon Review 2001).

Factors Limiting Natural Production

Because Puget Sound coho spend up to 15 months rearing in fresh water before migrating to the ocean, availability of suitable riparian habitat plays a large role in determining the status of this ESU. Of particular concern are: the elimination of off-channel rearing habitat (e.g., slow-moving backwaters, wetlands) due to channel modification; elevated stream temperatures and increased stream velocity due to loss of shade vegetation, large woody debris and channel modification; and blockages to spawning migration caused by culverts and other obstacles. Artificial production has masked the status of natural productivity for many Puget Sound coho populations. High harvest rates, and a recent decline in average size of spawners is also a factor for concern, because of the potential for reduced fecundity and/or productivity (Weitkamp et al. 1995).

Puget Sound Fisheries

About 9 percent of Puget Sound coho salmon are harvested in British Columbia and Alaska fisheries, and 13 percent in ocean fisheries off the U.S. Pacific Coast. Puget Sound sport fisheries account for approximately 30 percent of the catch, freshwater sport fisheries 3 percent, pre-terminal net fisheries 9 percent, and terminal net fisheries 36 percent (*Fishery Resource Assessment Model Coho Impact Summary for 1999* provided by Washington Department of Fish and Wildlife).

Puget Sound coho salmon are caught in directed fisheries, and incidentally in fisheries directed at sockeye and pink salmon. Because the seasonal peak of most coho runs in Puget Sound is later than that of chinook runs, their encounter in chinook-directed fisheries increases from earlier to later in the season. For instance, in the Bellingham Bay chinook-directed fishery, coho comprised less than one percent of catch during the first week of August, 32 percent of the catch by the second week of September, and 92 percent by the first week of October. Similar patterns exist in other fisheries.

Hatchery Production

From 1991 through 2000, approximately 24 million juvenile coho were released into Puget Sound annually. Of these releases, approximately 57 percent were in basins in mid- and southern Puget Sound, 19 percent in the Nooksack-Samish basin, 7 percent each in the Stillaguamish-Snohomish basins, 6 percent in the Strait of Juan de Fuca, and 3 percent in the Skagit basin. Over this period, total releases decreased from about 40 million in 1991 to less than 10 million in 2000 (Pacific States Marine Fisheries Commission, December 2002).[v]

Olympic Peninsula Coho ESU

The Olympic Peninsula Coho ESU contains populations from the Quinault, Queets, Hoh and Quillayute Rivers. Coho from the Olympic Peninsula ESU are rarely encountered in Puget Sound fisheries. According to coded-wire tag data from 1990 through 2000, 87 percent of coho from the Olympic Peninsula ESU are caught in Washington coastal fisheries, 10 percent in British Columbia, and less than 1 percent in Puget Sound fisheries (Pacific States Marine Fisheries Commission, December 2002).

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[v] Data may be incomplete for 2000. Releases in 1999 were about 12 million.

3.3.2.2 Puget Sound Sockeye Salmon (*O. nerka*)

General Life History

In North America, spawning populations of sockeye salmon range from the Columbia River northward to the Bering Sea, Alaska. The Strait of Juan de Fuca is considered to be near the southern limit of the sockeye's range. Sockeye salmon utilize stream systems with lakes, where fry reside from 1 to 3 years before migrating to the ocean. Spawning migrations take place from June through August. Sockeye typically migrate from lakes from March through July, and remain in estuaries for a relatively short time compared to other species. Sockeye spend 1 to 4 years at sea, returning to spawn as Age-3, Age-4, or Age-5 fish.

Population Structure

Washington Department of Fisheries et al. (1993) identified four distinct sockeye salmon populations in Puget Sound. The Baker River (tributary to the Skagit River) contains a native population maintained through a hatchery culture program, and is considered an Evolutionarily Significant Unit (ESU) (Gustafson et al. 1997). Historically, prior to construction of the Baker Dam, the run ascended the Baker River. Currently, sockeye are trapped below the dam and hauled above it to spawn.

Three other populations have been identified in the Lake Washington system, the largest being that returning to the Cedar River. This non-native population originated from fry plants of Skagit River sockeye in the 1930s, and is maintained through wild production, spawning throughout the 21 river miles below the Landsburg Diversion Dam. Returns to the Sammamish Slough and other small Lake Washington tributaries comprise the Bear Creek Provisional ESU, a population genetically dissimilar from the introduced Cedar River populations, and one that may be native to the Lake Washington system. Another distinct and possibly native population spawns on Lake Washington beaches.

Gustafson and Winans (1999) identified groups of river and sea-type spawning sockeye salmon in Puget Sound that are distinct from Puget Sound lake-type sockeye salmon, but did not reach a definitive conclusion regarding population structure. Puget Sound sea-/river-type sockeye were not genetically distinct from other river/sea-type along the Pacific coast. The authors suggested several likely hypotheses for their occurrence: 1) Puget Sound sea-/river-type sockeye are strays from British Columbia populations; 2) Puget Sound sea-/river-type sockeye represent one U.S. population; or 3) Puget Sound sea-/river-type sockeye are part of a larger Pacific west coast population. WDFW is reviewing the population structure and status of Puget Sound sea-/riverine sockeye as part of an update of the Washington Salmon and Steelhead Stock Inventory; the update was not complete at the time of this writing (personal communication with Ann Blakely, WDFW, Fishery Biologist, August 31, 2004).

Therefore, the following discussion concentrates on the sockeye salmon populations that have been identified to-date in Puget Sound.

Status

Baker River ESU. ~~The Baker River sockeye population status is considered critical.~~ The 1990 through 1994 average annual spawning escapement was about 2,700, compared to as many as 20,000 fish near the turn of the century and prior to construction of Baker Dam. Although population abundance has fluctuated considerably, the abundance trend from 1926 through 1995 decreased by approximately 2 percent per year. More recently (1986 through 1995), abundance has increased by approximately 32 percent a year. The escapement in 1994 of 16,000 fish was the highest since construction of Baker Dam. Like many sockeye populations, the Baker River ESU returns fluctuate markedly within a 4-year cycle, with the largest returns occurring regularly in a dominant brood year. The 1994 return and, subsequently, the 1998 return (13,000 fish) occurred in peak years for the run.

Big Bear Creek Provisional ESU. Recent average abundance in this ESU (10,000 to 20,000 spawning escapement) was judged by NMFS (Gustafson *et al.* 1997) to be relatively high, and the ESU is not considered at risk of extinction or likely to become so.

Cedar River Sockeye. Washington Department of Fisheries et al. (1993) classified this population as depressed due to a long-term decline in freshwater survival and escapements. Escapements from 1967 through 1991 ranged from 76,000 to 365,000 annually.

Lake Washington Beach Spawning Populations. Washington Department of Fisheries et al. (1993) classed the Lake Washington beach-spawning sockeye population as depressed due to a long-term negative trend in escapement.

Factors Limiting Natural Production

The primary limiting factor on Baker River sockeye is the near absence of natural spawning habitat. This population is vulnerable to dam passage constraints, water quality problems and associated diseases in its rearing basin. Lake Washington sockeye runs are vulnerable to the effects of human population growth in the area. The hydrology of the Cedar River has been altered by diking throughout the majority of its length below the Landsburg Diversion Dam.

Fishery Impacts in Puget Sound

Baker River Sockeye. Because the migration of the Baker River sockeye run occurs well in advance of the more abundant Fraser River and other more northern sockeye runs, commercial net fisheries, at least in the Strait of Juan de Fuca region, probably have little impact on this run. Relatively small numbers (from less than 40 per week in late August to as many as 1,490 per week in mid-September between 1996 and 2001) of sockeye salmon are taken in the early weeks of the Bellingham Bay and Samish Bay chinook-directed fisheries, but the origin of these fish is unknown (Washington Department of Fish and Wildlife, December 2002). Sockeye salmon are rarely taken in marine sport fisheries in Washington, including those directed at chinook.

Lake Washington Sockeye. Sport and tribal commercial sockeye fisheries in Lake Washington have occurred sporadically in recent years, when run size is expected to exceed the escapement goal of 350,000. The sport fishery in Lake Washington attracts high angler effort when the season does open, and the allowable catch is taken within a few days or weeks. Impacts of marine salmon fisheries on Lake Washington sockeye salmon populations have only recently been estimated by the Fraser Panel Technical Committee. Because the migration of this run occurs well in advance of the more abundant summer- and late-run Fraser River stocks, commercial net fisheries in the Strait of Juan de Fuca have measurable impact on Lake Washington sockeye when they target early Fraser River stocks.

3.3.2.3 Washington Coastal Chinook and Unlisted Columbia River Chinook

Unlisted Columbia River Chinook

There are two unlisted Columbia River chinook ESUs, the mid-Columbia spring-run ESU and the upper-Columbia summer-fall run ESU. Fish from these ESUs are rarely taken in Puget Sound fisheries. Based on coded-wire tag recoveries of upper Columbia summer-fall chinook, approximately 0.2 percent of fishery mortalities occurred in Puget Sound fisheries, mostly in the Marine Catch Area 4B treaty troll fishery and other fisheries in the western Strait of Juan de Fuca. Coded-wire tag recoveries also show that less than 0.1 percent of fishing mortalities on the mid-Columbia River spring ESU occur in Puget Sound.

Coastal Populations

Chinook from the Washington coastal ESU are taken somewhat more frequently in Puget Sound fisheries than Columbia River chinook. Coded-wire tag-data show that approximately 3 percent of fishing mortality on this ESU takes place in Puget Sound fisheries (Pacific States Marine Fisheries Commission, January 2003).

Chinook from the Oregon Coastal Natural Coho ESU are very rarely encountered in the Puget Sound Action Area. For the period 1991 through 2000, recoveries of coded-wire tagged chinook from indicator populations in the Northern Oregon Coastal ESU accounted for less than one-half of one percent of tags recovered from this ESU (Pacific States Marine Fisheries Commission, December 2002).

3.3.2.4 Puget Sound Chum Salmon (Unlisted)

Washington Department of Fisheries et al. (1993) identified 45 fall chum populations in Puget Sound, including nine in the northern area (Canada-Washington border to Stillaguamish), 30 in the southern area (Snohomish watershed south and Hood Canal), and six in the Strait of Juan de Fuca. The status was *unknown* for 13 of these populations and *healthy* for all others.

Total estimated run size for Puget Sound fall chum averaged slightly more than 1.0 million from 1968 through 1999, and just fewer than 1.5 million from 1991 through 1999. During the former period, run sizes have fluctuated from a low of 156,000 to more than 2.4 million fish. The long-term trend has been upward since the late 1960s. Thirty-seven percent of the total run originates in Hood Canal, 33 percent in South Puget Sound, 29 percent in North Puget Sound, and 1 percent in the Strait of Juan de Fuca (Washington Department of Fish and Wildlife, Chum Salmon Web Site).

Chum salmon from Washington appear to migrate northward along the coast along a path closer to shore than coho, chinook or steelhead. Most chum mature at 3 to 5 years of age. A higher proportion of chum from Washington mature at Age 3 than do those from more northerly areas. Because the peak of the mature chum salmon migration in Puget Sound (October-November) occurs later than that for chinook (August-September), chum are infrequently taken in chinook-directed fisheries (approximately 1 chum per 250 chinook between 1996 and 2001). Conversely, chinook are also rarely taken in fisheries targeting chum salmon (1 chinook per 476 chum between 1996 and 2001) (Washington Department of Fish and Wildlife, December 2002).

From 1991 through 2000, an average of more than 5.1 million hatchery chum salmon per year were released into Puget Sound. Of these, approximately 91 percent were fall chum (i.e., generally spawning after mid-October), and 1 percent were winter chum (i.e., generally spawning prior to mid-October) (Pacific States Marine Fisheries Commission, December 2002).

3.3.2.5 Puget Sound Steelhead (*O. mykiss*)

After hatching, steelhead typically spend from 2 to 4 years in their natal stream before migrating to sea. The juvenile steelhead migration usually occurs from April to June. They then spend up to 3 years in salt water prior to spawning. Unlike other species of *Oncorhynchus*, some steelhead populations may spawn more than once. Steelhead typically live from 6 to 8 years.

The Puget Sound Steelhead ESU occupies river basins of the Strait of Juan de Fuca, Puget Sound, and Hood Canal, Washington. Included are river basins as far west as the Elwha River and as far north as the Nooksack River. Puget Sound steelhead generally form a coherent group, distinct from populations elsewhere in Washington.

The majority of steelhead populations in Puget Sound are winter-run, but summer-run steelhead are also present, usually in subbasins of large river systems and above seasonal hydrologic barriers. Winter run (also known as *ocean-type*) steelhead typically spend less time rearing in streams as juveniles than do summer-run (also known as *stream-type*). Most summer-run fish are found in the Skagit, Stillaguamish, and Skykomish River systems. Mature summer-run steelhead enter streams between May and October. Spawning occurs anywhere from December to April of the following year. In the Skagit, Stillaguamish, and Snohomish systems, winter-run steelhead may enter their streams as early as mid-October. In contrast, winter-run steelhead enter rivers and streams in the Lake Washington basin, South Sound, and Hood Canal, beginning in November or December, and the peak of spawning occurs between March and May of the following year (Busby et al. 1996).

Total run size for Puget Sound steelhead in the early 1980s can be calculated from estimates in Light (1987) as approximately 100,000 winter steelhead and 20,000 summer steelhead. Light provided no estimate of hatchery proportions specific to Puget Sound streams, but for Puget Sound and coastal Washington combined, he estimated that 70 percent of steelhead in ocean runs were of hatchery origin. The percentage in escapement to spawning grounds would be substantially lower due to differential harvest and hatchery rack returns.

Washington Department of Fisheries et al. (1993) identified 53 stocks within the Puget Sound Steelhead ESU, of which 31 were considered to be of native origin and predominantly natural production. Their assessment of these 31 stocks was: 11 healthy, 3 depressed, 1 critical, and 16 unknown. Their assessment of the remaining (not native/natural) stocks was 3 healthy, 11 depressed, and 8 unknown.

Recent 5-year average natural escapements for streams with adequate data range from less than 100 to 7,200, with corresponding total run sizes of 550 to 19,800. Total recent run size for major stocks in the Puget Sound Steelhead ESU was more than 45,000, with total natural escapement of about 22,000.

Johnson et al. (1996) concluded that steelhead stocks in the Puget Sound ESU were probably naturally self-sustaining, but noted there was concern about summer steelhead stocks that are typically small, occupy limited habitat, and in most cases are subject to introgression by hatchery fish.

Washington has maintained an extensive hatchery program for steelhead for several decades. From 1990 through 2001, 2.3 million hatchery-reared steelhead smolts were released in Puget Sound, of which 80 percent were winter-run. Thirty-seven percent of these smolts were released in the Stillaguamish and Snohomish basins, 28 percent in mid-Puget Sound streams, 20 percent in the Skagit system, 8 percent in southern Puget Sound streams, 4 percent in the Nooksack River, and 3 percent in Hood Canal (Pacific States Marine Fisheries Commission, December 2002). The hatchery program is intended to augment natural production, and harvest rates on hatchery stocks are typically high (Busby et al. 1996).

Steelhead sport fishing is very popular in Washington. The most recent (1999 to 2000) annual sport steelhead catch in Puget Sound rivers was approximately 11,000 fish. Two river systems, the Snohomish and Stillaguamish, accounted for more than half of this catch (Washington Department of Fish and Wildlife 2002). In the late 1970s, the Washington Department of Wildlife began requiring anglers to release steelhead from naturally-spawning parents.

Tribal fishermen also take steelhead in commercial, ceremonial and subsistence fisheries, primarily with set nets. The tribal steelhead catch within the Puget Sound Action Area averaged approximately 3,600 fish annually from 1991 through 2001 (personal communication with Will Beattie, Conservation Planning Coordinator, Northwest Indian Fisheries Commission, December 2002).

Steelhead are rarely taken in ocean or Puget Sound marine commercial fisheries (NMFS 2000). They are occasionally taken in near-terminal fisheries or in-river fisheries targeting chinook. However, because nearly all (98%) of terminal-area commercial chinook landings occur before October, there is little overlap with migration of winter-run steelhead. Some overlap occurs between summer-run steelhead and chinook in August and September. Tribal landings data show an average of 91 steelhead taken in these two months combined between 1990 and 2001 (Washington Department of Fish and Wildlife commercial fisheries landing data provided by Lee Hoines, Washington Department of Fish and Wildlife 2002). Steelhead may occasionally be taken by anglers targeting chinook salmon in river fisheries.

3.3.2.6 Puget Sound Pink Salmon (*O. gorbuscha*)

Pink salmon mature at the smallest average size of any species of Pacific salmon. Their spawning distribution ranges from Puget Sound to Norton Sound, Alaska, in North America, and from North Korea Anadyr Gulf, Russia, in Asia (Heard 1991 and Mathisen 1994). Between 70 and 80 percent of the Washington pink salmon spawning escapement occurs in North Puget Sound (Washington Department of Fisheries et al. 1993; and Big Eagle & Associates and LGL, Ltd. 1995).

Pink salmon spawn during the late summer and fall in both large and small rivers, and tend to spawn closer to tidewater than other species of Pacific salmon – generally within 30 miles of a river mouth (Heard 1991, Washington Department of Fisheries et al. 1993). Fry migrate downstream primarily in March and April, although migration can extend into May. Puget Sound pink salmon appear to rear in nearshore areas for a few weeks to a few months, then move offshore. Some Puget Sound pink salmon, and possibly some from Hood Canal, spend their entire marine phase in the nearshore environment (Jewell 1966 and Heard 1991).

Because essentially all pink salmon mature at 2 years of age, this species lacks variable age structure. Two broodlines (even- and odd-year) result from generations spawning in alternate years. Twelve odd-year spawning populations have been identified in Washington: four in the Nooksack, Skagit, Stillaguamish, and Snohomish Rivers in North Puget Sound; two in South Puget Sound in the Puyallup and Nisqually Rivers; three in Hood Canal in the Hamma Hamma, Duckabush, and Dosewalips Rivers; and three on the Strait of Juan de Fuca in the upper Dungeness, lower Dungeness, and Elwha Rivers. One even-year population in the Snohomish River has been identified (Hard et al. 1996).

The National Marine Fisheries Service (NMFS) conducted a review of pink salmon ESUs in 1996. Available data suggested the even-year pink salmon population in the Snohomish River had been increasing since 1980. Most populations of Puget Sound odd-year pink salmon appear to be healthy, with overall abundance close to historical levels. The NMFS biological review team did express some concern about populations in the Strait of Juan de Fuca; however, they concluded that neither the Puget Sound even-year ESU nor the Puget Sound odd-year ESU warranted listing under the Endangered Species Act. Because the run timing of pink and chinook salmon in Puget Sound overlap considerably, pink salmon are taken in chinook-directed commercial fisheries. A review of commercial catch data for 1997, 1999 and 2001, showed one pink salmon landed per every 2.4 chinook in areas where there were chinook-directed fisheries, primarily in Marine Catch Areas 7B (Bellingham Bay) and 8D (Tulalip) in September. Salmon anglers may also catch pink salmon while targeting chinook. In fact, when pink salmon presence coincides with chinook presence, pinks are much more frequent in the catch than are chinook. During the peak of the pink salmon run (August-September), approximately one chinook is landed per every 37 pink salmon (Washington Department of Fish and Wildlife, December 2002.)

Relatively small numbers of pink salmon are reared in Puget Sound hatcheries. Approximately 3.0 million pink salmon juveniles were released in each odd-year between 1990 and 2001 (Pacific States Marine Fisheries Commission, December 2002).

3.3.3 Non-Salmonid Fishes (Groundfish)

At least 80 species of groundfish occur in Puget Sound. Most common are flatfishes such as sole and flounders, rockfishes, surf perches, halibut, sculpins, spiny dogfish, lingcod and Pacific cod. In recent history, walleye pollock were also very abundant, but have declined markedly over the past two decades. Flatfish, which include Pacific sandabs, butter sole, Dover sole, sand sole, starry flounder and other species, currently make up the largest part of the catch (46%). Rockfish make up 30 percent of the catch, with most of this occurring on five species: copper, quillback, black, brown, and yellowtail constitute more than 90 percent of the rockfish catch. Surf perches account for approximately 10 percent of the non-salmonid catch, Pacific halibut 2 percent, sculpins 2 percent, spiny dogfish 1 percent, and lingcod 1 percent. Pacific cod, which, like walleye pollock were formerly abundant, are now rarely taken.

Status of Puget Sound Groundfish Populations

An assessment by the Washington Department of Fish and Wildlife classified 55 percent of groundfish stocks in South Puget Sound and 44 percent of stocks in North Puget Sound as being in poor condition (Puget Sound Water Quality Action Team 2002). Pacific cod are in depressed or critical condition in most areas, as are walleye pollock and spiny dogfish in South Puget Sound. Lingcod and halibut stocks in most areas are at or above average levels. The status of rockfish species is considered depressed in both North and South Puget Sound. The status of flatfish stocks varies by area and species from critical to above average.

In response to a petition to list Puget Sound rockfish as threatened under the federal Endangered Species Act (Wright 1999), NMFS conducted a status review of Puget Sound brown, copper and quillback rockfish, and concluded that ESA listing was not warranted.

Trophic Interactions

Groundfish are widely distributed, and are important components of most ecosystems where they occur. Larvae and juveniles of several species, including rockfishes, have significant trophic value in pelagic ecosystems as prey for a variety of fishes, including chinook salmon (Ralston 1990) and coho salmon (Healy 1980). Sub-adults and adults of many groundfish are important top predators and competitors in nearshore benthic ecosystems, some species possibly having keystone roles in structuring biodiversity and promoting energy transfer in these systems.

Incidental Catch of Groundfish Species in Chinook Fisheries

Groundfish species, including rockfish and halibut, are frequently caught by anglers targeting chinook (or other salmon species) in Puget Sound. Based on data collected through creel surveys between 1986 and 1999, Palsson estimated anglers targeting salmon in Puget Sound caught 0.65 groundfish, including 0.05 rockfish per angler trip. Incidental groundfish catch varied by marine catch area from a high of 2.09 per angler trip in Marine Catch Area 5 (Sekiu-Pillar Point), to a low of 0.024 per angler trip in Marine Catch Area 11 (Tacoma-Vashon) (personal communication via e-mail from Wayne Palsson, Washington Department of Fish and Wildlife, December 2002). Groundfish species commonly taken other than rockfish include pollock, dogfish, Pacific cod, lingcod, and ratfish. Halibut are infrequently caught by anglers targeting salmon (personal communication with Greg Bargmann, Washington Department of Fish and Wildlife, January 2003).

Commercial net fishers targeting salmon may inadvertently take groundfish species. However, this is typically disruptive of their salmon fishing, and is therefore avoided to the extent possible. With few exceptions, groundfish catches are not landed and not reported.

3.3.4 Forage Species (Pacific Herring, Sandlance, Smelt)

Forage fish are so-called because they are an important part of the food chain of other fishes (including chinook salmon), seabirds, and mammals. Changes in the abundance of forage fish can have impacts on other species. The base of prey supporting fish-eating species in Puget Sound primarily consists of herring, sandlance, smelt, juvenile hake and juvenile pollock (West 1997). Puget Sound is typical of many marine environments that contain a large number of lower trophic-level species such as plankton; a substantial number of higher trophic-level species such as larger fish, seabirds and mammals; and relatively few intermediate trophic-level species such as small pelagic fish (Washington Department of Fish and Wildlife Forage Fish Management Plan). The Washington Department of Fish and Wildlife has established a *Priority Habitats and Species List* to identify species and habitats of special concern. Pacific herring, surf smelt and Pacific sandlance are included on this list. Washington Administrative Code (WAC) 220-110-250 established *saltwater habitats of special concern* including smelt, herring and sandlance spawning beds. Construction projects may be prohibited or conditioned in these areas during certain times of the year (Washington Administrative Code 220-110-217) (Washington Department of Fish and Wildlife, *Forage Fish Management Plan*). NMFS conducted a Pacific herring status review in response to a petition to list this species. The review team concluded that the *distinct* *population segment* represented by stocks in the Georgia Basin and Puget Sound was not at risk of extinction, nor likely to become so. However, most members expressed concern that they could not entirely rule out the possibility that the Georgia Basin (Puget Sound) population segment at present is likely to become in danger of extinction (Stout et al. 2001).

3.3.5 Fish Habitat Affected by Salmon Fishing

Habitat Types Affected

Fish habitat potentially affected by salmon fishing within the Puget Sound Action Area includes benthic substrate and associated plant and animal communities in marine areas where gillnets, purse seines and beach seines are used, especially in shallower areas or areas of eelgrass beds. Spawning and riparian rearing habitat may be affected by in-river fisheries, by wading fishermen, the wakes of fishing craft, or other mechanical disturbances.

Gear Types with Detectable Habitat Impacts

The most common habitat impact that may result from actively-fished gear would be scouring of the seabed or river bottom by the weighted line at the bottom of gillnets, purse seines and beach seines. While this undoubtedly occurs in many areas, fishermen endeavor to avoid entanglement and abrasion to their fishing gear by minimizing bottom contact. While local effects may be observable, it is unlikely that impacts are detectable on a broad scale.

Derelict Fishing Gear

Fishing gear in all types of salmon fisheries is lost as a result of entanglement with bottom structures, logs and debris, or because of storms, flood events and other occurrences. While lost fishing gear is most commonly associated with marine fisheries, river set-nets are also lost. Salmon, other fishes, seabirds, mammals and other animals may become entangled in derelict nets or entangle in or ingest monofilament fishing line. ~~Gillnets, in particular, pose a problem as the nets~~Lost nets lying on the seabed continue to entangle fish or other species long after they are lost or abandoned. Submerged gillnets typically drift until they become entangled on submerged features or structures where they may impact bottom-dwelling organisms (personal communication via e-mail from Jeffrey June, Natural Resources Consultants, November 2002). Palsson reported recent investigations that suggest the direct and indirect effects of lost fishing gear likely outweigh the negative effects that may occur from contact with bottom habitat or the incidental entanglement of fishes, mammals or birds during actual fisheries (personal communication from Wayne Palsson, Washington Department of Fish and Wildlife, November 2002).

All types of abandoned, lost and discarded fishing gear can present safety, liability, nuisance and environmental impact issues in marine waters. Identification, location and safe removal of derelict fishing gear can reduce these impacts. The Northwest Straits Commission (NWSC) recently teamed with the National Oceanic and Atmospheric Administration (NOAA) to address the issue of derelict fishing gear in north Puget Sound and the Strait of Juan de Fuca. The result of this project is a comprehensive program to safely remove derelict fishing gear from the marine environment in an environmentally-acceptable manner. The Washington Department of Fish and Wildlife has recently published guidelines for derelict fishing gear removal in Washington marine waters based on the NOAA/NWSC project.

In 2004, the Greystone Foundation provided funding to the Northwest Straits Foundation to conduct derelict fishing gear removal in the Strait of Juan de Fuca and the San Juan Islands. Natural Resources Consultants, Inc. was contracted to manage the derelict fishing gear removal project. The removal operations were coordinated with the Washington Department of Fish and Wildlife, Clallam County, San Juan County, tribal governments, and the U.S. Fish and Wildlife Service's Northwest Refuge Program.

This project focused on the removal of derelict nets and crab pots in Port Angeles, Dungeness Bay, Sequim Bay, and off Lopez Island. The removal project was divided into two phases with Phase 1 targeting derelict crab pots detected during a sidescan sonar survey in late June/early July 2003, in Port Angeles, Dungeness Bay and Sequim Bay. Phase 2 operations targeted derelict nets detected in January 2004, by commercial sea urchin and sea cucumber divers off the south end of Lopez Island. Natural Resource Consultants is beginning to remove derelict gear in other Puget Sound areas as well, using the protocols developed with the NWSC (Seattle Times 2004).

A total of 65 crab pots, two crab rings, 1 octopus tire trap, 45 gillnets, and one purse seine net was removed in this project. The total area covered by all of the nets removed was calculated to be 526,000 square feet, or about 12.1 acres. However, this is likely an overestimate of the actual seabed area impacted since in many cases the nets were overlapping one another. The removed nets weighed approximately 5,000 lbs. The derelict gillnets encountered were generally still capable of entanglement and mortality of marine mammals, seabirds, fish and invertebrates, and likely presented a hazard to divers and vessel navigation. In the 46 nets encountered, 23 dead and 2 live but entangled fish (including 2 dead salmonids) were recorded from the recovered nets. Divers reported few, if any, rockfish visible in the areas with nets, contrasting to adjacent areas without nets where a greater number and diversity of fish and invertebrates were observed. These results are too recent (April 5,

2004) for rigorous estimates of cumulative impacts to populations of fish and benthic organisms to be available.

Of the 41 nets removed from the seabed off Lopez Island, 25 (61%) appeared to be gillnets lost relatively recently (within the past several years), evidenced by a general lack of biological growth and the overall condition and strength of the netting material. The other 16 nets appeared much older, were heavily over-grown, and generally appeared to have been submerged for some extended time. Divers reported that 27 of the 41 nets removed (66%) had at least some portion of the net surface in suspension in the water column, either due to entanglement with high-relief rocky substrate or due to drifting free off a pinnacle or reef edge. The other 14 nets were lying relatively flat against the seabed without suspensions.

Of the 41 nets removed, 29 (71%) were removed from high-relief rocky substrate compared with 12 nets (29%) removed from low–relief rock, sand or gravel substrate. Generally, newer nets, with suspension, on high-relief rocky bottom (18 nets met this subjective criteria) were found to have a greater diversity of species (11 species groups) and number of individual animals entangled and killed (45) than older nets, lying prone on low-relief rocky substrate (5 nets with 2 species and 2 animals). However, the sample size and methodology employed did not allow for statistical testing of this observation. Divers reported that most of the derelict nets were blocking access to important habitat features such as reef ledges and spaces under and around boulders.

Hook and Line Angling and Effects of Stream Wading

Anglers frequently lose terminal tackle in river salmon and steelhead fisheries when their weights become stuck or tangled. Because many artificial baits used in these fisheries are buoyant, they float above bottom where they may continue to attract (and hook) fish.

Trampling of spawning redds during stream wading has the potential to cause high mortality of salmonids. Most information on redd disturbance is anecdotal; however, one study observed 46 to 49 percent mortality of alevins with only one or two passes by wading anglers per day. The extent or cumulative effect of this type of damage is not known (Roberts and White 1992).

Studies in Alaska and New Zealand have found that in shallow water where boat use is frequent, developing salmon eggs and alevins in the gravel can suffer high mortalities (Horton 1994; Sutherland and Ogle 1975). Fishery managers sometimes try to ameliorate these potential effects by closing important spawning reaches to boating or wading (Pacific Fisheries Management Council 1999, Appendix A). Ongoing studies on Alaska's Kenai River (where angler trips exceed 300,000 per year) have focused on the impact of boats and shore anglers on key riparian rearing habitat for juvenile chinook. The studies have found a relationship between shore angler use, a decrease in riparian plant diversity, and bank erosion. The same studies have also found an increase in bank erosion in those areas of the river with high power boat use (King 2002).

3.3.6 Marine-Derived Nutrients from Salmon Spawners

Pacific salmon accumulate almost all of their body mass while in the marine environment (Groot and Margolis 1991). When they return to the streams where they were born, to spawn, adult salmon deliver a substantial quantity of marine-derived nutrients to freshwater and terrestrial ecosystems~~,~~. This provides ~~as~~ a direct food source for juvenile ~~or~~ and resident salmonids, aquatic~~and~~ invertebrates, and terrestrial animals, and ~~as~~ their decomposition supplies basic nutrients to the ecosystem (Larkin and Slaney 1996; Gresh et al. 2000; Murota 2002; and Wipfli et al. 1998).

Stream biological communities incorporate salmon-derived nutrients through three primary pathways: 1) animals and other organisms consume plants, insects and other primary producers that directly feed on or derive nutrients from salmon carcasses and eggs; 2) bacteria, algae and other streambed microfauna consume dissolved organic matter released by salmon carcasses; and 3) animals, juvenile fish, insects and other organisms directly consume salmon carcasses, eggs and fry (Cederholm et al. 1999; and Bilby et al. 1998). High flow or predation, and scavenging by birds and mammals (Cederholm et al. 1989; and Ben-David et al. 1998) ~~can~~ deliver salmon-derived nutrients to areas adjacent to and upland from streams in which salmon spawn (Cederholm et al. 2000; Garten 1993; Wilson and Halupka 1995; Helfield and Naiman 2001; Hocking and Reimchen 2002; and Reimchen et al. 2003~~2~~).

Nutrient recycling by salmon is particularly important in nutrient-limited river and lake systems in the Pacific Northwest. Addition of nutrients to freshwater systems~~, in the form of carcasses or inorganic fertilizer,~~ can influence biological community structure and increase stream productivity at several levels of the freshwater food chain (Kline et al. 1990; Piorkowski 1995; ~~and~~ Quamme and Slaney 2002; Stockner 2003). Addition of nitrogen and phosphorous during lake enrichment programs has elevated primary production and increased rearing capacity, for juvenile sockeye salmon in lake systems (Hyatt and Stockner 1985; Johnston et al. 1990; Kyle et al. 1997; and Bradford et al. 2000). In river systems, biological benefits of nutrient recycling may also include increased growth and density of juvenile salmonid populations (Johnston et al. 1990; Bradford et al. 2000; and Ward and Slaney 2002). In turn, increased fish size may result in higher survival of juvenile coho salmon (Bell 2001; Brakensiek 2002; Hartman and Scrivener 1990; Johnston et al. 1990; Quinn and Peterson 1996; and Holtby 1988) and steelhead (Ward and Slaney 1988; Hager and Noble 1976; and Bilton et al. 1982). Preliminary results of research being conducted in Idaho on stream-type chinook suggest that carrying capacity is better correlated to nutrient loading from the parent generation than to physical measures of habitat (Achord et al. 2003).

The response observed in Keogh River, British Columbia, experiments (Slaney et al. 2003; Ward et al. 2003; Wilson 2003), and Snow/Salmon Creek chum/coho interactions show that modest increases in nutrient levels exert a strong influence on the production of some species of stream-rearing anadromous salmonids.

Emergent chinook fry may feed directly on the carcasses of late-spawning chum and steelhead, but the benefits of marine-derived nutrients for juvenile chinook salmon may be more fully realized in estuaries (Simenstad 1997), where most chinook rear for a critical period prior to migrating seaward. However, little is currently known about the roles of marine-derived nutrients in estuaries. In some instances, the eutrophication of estuaries associated with surface water runoff is negatively affecting fish habitat and survival. The influence of additional marine-derived nutrients on these systems is uncertain.

Each watershed needs to be examined to determine the temporal and spatial aspects of spawner and juvenile fish distribution. The same can be said for the direct benefits spawning salmon provide to birds and terrestrial mammals. All of these factors must be evaluated in order to understand likely pathways of consumption. It is also necessary to understand the mechanisms of nutrient storage and release, as well as other biotic and physical factors that affect survival. Storage within the epilithic layer, storage within plants that access hyporheic zone nutrients, and other sites of nutrient storage and release must be understood in order to maintain ecosystem health. High stream flow during the incubation period is significantly correlated with egg-to-smolt survival in the Skagit River and Cedar River (Seiler et al 1999). Also, degraded stream and estuarine rearing habitat reduces smolt survival in many Puget Sound systems (Stillaguamish Technical Advisory Group 2000; WDFW and Puyallup Tribe 2000).

Salmon carcasses and eggs have been shown to be an important food source for sockeye salmon, steelhead trout, cutthroat trout and coho salmon; and appear to benefit stream-resident chinook (Bilby et al. 1996; Gustafson and Winans 1999; Helfield and Naiman 2001; Kline et al. 1990; Michael 2004; Piorkowski 1995; and Winter et al. 2000); and may play a critical role when other food items are less available. Bull trout are known to be significant predators of salmon carcasses and eggs in many Puget Sound streams. It has also been shown that terrestrial mammals and birds, such as bears (Hildebrand et al. 1999) and bald eagles, receive direct benefits from salmon carcasses (Cederholm et al. 1989). More than 138 species have been documented as having a direct or indirect dependence on spawning salmon or gametes (Cederholm et al. 2000).

Direct consumption of salmon carcasses and nutrient contribution is dependent on their retention time in streams, and so may vary annually due to the intensity of water flow, the size of river systems, type of habitat, amount of large-woody debris in the river, and the species of salmon (Cederholm and Peterson 1985; Cederholm et al. 1989; Glock et al. 1980; and Michael 1995).

Spatial and temporal variations in presence of carcasses also affect their level of benefit to other species. Benefits to juvenile steelhead and coho documented by Bilby et al. (1998) were provided by spawning coho in headwater streams. These benefits would not be delivered by lower-river spawning pink, chum, or chinook. However, stream-type chinook[vi], as more headwater oriented spawners, could play a role similar to coho spawners in the delivery of nutrients to upstream areas. On the other hand, benefits provided by ocean-type spawning chinook could also be provided by pink salmon, since the two species spawn at essentially the same time in many of the same areas.

Further, a run of fish that spawns after bears enter hibernation, or do not reach the area where bears live, would not contribute to bear diet regardless of carcass abundance. Similarly, wintering bald eagles, which typically arrive in November, would not make use of carcasses available in September.

~~Salmon carcasses and eggs are also an important food source for freshwater salmon and trout communities (Bilby et al. 1996; Helfield and Naiman 2001; Kline et al. 1990; Piorkowski 1995; and Winter et al. 2000), and may play a critical role when other food items are less available. A study by Cederholm et al. (1989) also revealed significant predation on salmon carcasses by mammals and birds. Cederholm et al. (2000) also documented more than 138 species having a strong positive life-history relationship to Pacific salmon.~~

~~However, results of these studies do not universally indicate the degree of importance or pathways of marine-derived nutrients~~The degree of importance of marine-derived nutrients across different freshwater systems ~~. These are dependent~~depends on the characteristics of the freshwater river systems themselves. For example, Bilby et al. (1996) stress the importance of chemical absorption of nutrients in headwater streams in the Pacific Northwest, typically preferred for spawning by adult coho salmon (Sandercock 1991), where primary production is limited during winter due to cold temperatures, low light levels, and frequent scouring by high flow events. On the other hand, Piorkowski (1995) found that although salmon carcasses and eggs were an important food source for salmon and trout juveniles, consumption by plants, insects and other primary producers was insignificant. He attributed the differences between his findings and others to 1) the size of the stream relative to the size of the salmon

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[vi] The majority of Puget Sound chinook salmon are ocean-type chinook, migrating to marine water soon after emergence.

run; and 2) the intensity of precipitation that flushed nutrients from the system. Therefore, although research to-date provides evidence of the role of salmon-derived nutrients in ecosystem function, this complex relationship remains poorly understood.

Research on salmon and marine-derived nutrients frequently implies that current harvest management strategies risk further decline or prevent recovery of salmon populations (Michael 1995 and 1998). Specifically, this research implies that spawning escapements realized under current harvest objectives are inadequate to provide the nutrient input necessary for ecosystem function. Many studies assert that declining salmon abundance and escapement currently exacerbate nutrient limitation in many systems. Gresh et al. (2000) estimated that the current contribution of marine-derived nutrients from adult Pacific salmon to rivers in the Pacific Northwest is as low as 6 to 7 percent of historic levels, and that the resulting nutrient deficit could be exacerbating continued declines in salmon abundance or impeding recovery.

In many river systems throughout the Pacific Northwest, returns of chum and pink salmon comprise the majority of spawner biomass. These species typically spawn in the lower portion of stream and river systems, implying that chum and pink salmon contribute substantial inputs of marine-derived nutrients to environments used by ocean-type juvenile chinook salmon. However, analyses of the Skagit system have not demonstrated a causal relationship between the spawning escapement of pink, chum, or coho salmon, and the size or abundance of coho or chinook salmon smolts (R. Hayman 1999). The strong influence of incubation period flow on chinook smolt production (Seiler et al. 2003) indicates a limiting effect on egg or alevin survival, so their current productivity may not be nutrient-limited.

Harvest management planning objectives, and the implementation of annual fishing regimes, are principal determinants of the levels of natural spawning escapement achieved for all salmon species, and therefore influence nutrient loading in each system. However, chinook harvest management plans only directly affect chinook escapement (not total population size or productivity), which even under zero harvest is unlikely to provide more than 5 percent of the carcass nutrient loading when the contribution of other salmon species is taken into account. Furthermore, with the huge increase in spawning escapements of pink and chum in recent years, Puget Sound presents opportunities for *in situ* observations of the effects of marine-derived nutrients on overall salmonid productivity. These situations merit close monitoring to determine whether relationships can be quantified.~~research has not advanced to the point of quantifying threshold nutrient loading levels associated with adult salmon necessary to support ecosystem function and optimize the survival of post-emergent juvenile salmon.~~

Mesocosm studies by Wipfli et al. (2003) showed a stream-rock-insect-fish system was capable of absorbing at least 1.9 kg/m² (4.2 lbs/1.2 yd^2) of carcass biomass, with resultant increases in fish growth. Bilby et al. (2001) found that the ability of coho juveniles to capture nitrogen delivered by spawning coho increased with increasing coho carcass abundance up to an asymptote of about 0.004 pounds per square foot, above which marine nutrients in juvenile coho salmon rapidly approached a saturation level. For a small stream (approximately 15 feet wide), this would translate into about 190 4-kg coho per linear kilometer of stream (approximately 300 fish in a mile of the same stream). Based upon spawner escapement data and research findings, the authors concluded that the majority of coho salmon spawning streams in western Washington are well below capacity for incorporating nutrients delivered by spawning coho into juvenile coho rearing in that stream. Fertilization experiments carried out on the Keogh River loaded the system, in years when pinks spawned and fertilizer was added, with the equivalent of about 0.63-kg/m^2 of carcasses (1.4 pounds/1.2 yd^2). These values can serve as benchmarks against which current biomass loadings can be compared.

From a purely scientific perspective, however, there are limitations to wide application of results from this work (many of which the researchers acknowledge). First, study sites were purposely chosen to meet the purposes of each study. For example, Bilby et al. (1996) only include areas with spawning coho salmon and returns of no other anadromous salmonid species. This implies that results may only be applicable in such areas, and raises questions whether marine nutrient dynamics would be similar in systems with returning runs of multiple salmon species. The temporal distribution of spawning by numerous species of salmon can mean prolonged input of marine-derived nutrients, which may be more effectively incorporated within a system (due to nutrient flushing) at a lower density of spawners for a given species.

Second, juvenile coho salmon alone are probably not an appropriate indicator for determining whether productivity in a system is nutrient-limited (Simberloff 1998). Salmon-derived nutrients found in juvenile coho salmon have been primarily attributed to direct consumption of salmon carcasses and eggs. If this is indeed the primary mechanism for nutrient uptake, then juvenile coho salmon are less revealing of other pathways for incorporation and trophic distribution of marine-derived nutrients within a system.

Third, uncertainty remains as to whether increasing the input of salmon-derived nutrients to river systems will subsequently result in higher returns of adult salmon.

Overall, the role of salmon-derived nutrients in ecosystem function is~~Nutrient dynamics in aquatic systems are~~ complex (Northcote 1988; Polis et al. 1997; Bisson and Bilby 1998; Murphy 1998; and

Naiman et al. 2000), and depend on numerous site-specific factors including the species of salmon, spawning density and location, stream discharge regimes, stream habitat complexity, basin geology, light, temperature and community structure. In particular, the role of adult chinook in this regard must be examined in the context of 1) the limitations of current research, and 2) chinook life history and abundance (i.e., escapement) relative to the much higher escapement of coho, pink, and chum salmon in the large river systems that support chinook populations. At the time of this writing, there is no published research that quantifies the relationship between marine-derived nutrients and the productivity of ocean-type chinook salmon, the primary life-history type for Puget Sound chinook. Ocean-type chinook exhibit relatively short freshwater residence compared to coho, sockeye and steelhead salmon. The latter species are the focus of most marine-derived nutrients studies. It is not known whether newly-emerged chinook salmon fry actively feed on chum and steelhead salmon carcasses and eggs, or if carcasses of other species are retained for a sufficient period of time to enable their direct consumption, especially in large river systems with peak winter flow events, although it is possible.

The relative contribution by adult returns of all salmon species must be evaluated in terms of benefits to salmon and other animal populations, as well as to overall ecosystem function. For direct application in salmon harvest management, it is important to consider the temporal and spatial distribution of salmon spawners, as well as other physical, biological and environmental variables, on a stream-specific basis in order to determine the optimal density of carcasses by species. Recent high escapements of pink, coho and chum salmon afford managers and researchers abundant opportunities to pursue these investigations.

~~While it appears that salmon-derived nutrients can benefit sockeye salmon, cutthroat trout and coho salmon populations, at this time there are no research publications that directly establish the relationship between marine-derived nutrients and chinook salmon. Chinook populations in Puget Sound primarily exhibit an ocean-type life history, with relatively short freshwater residence compared to coho, sockeye and steelhead salmon. The latter species are the focus of most marine-derived nutrients studies. It is not known whether newly-emerged chinook salmon fry actively feed on salmon carcasses and eggs, or if carcasses are retained for a sufficient period of time to allow direct consumption, especially in large river systems with peak winter flow events.~~

~~Bilby et al. (2001) found that enrichment levels increased with increasing coho carcass abundance. However, the relationship also revealed a point of diminishing enrichment above carcass abundance levels of 0.004 pounds per square foot (approximately 310 fish per square mile), above which marine~~

~~nutrients in juvenile coho salmon rapidly approached a saturation level. Based upon spawner escapement data and research findings, the authors concluded that the majority of coho salmon spawning in western Washington streams are well below capacity for incorporating more marine-derived nutrients. From a purely scientific perspective, however, there are limitations to wide application of results from this work (many of which the researchers acknowledge). First, study sites were purposely chosen to only include areas with spawning coho salmon and returns of no other anadromous salmonid species. This implies that results may only be applicable in such areas, and questions whether marine nutrient dynamics would be similar in systems with returning runs of multiple salmon species. The temporal distribution of spawning by numerous species of salmon can mean prolonged input of marine-derived nutrients, which may be more effectively incorporated within a system (due to nutrient flushing) at a lower density of spawners for a given species. Second, juvenile coho salmon alone are probably not an appropriate indicator for determining whether productivity in a system is nutrient-limited (Simberloff 1998). The nutrients attributable to salmon carcass deposition found in juvenile coho salmon has been primarily attributed to direct consumption of salmon carcasses and eggs. If this is indeed the primary mechanism for nutrient uptake, then juvenile coho salmon are less revealing of other pathways for incorporation and trophic distribution of marine-derived nutrients within a system. Third, uncertainty remains as to whether increasing the input of salmon-derived nutrients to river systems will subsequently result in higher returns of adult salmon.~~

~~While it appears that salmon-derived nutrients can benefit sockeye salmon, cutthroat trout and coho salmon populations, at this time there are no research publications that directly establish the relationship between marine-derived nutrients and chinook salmon. Chinook populations in Puget Sound primarily exhibit an ocean-type life history, with relatively short freshwater residence compared to coho, sockeye and steelhead salmon. The latter species are the focus of most marine-derived nutrients studies. It is not known whether newly-emerged chinook salmon fry actively feed on salmon carcasses and eggs, or if carcasses are retained for a sufficient period of time to allow direct consumption, especially in large river systems with peak winter flow events. Freshwater survival, through the egg-to-smolt phases, is undoubtedly constrained by other biotic and physical factors. For example, high streamflow during the incubation period is significantly correlated with egg-to-smolt survival in the Skagit River and Cedar River (Seiler et al 1999). Degraded stream and estuarine rearing habitat reduces smolt survival in many Puget Sound systems (Stillaguamish Technical Advisory Group 2000; WDFW and Puyallup Tribe 2000). The benefits of marine-derived nutrients for juvenile chinook salmon may be more fully realized in estuaries (Simenstad 1997), where most chinook rear for a critical period prior to migrating seaward. However, little is currently known about the roles of marine-~~

~~derived nutrients in estuaries. In addition, in some instances the eutrophication of estuaries associated with agricultural and urban runoff may be negatively affecting fish habitat and survival.~~

~~Finally, in many river systems throughout the Pacific Northwest, returns of chum and pink salmon comprise the majority of spawner biomass. These species typically spawn in the lower portion of stream and river systems. This implies that chum and pink salmon contribute substantial inputs of marine-derived nutrients to environments used by ocean-type juvenile chinook salmon. Whether survival of juvenile chinook salmon is limited by nutrient deficiencies needs to be evaluated in a multi-species context. Furthermore, the relative contribution by adult returns of different salmon species to both ecosystem function and salmon populations with unique life-history strategies needs to be more fully recognized. Consequently, it has not been demonstrated that carcass nutrient limitation, as it may affect secondary production of prey species or direct enhancement of food supply, currently exerts a significant limitation on the productivity of chinook or other salmon species in Puget Sound systems.~~

3.3.7 Selectivity on Biological Characteristics of Salmon

The transfer from parents to offspring (*inheritance*) of certain biological traits such as age at maturity, growth rate, and the effect of these traits on each other has been extensively researched and documented (Clark and Blackbird 1994; Donaldson and Menasveta 1961; Hankin 1993; Hankin et al. 1993; Hard et al. 1985; Heath et al. 1994a; and Silverstein et al. 1998). Under certain circumstances, fishing may influence the biological traits of salmon that return to spawn, and thus the traits that are conveyed to their offspring. The potential long-term effects of selective fishing may be two-fold. First, possible reductions in the long-term yield of the fishery (Ricker 1976) and smaller fish size could erode the economic viability of the fishery. In other words, fishermen would have to increase catch to maintain the same level of income (assuming other economic factors remain relatively stable). Researchers have found that total yields in mixed-stock ocean fisheries may be considerably less than those that could be achieved if populations could be managed and harvested separately (Ricker 1958; Henry 1972; Ricker 1976; and Hilborn 1985). Second, selective fishing may affect the diversity of size, age and sex ratio in the salmon escapement. Diversity in biological traits is necessary if populations are to respond successfully to changing environmental conditions. For example, numerous studies have emphasized the possible importance of large size in naturally-spawning populations of chinook salmon for mate choice and reproductive success (Baxter 1991; Berejikian et al. 2000; Healey 2001; Healey and Heard 1984; and Silverstein and Hershberger 1992). Since the second issue is the basis for the first, it is the focus of this discussion.

Selective fishing is defined in this subsection, and the potential consequences of selective fishing are explored. Generally, a fishery is characterized as *selective* whenever fish with particular characteristics are caught more frequently than they occur in the population at large. Salmon fisheries may be size- or age- selective within stocks, stock-selective, or species-selective.[vii]

[vii] Indirect sex-selectivity may result due to different size distributions and age structures between male and female chinook. In general, males mature at a younger average age than females (Groot and Margolis 1991).

Size-Selective Fisheries

Size-selective fisheries catch fish within a certain size range at a greater rate than smaller or larger fish. For example, ocean commercial and recreational fisheries typically have minimum size limits, thereby potentially generating greater exploitation rates on larger and older fish than on younger and smaller fish. Terminal gillnet fisheries may select for fish that are within an intermediate size range because the size of the net mesh is set to target the size range that characterizes the runs or general size of the target species. Often, such terminal gillnet fisheries represent *age-selective* fishing because fish of a certain age generally fall within a certain size range. For example, in California's Klamath River, the gillnet fishery uses mesh size that predominantly catches Age-4 fish; most Age-3 and Age-2 fish pass through the nets, whereas many Age-5 fish are too large to be caught by gillnets.

The "theory of a fishery," as first advanced by Baranov (1918; see Ricker 1978), proposes that the direct cumulative effect of removing larger and older fish may be to shift the distribution of a reproducing fish population toward smaller, younger (Hankin and Healey 1986) and slower-growing fish. For example, in ocean fisheries for chinook salmon, minimum commercial size limits typically mean that only a fraction of the Age-3 adults from a given stock are vulnerable to commercial capture. If those Age-3 fish that are above the legal size limit were genetically programmed *fast-growing* fish, then one might conclude that selective fisheries would be generating long-term selection for reduced growth rates.

Possible fishery-induced selection for reduced growth rates may be complicated, however, by several factors in chinook salmon fisheries. First, the actual size that a salmon reaches at a particular age may not be highly correlated with a genetically determined *growth rate* for several reasons. The realized size of a fish at a given age must reflect unknown interactions between inherent growth rate, variability in supply and quality of food, and variability in environment (especially water temperature). Because of this variability, actual size at age may not, in general, be highly correlated with the underlying genetically controlled growth rate.

Second, long-term genetic selection due to size-selective fisheries may be stronger for reduced age at maturity than for growth rate[viii]. If age at maturity has a heritable component, older-aged parents will tend to produce progeny that mature at older ages, whereas younger-aged parents will produce progeny that mature at younger ages. Therefore, if younger-aged salmon spawned randomly on the spawning grounds, then size-selective fisheries for larger, older chinook might select for earlier age at maturity.

[viii] If the heritable component for age is larger than the heritable component for growth rate.

Third, for chinook salmon, there is substantial evidence that age at maturity depends in part on size at age (see Hankin et al. 1993 and references therein). For a fixed age, say Age-2, fish that are smaller are less likely to mature at that age than are fish that are larger.[ix] Through this interaction between size at age and maturity, removal of fish that are larger at age might instead select for fish that mature at later ages,[x] counteracting the effects described in the previous paragraph. This effect probably becomes less pronounced at older ages.

Finally, spawning behavior of naturally-spawning chinook salmon may, to some extent, alleviate the kind of long-term genetic shift toward younger age at maturity that might be expected to result from size-selective fisheries. Baxter (1991) found that larger and older chinook salmon, especially males, had greater reproductive success on spawning grounds than younger and smaller males. (also argued by Healey 1986). Thus, even if size-selective fisheries generated substantial shifts toward younger spawners, the greater reproductive success of larger and older males might at least partially buffer against such fishery-induced shifts to younger ages. In summary, a long-term shift to younger spawners may result 1) *if* chinook salmon mate randomly, without regard to age, on spawning grounds, and 2) *if* age at maturity is independent of growth rate. However, 3) larger and older male chinook salmon (and possibly females) generally have greater mating success than smaller and younger male chinook salmon (and possibly females); 4) fast-growing chinook salmon tend to mature at younger ages than slow-growing chinook salmon, but are likely to be selected *against* in size-selective ocean fisheries; and 5) size at age may have only a weak correlation with some inherent genetically inherited *growth rate*. Together, items 3) through 5) may counteract the kinds of long-term genetic effects that one might expect if items 1) and 2) were valid.

Hard (2004) used age-structured quantitative genetic models to assess the possible long-term evolutionary effects of size-selective fishing on chinook salmon. Based on genetic data from one Puget Sound population, Hard concluded that under most conditions, directional selection imposed by size-selective fishing is likely to produce, at most, modest short-term reductions in size, but the effects depend critically on the harvest rate, harvest size threshold, the strength of stabilizing natural selection on size, and most likely the age structure and heritability of each trait, as well. He also found that the capacity of size-selective fishing to reduce size depends on correlations among size, age and growth rate.

[ix] This may be less true at older ages.

[x] However, this will depend on the relationship between growth rate and age at maturity.

Stock-Selective fisheries

Stock-selective fisheries harvest some populations at different rates than other populations. They may occur in two ways. In marine waters, a large number of salmon populations originating from different river basins may be vulnerable to fishing at similar times and locations, and may therefore experience similar marine exploitation rates. This phenomenon is commonly referred to as the *mixed-stock harvest problem* (see, for example, Bevan 1987). To avoid overexploiting vulnerable populations, harvest policies would instead call for application of stock-specific exploitation rates that depend on the underlying stock productivity, which varies among salmon stocks. Fisheries are deliberately structured to be stock-selective by shaping the time, location or physical attributes of fish that may be caught.

Stock-selective fisheries may also take place in fresh water as a consequence of regulations. For example, in a large river system with a large number of distinct chinook salmon stocks, each with its own distinct river entry pattern, open and closed periods for fisheries may result in differential exploitation rates being applied to different stocks. If harvest is not allowed until a substantial number of fish have escaped to spawn, then it seems inevitable that exploitation rates are lower for those stocks that enter earlier as compared to those stocks that enter when fisheries are open. In that case, the fishery-related mortality rate would be much lower for fish in the early part of the run than for fish in the late part of the run. Because run timing is thought to be an inherited trait, such fishery harvest policy may, in the long term, unintentionally select for early-returning fish (see Nicholas and Hankin 1988 for examples of this phenomenon in a hatchery setting).

Other examples of stock-selective fisheries for salmon are those that call for the release of all fish caught without an identifying mark (e.g., intact adipose fins), while a certain number (specified by bag or possession limits) of fish with marks may be retained. These policies are deliberately designed to produce, at least in theory, greater exploitation rates for hatchery fish (marked) than for wild fish (unmarked).

Species-Selective Fisheries

Finally, fisheries may also be species-selective as, for example, results when chinook salmon must be released if caught, whereas coho salmon may be retained. Harvest managers have implemented stock- and species-selective fisheries in Puget Sound. There are currently recreational mark-selective fisheries for chinook salmon in the Strait of Juan de Fuca and limited areas of the Snohomish River .

Selective Effects of Fishing in Puget Sound

Although the potential consequences of size-selective fishing have been recognized, the ability of fisheries managers to address the potential long-term consequences is limited. In part, this is because much of the evidence for selective effects of fishing (e.g., change in the size or age composition of catch or spawners) is circumstantial, and is confounded by other factors such as data quality and several ecological variables, including marine productivity, density-dependent growth and mate choice on the spawning grounds (Heath et al. 1999; Ricker 1972; Riddell 1986; Ricker 1995; and Hard 2004). For example, Bigler et al. (1996) found a decreasing average body size in 45 of 47 salmon populations in the Northern Pacific. They found that body size was inversely related to population abundance, and speculated that enhancement programs during the 1980s and 1990s increased population sizes but reduced growth rates due to competition for food in the ocean. Clearly, these kinds of causes could result in the same kinds of reductions in size at age as might be caused by long-term fishery selection against fast-growing fish.

In addition, the magnitude of selective effects will vary depending on the intensity of selective-fishing on a particular salmon population, the period of time over which those effects are encountered, and the biological characteristics of the population itself (Heath et al. 1994b; and Hard 2004). Hard (2004) predicted that, in general, reducing the exploitation rate reduces the selection intensity, and that changes in life history traits under most of the harvest scenarios he examined were modest, at best, over a few generations. His study of chinook salmon returning to the Grover's Creek Hatchery in Puget Sound predicted that ~~effects~~ fishing is likely to reduce ~~on~~ age, weight, growth rate, and lead to earlier spawn timing ~~are likely to increase~~ under higher exploitation rates and intensity of natural selection. Under selective conditions most likely to exist, expected effects on these traits over 25 years were low to undetectable below exploitation rates of 40 percent. The greatest expected effects were on length at age and mean weight, which declined by 0.12 to 0.28 of an inch and less than 7 ounces, respectively, over this period.[xi]

Information on the effects of fishery selectivity on Puget Sound chinook salmon is very limited. The National Marine Fisheries Service (NMFS) found a decline in the size of Puget Sound coho spawners since the 1970s, and noted it as a risk factor (Weitkamp et al. 1995). However, in its review of west coast chinook salmon populations (Myers et al. 1998), NMFS did not note any trends in recent decades for size, weight, or age for Puget Sound chinook salmon that might be the result of fishing activities.

The lack of an observed selective-fishing effect may be the result of the way Puget Sound fisheries are structured. Puget Sound salmon fisheries, including those harvesting chinook salmon, are managed for

[xi] These effects assumed harvest rates between 50 and 70 percent and strong stabilizing natural selection on size. One should be cautious in applying these results widely since the study was limited to a single, hatchery population and effects of selection will depend on the characteristics of the individual population. However, it does provide some basis for comparison.

stock-specific exploitation rates that depend on the underlying productivity of each population. In other words, fisheries are managed to protect the less abundant, or weaker, populations. Such an approach is commonly referred to as *weak stock management*, and often results in foregoing catch on abundant populations in order to protect less abundant populations. In most areas, Puget Sound chinook salmon harvest generally occurs throughout their run timing. In a few areas, harvest may be focused on the early or late part of the chinook salmon run in order to protect the majority of the population while allowing some harvest on other salmon species that occur earlier or later in timing. However, this would generally affect 10 percent or less of the population on either end of its run timing, depending on the specifics of the annual fishing regime.

With regard to the potential age-selectivity of gear types, Puget Sound gillnet fisheries do not appear to be any more age-selective for chinook than gear types like purse seines that use small mesh and are thus considered to be relatively non-selective (Table 3.3.7-1 and Figure 3.3.7-1). Ricker (1980, 1981, 1995) documented a decline in the average weight of Puget Sound chinook salmon caught between the 1950s and 1970s, which stabilized at a lower level in the 1980s. However, his analysis was not population specific and was conducted on mixed-stock fishery data which included populations returning both to Canada and Puget Sound. Based on the Puget Sound population-specific data that are available, there are no trends in age structure observed in Puget Sound chinook salmon escapement over the last 24 to 30 years (including the period observed by Ricker) that one might expect if there were fishing-down effects[xii] (Figure 3.3.7-2). In addition, the mean age of escapement differs from that in the catch by only 0.3 year (15 to 16 weeks) over the same period.

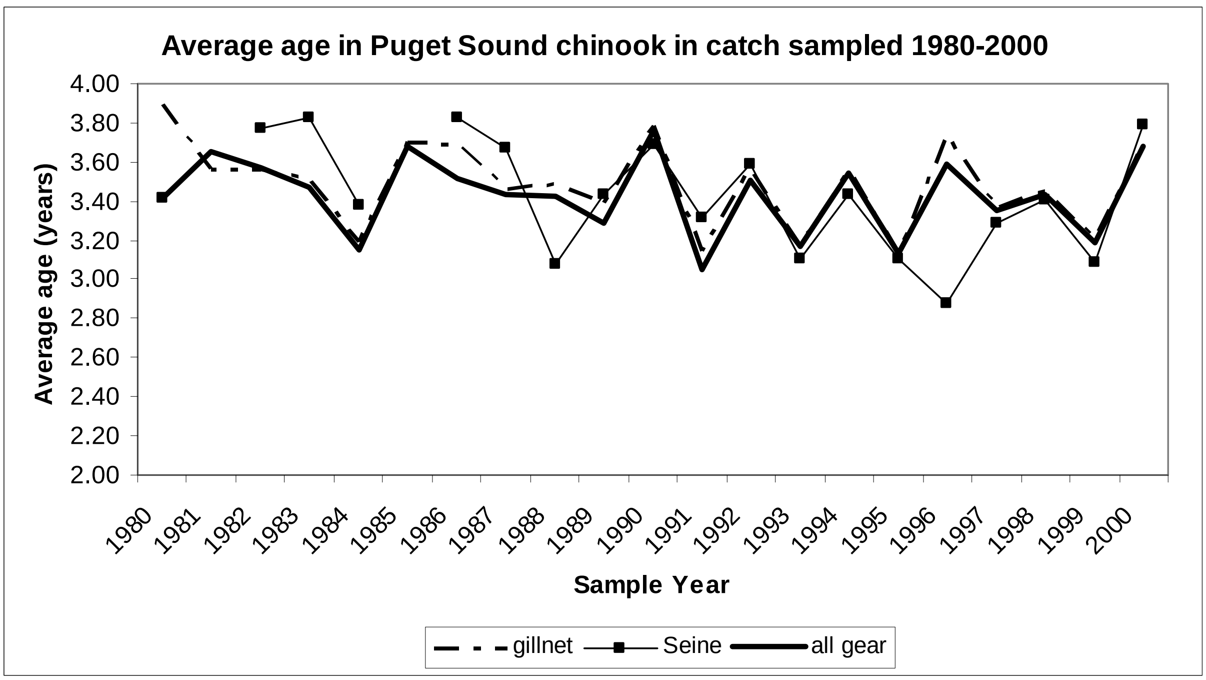
[xii] Although it is possible that shifts in age structure caused by fishing activities occurred before the time period for which these are data, any trends from that time do not appear to have continued.

Table 3.3.7-1. Average age composition of the Puget Sound chinook salmon catch by gear type.

Gear Type	Age composition of Puget Sound chinook salmon catch (1980–2000)			
	Age-2	Age-3	Age-4	Age-5
Gillnet	3%	34%	59%	5%
Purse seine	7%	37%	54%	4%
All gear types	3%	35%	56%	6%

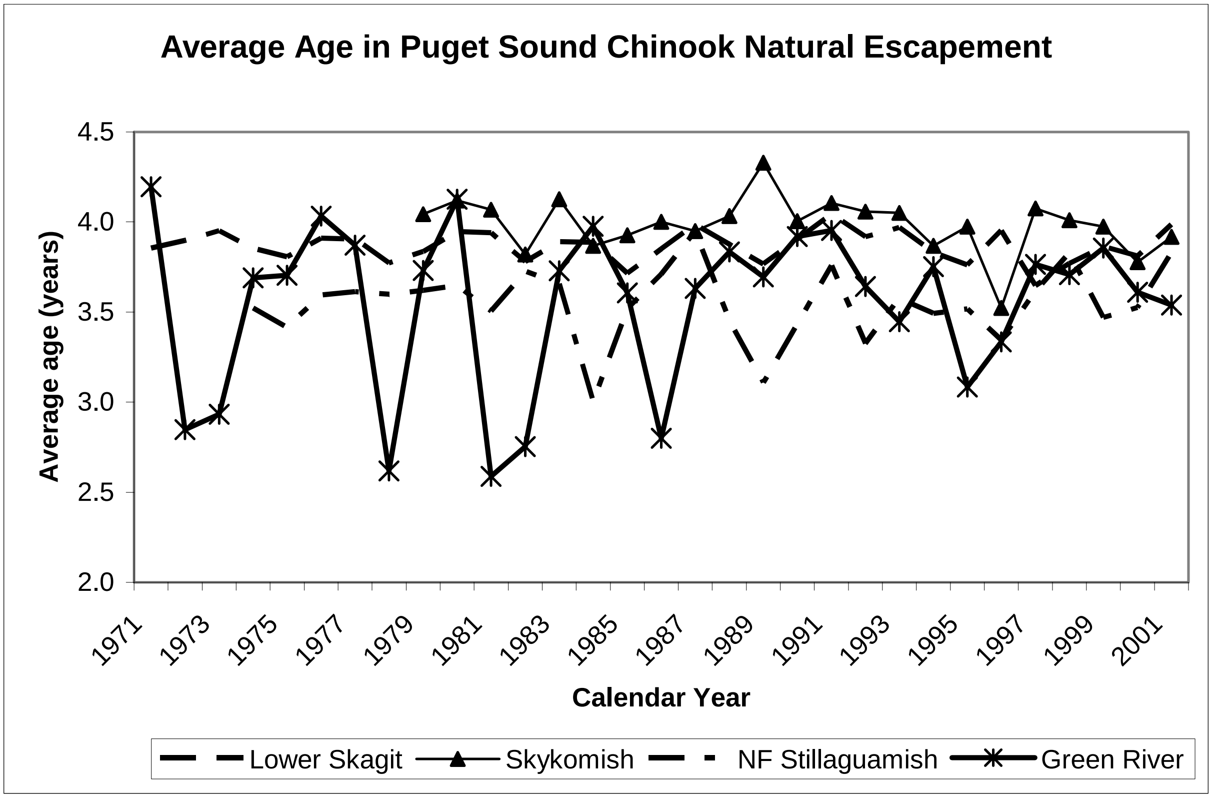
Source: Washington Department of Fish and Wildlife.

Figure 3.3.7-1. Age composition of Puget Sound chinook salmon catch: relatively stable since 1980.



Source: S. Bishop, National Marine Fisheries Service, Northwest Region. based on data provided by the Washington Department of Fish and Wildlife, 2001.

Figure 3.3.7-2. Age composition of Puget Sound chinook salmon escapement: stable since the 1970s.



Source: Puget Sound Technical Recovery Team data.

~~Analysis not yet Complete~~

The analysis described above examined whether there had been any detectable changes in age composition of Puget Sound chinook salmon. NMFS ~~is currently conducting~~ also conducted analyses to determine whether there ~~are~~ were detectable changes in size at a specific age and sex of Puget Sound chinook salmon and, if so, whether they might be attributable to fishing effects. That is, although there might not be a change in the age composition, fish of the same age could be getting smaller or larger over time[xiii]. ~~While these analyses were not available for inclusion in the Draft Environmental Impact Statement, they will be included in the Final Environmental Impact Statement. A brief description of~~

[xiii] While these analyses were not available for inclusion in the Draft Environmental Impact Statement, NMFS indicated at the time that the Draft Environmental Impact Statement was provided for public review and comment that the analyses would be completed and included in the Final Environmental Impact Statement. NMFS included in the Draft Environmental Impact Statement a brief description of the analysis so the public had the opportunity to comment on the approach that NMFS was taking.

~~the analyses is included here so that the public is aware of the approach that NMFS is taking and so that the public has as much information as possible at this time on which to comment.~~ As discussed earlier in this subsection, diversity in both age and size are important so that populations can respond successfully to changing environmental conditions. For example, larger females may be able to bury their eggs more deeply, thereby protecting them from washing away in high water flow conditions. On the other hand, smaller body size may allow some adults to return to successfully reproduce in drought years when larger adults become stranded or are more vulnerable to predators under low water flow conditions.

In conducting its analyses, NMFS examined whether there was a difference in size at age between Puget Sound chinook salmon caught in the fishery and those that spawn. NMFS focused its analyses on a subset of Puget Sound chinook salmon populations for which sufficient information was available and that represented some diversity in life history (spring and fall run types), geographic distribution and fishing intensity. NMFS ~~is~~ also limited its analysis to terminal in-river net ~~and recreational~~ fisheries[xiv] for which data were available so that ~~it is~~ the analyses were not confounded by the catch of immature fish that commonly occurs in marine fisheries. While NMFS is aware that marine fisheries may also be selective through the use of size limits or selective gear, the analyses ~~should~~ were intended to narrow the number of environmental factors that might account for a change in size at age detected in the analysis. To do this, the analyses should evaluate adults experiencing as similar an environment as possible. Otherwise, it would not be possible to determine whether a change in size at age from analyses that included immature fish was due to a change in the size of returning adults of a particular age, or due to differences in growth rates from fish that matured at a given age versus those that would have grown and matured at an older age. While fisheries may act to affect either size directly or growth rate (see earlier discussion), these analyses are intended to examine the direct effect of fisheries on size. Although we can theoretically explore the effects of fisheries on growth rate (Hard 2004), it is not technically feasible with the tools and data available at this time to directly assess the effects of Puget Sound fisheries on growth rate.

To assess possible change in size at age of Puget Sound chinook salmon, the analyses ~~will be~~were broken into ~~two~~ three steps. ~~. First, f~~For a selected group of Puget Sound chinook salmon populations: 1) NMFS ~~will~~ compared the average size at age and sex of coded-wire tagged fish recovered in the terminal net fishery with those recovered in the hatchery escapement during the period ~~1980-2000~~ 1975–2001; 2) size at age and sex information collected from naturally spawning adults was compared

[xiv] These fisheries intercept fish returning to a single river system; the one in which the fishery occurs.

with results obtained from the first step for returning hatchery adults; and, 3) analysis was conducted to see whether the magnitude of change in size could be linked to effects of the terminal fishery. As seen from Table 3.3.7-2, total exploitation rates for these populations have generally decreased over time. Terminal fishery rates have remained relatively stable or increased over the same time period, indicating that terminal harvest accounts for a greater proportion of the harvest related mortality in recent years. The Green River, Skokomish, Nisqually and Samish populations have moderate to high terminal and total exploitation rates while terminal exploitation rates on the Nooksack and Skagit spring populations are low. Total exploitation rates for the Skagit spring chinook are moderate.

Table 3.3.7-2. Characteristics of populations chosen for size at age analyses.

			Average Exploitation Rate		
Population	Location	Life History Type	Time Period	Total	Terminal
Green River	Central Puget Sound	Fall	1983-2000	56%	19%
			1983-1986	64%	19%
			1998-2000	36%	21%
Skokomish	Hood Canal	Fall	1983-2000	60%	18%
			1983-1986	72%	23%
			1998-2000	36%	17%
Nisqually	South Puget Sound	Fall	1983-2000	86%	41%
			1983-1986	84%	27%
			1998-2000	75%	53%
Nooksack	North Puget Sound	Spring	1983-2000	31%	2%
			1983-1986	37%	3%
			1998-2000	16%	2%
Samish	North Puget Sound	Fall	1983-2000	76%	36%
			1983-1986	80%	30%
			1998-2000	66%	47%
Skagit	North Puget Sound	Spring	1983-2000	50%	1%
			1983-1986	60%	0%
			1998-2000	26%	1%

Source: Larrie Lavoy, Washington Department of Fish and Wildlife, May 20, 2000.

Gillnets are the primary fishing gear used in terminal net fisheries. Because of the size of the mesh size used in the nets, three- and four-year-old fish comprise the majority of the fish caught in the terminal fisheries (Figure 3.3.7-1). Therefore, if fisheries are exerting a significant effect on size at age, it would most likely be observed for these ages. Some caution is warranted in the use of the results since the analyses are based on the best available data and not that which was collected under an experimental design with the intent of examining changes of mean length over time

In the first step, the average size at age/sex of coded-wire tagged fish recovered in the terminal net fishery was compared with those recovered in the hatchery escapement during the period 1975–2001 (Ryding and Reidinger 2004). ~~T~~These coded-wire tag fish are part of the Pacific Salmon Commission indicator stock program which was implemented specifically to assess survival, distribution and fishing-related mortality for Puget Sound Chinook salmon. ~~This will~~ The use of coded-wire tagged fish ensured that the analysis included only fish from the same population based on the unique coded-wire tag code implanted into the fish prior to their release from the hatchery. Results of the length analysis are presented in Table 3.3.7-3. Estimates are presented as the increase or decrease in the length of a fish per year. Significant results should be treated with caution because, thus far, no adjustments were made in the α-level to account for the number of tests in the analysis. The effect of this might be that currently statistically significant results would not be significant. Therefore, this analysis will overestimate the number of significant results.[xv]

Statistically significant trends in size-at-age were detected for at least one age for chinook returning to all hatchery facilities except the Samish Hatchery. Except for four-year-old fish, there was no consistent pattern in the trends of size-at-age, with trends being significantly different between males and females, and trends in female size-at-age more often statistically significant than those of the males. Where terminal abundance (catch plus escapement) was compared with escapement, the results were generally similar. For the ages most likely to be affected by fisheries (three- and four-year-old fish), all statistically significant trends in size-at-age in those populations with moderate to high exploitation rates were decreasing. All trends in size-at-age for these populations for Age-4 males and

[xv] The series of tests required to assess length trends across all stocks requires a downward adjustment to the significance level under the original null hypothesis of no change in length over time. One method would be to divide the α-level (0.05) by the number of tests (48), the "new" significance level (0.001) would indicate that the trends for age-3 male Skagit, age-4 male Skokomish (escapement only), age-4 Nisqually and age-4 female Green and Skokomish, fish would be significant. However, this is a highly conservative adjustment.

Table 3.3.7-3. Changes in size-at-age and sex for selected Puget Sound chinook populations (significance level (P) = 0.10).

Hatchery	Life History Type	Terminal Exploitation Rate	Age 2		Age 3				Age 4				Age 5			
			Males		Females		Males		Females		Males		Females		Males	
			Estimate	P-value	Estimate	P-value	Estimate	P-value	Estimate	P-value	Estimate	P-value	Estimate	P-value	Estimate	P-value
Green River – Fishery and Escapement	Fall	Moderate	-0.009	0.908	-0.081	0.561	-0.029 NSD	0.681	-0.124	0.001	-0.150 NSD	0.005	-0.106	0.148	-0.053 NSD	0.720
Green River – Escapement only	Fall	Moderate	-0.006	0.938	-0.193	0.263	-0.016 NSD	0.819	-0.145	<0.001	-0.116 NSD	0.041	-0.151	0.031	-0.103 NSD	0.451
Skokomish– Fishery and Escapement	Fall	Moderate	0.131	0.482	-0.118	0.202	-0.032	0.732	-0.221	<0.001	-0.290 NSD	0.011	-0.051	0.566	-0.146 NSD	0.279
Skokomish– Escapement only	Fall	Moderate	0.175	0.337	-0.182	0.084	-0.039 NSD	0.714	-0.276	<0.001	-0.450 NSD	<0.001	0.025	0.079	0.007 NSD	0.974
Nisqually – Fishery and Escapement	Fall	High	0.111	0.484	-0.289	0.050	-0.224 NSD	0.168	-0.276	<0.001	-0.442 NSD	<0.001	0.145	0.655	0.940 NSD	0.173
Nooksack– Fishery and Escapement	Spring	Low	0.316	0.025	-1.150	0.416	0.326 NSD	0.327	-0.171	0.289	-0.471 NSD	0.113	0.300	0.315	-0.471 NSD	0.113
Samish– Fishery and Escapement	Fall	High	0.201	0.239	-0.063	0.652	0.043 NSD	0.501	-0.031	0.609	-0.075 NSD	0.357	0.009	0.969	0.025 NSD	0.964
Skagit– Fishery and Escapement	Spring	Low	0.591	0.202	NA	NA	0.541	<0.001	0.212	0.133	0.026 NSD	0.845	0.281	0.013	0.271 NSD	0.144

Notes: Significant results are shaded.
The abbreviation NSD signifies no significant difference between female and male length trends.

Source: K. E. Ryding and K.F. Reidinger, Washington Department of Fish and Wildlife, September, 2004

females were statistically significant and declining. Trends were also significant and declining for Age-3 females for Skokomish River hatchery escapement and Nisqually River terminal abundance. For three- and four-year-old fish in those populations with low terminal exploitation rates, only Skagit spring three-year-old females was statistically significant and the trend were increasing.

Therefore, this step of the analysis indicates that there were significant trends in size-at-age and sex for some Puget Sound chinook salmon populations, and shows some consistency with the expectation that populations with high exploitation rates would show declining trends in size for ages most likely to be affected by fishery selectivity. When populations with moderate to high terminal area exploitation rates are compared with populations with low exploitation rates, the populations with higher exploitation rates showed a consistent pattern of decreasing size-at-age for both male and female Age-4 chinook, one of the two ages most likely to experience any selective effects. Declines ranged from 0.11 to 0.45 centimeters/year, or 0.55 to 2.5 centimeters per generation. Whether these changes are biologically significant is unknown. Where significant, trends in Age-3 chinook were also declining. However, the majority of size-at-age trends for Age-3 fish were not significant, regardless of fishing intensity.

On the other hand, other aspects of the results suggest factors other than fisheries are equally as likely: 1) the comparison between populations in moderate-high and low exploitation rate categories also compared populations with different life histories, so the difference could be due to differences in environmental conditions experienced by the different life history types; 2) the trends did not show consistent contrasts between the ages most vulnerable to selective fishing effects and those ages that are not, although this may have resulted from small numbers of samples for two- and five-year-old fish; 3) the trends in Age-3 chinook which are also vulnerable to selective fishing effects were generally insignificant regardless of fishing intensity; 4) the trends would also have reflected the result of cumulative selective pressures of fisheries other than Puget Sound terminal net fisheries; 5) the trends were not entirely consistent between high and low exploitation rate populations when total exploitation rates are considered. While the terminal area exploitation rates were low for Skagit spring chinook, the total exploitation rate was similar to those of the Green and Skokomish Rivers and the Samish River showed no significant trends in size-at-age, although it is classified as a moderate to high exploitation rate population.

~~Secondly~~In the second step of the analysis, ~~NMFS will use~~ size-at-age and sex information collected from naturally-spawning adults ~~to~~ was compared with results from the first step. ~~To the extent possible, the analysis will separate hatchery-origin fish spawning naturally from naturally produced fish spawning naturally.~~ This aspect of the analyses was intended to compare adult spawners that spawn naturally ~~produced~~ with the hatchery-based comparison of recovered coded-wire-tagged adults from the same population. Originally, the analysis intended to separate hatchery-origin fish spawning naturally from naturally-produced fish spawning naturally. However, hatchery-origin and natural-origin spawners were not separated in the analysis because hatchery-origin adults contribute significantly to natural escapement for many Puget Sound chinook populations, and are believed to contribute to subsequent generations of naturally-produced chinook salmon. If size-at-age is a heritable trait, then all spawners that contribute to subsequent generations of naturally-produced chinook salmon should be included in the analysis. Since hatchery contribution to natural spawning is significant for most of the populations in the analysis and the use of mark-selective fisheries for hatchery fish is limited, ~~d.~~ ~~Therefore,~~ fisheries are ~~thought~~likely to act in similar ways~~equally~~ on the hatchery and natural components of the populations so that there would not be a substantial difference in the response of the hatchery and natural components. This step of the analyses will test this assumption.

The results of the analysis on the natural spawners by each population and age group are summarized in Table 3.3.7-4. Only three of the six Puget Sound chinook salmon populations, including only one of the four populations in the moderate-high exploitation rate category evaluated in step 1, had sufficient data available to conduct the analysis. The trends in size-at-age were significant for five of the six analyses conducted. The only significant decreasing trend was for Age-3 Nooksack spring chinook spawners. For all but one (four-year-old Skagit spring chinook) of the six population/age groups examined, the trends in size-at-age were not significantly different among males and females.

Table 3.3.7-4. Changes in size-at-age for selected Puget Sound chinook populations (significance level (P) = 0.05). Significant results are shaded.

Population	Life History Type	Terminal Exploitation Rate	Age 3		Age 4		Age 5	
			Estimate	P-value	Estimate	P-value	Estimate	P-value
Green	Fall	Moderate	-0.025	0.647	0.144	<0.001		
Nooksack	Spring	Low	-0.360	0.002	0.258	<0.001		
Skagit	Spring	Low			0.246	0.050	0.446	0.003

Source: B. Conrad, Northwest Indian Fisheries Commission, October 5, 2004.

Although limited, the results of these analyses did not indicate declining trends in size with higher exploitation rates as might be expected. However, the increase in size-at-age for the Green River population was less than the increases for the other two populations that fall into the low exploitation rate category. On the other hand, three-year-old Nooksack spring chinook (low exploitation rate) showed a significant decreasing trend in size-at-age that is not seen in the Green River population (moderate exploitation rate). Although the results are consistent across Age-4 natural spawners, 1) the trends were increasing for both high and low exploitation rate populations; 2) the trend of size-at-age is mixed among ages most likely to experience selective effects of fisheries; and 3) as in the step 1 analysis, the apparent differences in magnitude of change between the high and low exploitation rate populations could be the result of difference in environmental effects on different life history strategies.

A comparison of results from step 1 (hatchery escapement and terminal abundance) and step 2 (natural escapement) is summarized in Table 3.3.7-5. The results in steps 1 and 2 are consistent in direction and significance of trends for only two of the six analyses that were compared, and the magnitude of change was substantially different between the analyses that were similar. For example, the analysis of naturally-spawning Skagit spring chinook indicated an increase in size-at-age almost 60 percent greater than that in the analysis of hatchery escapement. Whereas the analysis of hatchery escapement and terminal abundance consistently indicated significant declining trends in size-at-age for ages most likely to be vulnerable to selective effects of fisheries, the statistically significant trends in the analysis of natural escapement indicated primarily increasing trends in size-at-age for those ages. Although only one population in the moderate-high exploitation rate category was included in the analysis of natural escapement, that analysis indicated an increasing trend in size-at-age rather than a declining trend as seen in the step 1 analysis, although the increase (0.6 centimeter/generation) was much less than for the other two populations that fell into the low exploitation rate category. Both analyses indicated that trends between male and female chinook spawners were similar.

The results of the analyses in step 2 seem to indicate that trends of size-at-age and sex between the hatchery and naturally-spawning components are different (rejecting the original assumption). The results also do not indicate that fisheries are affecting the naturally-spawning component of the population in the ways that might be expected from the earlier discussion; i.e., declining size-at-age with increasing exploitation. However, it is possible that the fishery has a dampening effect since the increasing trend in size-at-age for the population with the moderate exploitation rate is substantially less than those of the two populations with low exploitation rates. The differences in the two analyses could reflect actual differences between trends in size-at-age in hatchery and naturally-spawning adult chinook, differences in the sampling and data collection in the two environments, or differences in life history.

Table 3.3.7-5. Comparison of size-at-age analyses for hatchery and natural-spawning escapement analysis for those population and age strata in common to both analyses.

Population	Life History Type	Terminal Exploitation Rate	Age	Hatchery Escapement		Natural Escapement	
				Estimate	P-value	Estimate	P-value
Green	Fall	Moderate	3	-0.193	0.263	-0.025	0.647
			4	-0.145	<0.001	0.144	<0.001
Nooksack	Spring	Low	3	-1.150	0.416	-0.360	0.002
			4	-0.171	0.289	0.258	<0.001
Skagit	Spring	Low	4	0.212	0.133	0.246	0.050
			5	0.281	0.013	0.446	0.003

Source: B. Conrad, Northwest Indian Fisheries Commission, October 5, 2004; Ryding and Reidinger, Washington Department of Fish and Wildlife, September 2004.

Note: Significant results are shaded.

From the discussion above, it is evident that analyses of observed trends alone cannot confirm that harvest is primarily responsible for declines in size-at-age; therefore, an ~~Finally, if there is a detectable change in size-at-age, further~~ analysis was~~ill be~~ conducted to see whether the magnitude of change in size ~~can~~ could be linked to the intensity of the fishery. To do this, the populations~~ will be divided into high and low exploitation rate groups based on the conclusions of Hard (2004) to determine whether there is a pattern in the results of the size at age analysis that corresponds to the magnitude of exploitation rate~~ were assessed using the models of Hard (2004) to determine to what extent fisheries might be a factor where statistically significant patterns in size-at-age and sex were identified in the first two steps. Some key genetic and life history parameters were based on data obtained from the Grovers Creek Hatchery chinook population, which may or may not be representative of the populations in this analysis. However, it was the best available information for the purpose of this modeling exercise. The model examined four possible scenarios: two levels of legal size threshold (50 and 70 centimeters), and two levels of natural selection intensity (strong and weak) on size (personal communication with Jeff Hard, Research Fishery Biologist, Northwest Fisheries Science Center, September 16, 2004). This step compares what the trends in size-at-age would be under different levels of environmental and fishing conditions with the results in step 1 to see if the observed trends are consistent with any of the scenarios. The same general conclusions with regard to increasing and decreasing trends are equally applicable to results from step 2.

The results of the analyses of the populations under the four harvest scenarios are summarized in Tables 3.3.7-6 through 3.3.7-9. There are two general cases where the expected trends are not particularly informative: first, where the observed trend is increasing over time (the expected trend under size-selective harvest involving directional selection toward smaller size is always predicted to be decreasing if there is genetic and phenotypic variation for size); and second, where the decreasing expected trend is much larger than a decreasing observed trend (which implies the presence of one or more strong environmental factors acting to increase mean size-at-age over time). In the first case, expected trends from the model runs do nothing more than reflect the presence of a large positive composite environmental effect acting to oppose fishing effects. The second case is most evident for particular cases involving two- and three-year-old males (especially in the Green River and Skokomish hatchery populations, but also in the Samish population) – fish that are less susceptible to harvest. The model predicts a much more dramatic effect of harvest on size of these fish than was observed in any of the populations, but it is likely that the largely insignificant positive trends observed in some of these cases arise primarily from weak environmental factors favoring more rapid growth during the first year at sea. For most of the other comparisons, the harvest model accounts for less than half the observed declines in length under all scenarios.

In general, for those populations that exhibit declining trends, the harvest model can account for only a modest fraction (<50%) of the trend when natural selection on length is weak and the size threshold is relatively small (50 centimeters), and it appears to be somewhat larger in the Green River and Skokomish hatchery populations. The fraction of the trend explained by the harvest model tends to increase when the intensity of natural selection on size is high. It also increases, but to a lesser extent, when the selection differential on size imposed by harvest (a function of the harvest rate and the threshold size of harvestable fish) increases.

Collectively, the mixture of upward and downward observed trends and the fact that the expected trends estimated by the harvest model generally explain only a modest fraction (<50%) of corresponding observed trends suggest that environmental influences on the observed size trends are large. For decreasing observed trends, these influences may include factors such as environmental conditions that reduce growth and size, or artificial or domestication selection in the hatchery. However, these influences also appear to vary considerably among the populations, pointing to the possibility of marked population-environment interaction effects. For increasing observed trends, these influences are likely to reflect environmental conditions that enhance growth and size that could result from more favorable marine conditions, improvements in hatchery practices, reductions in harvest intensity, changes in migration patterns, or other factors that affect growth and size. Unfortunately, it is not possible from the present analysis to determine the directions or magnitudes of these environmental effects for any particular population with confidence, because harvest and environmental effects on growth and size cannot be reliably discriminated.

Table 3.3.7-6. Observed trends in Puget Sound hatchery chinook salmon adult lengths (cm/year) and corresponding expected trends (cm/year) under directional harvest selection (Ryding and Reidinger 2004). Model runs incorporated strong stabilizing selection on length ($\omega = 1\sigma$) and a threshold for legal harvest of 50 cm.

		Age 2		Age 3				Age 4				Age 5			
		Males		Females		Males		Females		Males		Females		Males	
Hatchery	Run Type	Observed Trend	Expected Trend	Observed Trend	Expected Trend	Observed Trend	Expected Trend	Observed Trend	Expected Trend	Observed Trend	Expected Trend	Observed Trend	Expected Trend	Observed Trend	Expected Trend
Green River	Fall	-0.006^{ns}	-0.053 (883.3)	-0.193^{ns}	-0.037 (19.2)	-0.016^{ns}	-0.056 (350.0)	-0.145***	-0.059 (40.7)	-0.116*	-0.062 (53.4)	-0.151*	-0.052 (34.4)	-0.103^{ns}	-0.048 (46.6)
Skokomish	Fall	0.175^{ns}	-0.088	-0.182*	-0.069 (37.9)	-0.039^{ns}	-0.126 (323.1)	-0.276***	-0.053 (19.2)	-0.450***	-0.063 (42.0)	0.025*	-0.042	0.007^{ns}	-0.057
Nisqually	Fall	0.111^{ns}	-0.064	-0.289*	-0.031 (10.7)	-0.224^{ns}	-0.031 (13.8)	-0.276***	-0.040 (14.5)	-0.442***	-0.032 (7.2)	0.145^{ns}	-0.027	0.940^{ns}	-0.030
Nooksack	Spring	0.316*	-0.015	-1.150^{ns}	-0.022 (1.9)	0.326^{ns}	-0.028	-0.171^{ns}	-0.007 (4.1)	-0.471^{ns}	-0.019 (4.0)	0.300^{ns}	-0.007	-0.471^{ns}	-0.022 (4.7)
Samish	Fall	0.201^{ns}	-0.087	-0.063^{ns}	-0.048 (76.2)	0.043^{ns}	-0.041	-0.031^{ns}	-0.046 (883.3)	-0.075^{ns}	-0.044 (58.7)	0.009^{ns}	-0.047	0.025^{ns}	-0.045
Skagit	Spring	0.591^{ns}	-0.012	NA	--	0.541***	-0.020	0.212^{ns}	-0.045	0.026^{ns}	-0.034	0.281*	-0.027	0.271^{ns}	-0.023

Source: Jeff Hard, NMFS Northwest Fisheries Science Center, September 16, 2004.
Percent of observed trend in parentheses, where applicable.
^{ns} Not significantly different from zero.
* $P < 0.10$
*** $P < 0.001$

Table 3.3.7-7. Observed trends in Puget Sound hatchery chinook salmon adult lengths (cm/year) and corresponding expected trends (cm/year) under directional harvest selection (Ryding and Reidinger 2004). Model runs incorporated weak stabilizing selection on length ($\omega = 4\sigma$) and a threshold for legal harvest of 50 cm.

		Age 2		Age 3				Age 4				Age 5			
		Males		Females		Males		Females		Males		Females		Males	
Hatchery	Run Type	Observed Trend	Expected Trend	Observed Trend	Expected Trend	Observed Trend	Expected Trend	Observed Trend	Expected Trend	Observed Trend	Expected Trend	Observed Trend	Expected Trend	Observed Trend	Expected Trend
Green River	Fall	-0.006[ns]	-0.036 (600.0)	-0.193[ns]	-0.056 (29.0)	-0.016[ns]	-0.056 (350.0)	-0.145[***]	-0.063 (43.4)	-0.116[*]	-0.062 (53.2)	-0.151[*]	-0.049 (32.4)	-0.103[ns]	-0.042 (40.8)
Skokomish	Fall	0.175[ns]	-0.046	-0.182[*]	-0.062 (34.1)	-0.039[ns]	-0.065 (166.7)	-0.276[***]	-0.049 (17.8)	-0.450[***]	-0.040 (8.9)	0.025*	-0.034	0.007[ns]	-0.032
Nisqually	Fall	0.111[ns]	-0.047	-0.289[*]	-0.041 (14.2)	-0.224[ns]	-0.042 (18.8)	-0.276[***]	-0.050 (18.1)	-0.442[***]	-0.038 (8.6)	0.145[ns]	-0.031	0.940[ns]	-0.030
Nooksack	Spring	0.316[*]	-0.012	-1.150[ns]	-0.028 (2.4)	0.326[ns]	-0.014	-0.171[ns]	-0.014 (8.2)	-0.471[ns]	-0.015 (3.2)	0.300[ns]	-0.012	-0.471[ns]	-0.015 (3.2)
Samish	Fall	0.201[ns]	-0.081	-0.063[ns]	-0.065 (100.3)	0.043[ns]	-0.060	-0.031[ns]	-0.063 (200.3)	-0.075[ns]	-0.063 (84.0)	0.009[ns]	-0.055	0.025[ns]	-0.056
Skagit	Spring	0.591[ns]	-0.015	NA	--	0.541[***]	-0.020	0.212[ns]	-0.043	0.026[ns]	-0.040	0.281[*]	-0.026	0.271[ns]	-0.026

Source: Jeff Hard, NMFS Northwest Fisheries Science Center, September 16, 2004.
Percent of observed trend in parentheses, where applicable.
[ns] Not significantly different from zero.
[*] P < 0.10
[***] P < 0.001

Table 3.3.7-8. Observed trends in Puget Sound hatchery chinook salmon adult lengths (cm yr^{-1}) and corresponding expected trends (cm yr^{-1}) under directional harvest selection (Ryding and Reidinger 2004). Model runs incorporated strong stabilizing selection on length ($\omega = 1\sigma$) and a threshold for legal harvest of 70 cm.

		Age 2		Age 3				Age 4				Age 5			
		Males		Females		Males		Females		Males		Females		Males	
Hatchery	Run Type	Observed Trend	Expected Trend	Observed Trend	Expected Trend	Observed Trend	Expected Trend	Observed Trend	Expected Trend	Observed Trend	Expected Trend	Observed Trend	Expected Trend	Observed Trend	Expected Trend
Green River	Fall	-0.006^{ns}	-0.033 (550.0)	-0.193^{ns}	-0.097 (50.2)	-0.016^{ns}	-0.091 (568.8)	-0.145***	-0.095 (65.5)	-0.116*	-0.092 (79.3)	-0.151*	-0.067 (44.4)	-0.103^{ns}	-0.055 (53.4)
Skokomish	Fall	0.175^{ns}	-0.022	-0.182*	-0.093 (51.1)	-0.039^{ns}	-0.047 (120.5)	-0.276***	-0.061 (22.1)	-0.450***	-0.033 (7.3)	0.025*	-0.039	0.007^{ns}	-0.021
Nisqually	Fall	0.111^{ns}	-0.048	-0.289*	-0.076 (26.3)	-0.224^{ns}	-0.076 (33.9)	-0.276***	-0.083 (30.1)	-0.442***	-0.062 (14.0)	0.145^{ns}	-0.045	0.940^{ns}	-0.044
Nooksack	Spring	0.316*	-0.009	-1.150^{ns}	-0.064 (5.6)	0.326^{ns}	-0.008	-0.171^{ns}	-0.037 (21.6)	-0.471^{ns}	-0.022 (4.7)	0.300^{ns}	-0.027	-0.471^{ns}	-0.013 (2.8)
Samish	Fall	0.201^{ns}	-0.097	-0.063^{ns}	-0.119 (188.9)	0.043^{ns}	-0.112	-0.031^{ns}	-0.113 (364.5)	-0.075^{ns}	-0.114 (152.0)	0.009^{ns}	-0.088	0.025^{ns}	-0.090
Skagit	Spring	0.591^{ns}	-0.011	NA	--	0.541***	-0.011	0.212^{ns}	-0.089	0.026^{ns}	-0.051	0.281*	-0.051	0.271^{ns}	-0.023

Source: Jeff Hard, NMFS Northwest Fisheries Science Center, September 16, 2004.
Percent of observed trend in parentheses, where applicable.
^{ns} Not significantly different from zero.
* $P < 0.10$
*** $P < 0.001$

Table 3.3.7-9. Observed trends in Puget Sound hatchery chinook salmon adult lengths (cm yr^{-1}) and corresponding expected trends (cm yr^{-1}) under directional harvest selection (Ryding and Reidinger 2004). Model runs incorporated weak stabilizing selection on length ($\omega = 4\sigma$) and a threshold for legal harvest of 70 cm.

		Age 2		Age 3				Age 4				Age 5			
		Males		Females		Males		Females		Males		Females		Males	
Hatchery	Run Type	Observed Trend	Expected Trend	Observed Trend	Expected Trend	Observed Trend	Expected Trend	Observed Trend	Expected Trend	Observed Trend	Expected Trend	Observed Trend	Expected Trend	Observed Trend	Expected Trend
Green River	Fall	-0.006^{ns}	-0.027 (450.0)	-0.193^{ns}	-0.054 (28.0)	-0.016^{ns}	-0.053 (331.3)	-0.145***	-0.059 (40.7)	-0.116*	-0.056 (43.3)	-0.151*	-0.042 (27.8)	-0.103^{ns}	-0.037 (35.9)
George Adams	Fall	0.175^{ns}	-0.041	-0.182*	-0.069 (37.9)	-0.039^{ns}	-0.065 (166.7)	-0.276***	-0.056 (20.3)	-0.450***	-0.046 (10.2)	0.025*	-0.035	0.007^{ns}	-0.032
Nisqually	Fall	0.111^{ns}	-0.047	-0.289*	-0.052 (18.0)	-0.224^{ns}	-0.051 (22.7)	-0.276***	-0.063 (22.8)	-0.442***	-0.048 (10.9)	0.145^{ns}	-0.035	0.940^{ns}	-0.035
Nooksack	Spring	0.316*	-0.006	-1.150^{ns}	-0.027 (2.3)	0.326^{ns}	-0.007	-0.171^{ns}	-0.015 (8.8)	-0.471^{ns}	-0.012 (2.5)	0.300^{ns}	-0.012	-0.471^{ns}	-0.009 (1.9)
Samish	Fall	0.201^{ns}	-0.077	-0.063^{ns}	-0.068 (107.9)	0.043^{ns}	-0.064	-0.031^{ns}	-0.069 (222.6)	-0.075^{ns}	-0.069 (92.0)	0.009^{ns}	-0.057	0.025^{ns}	-0.057
Skagit	Spring	0.591^{ns}	-0.009	NA	--	0.541***	-0.009	0.212^{ns}	-0.045	0.026^{ns}	-0.029	0.281*	-0.026	0.271^{ns}	-0.015

Source: Jeff Hard, NMFS Northwest Fisheries Science Center, September 16, 2004.
Percent of observed trend in parentheses, where applicable.
^{ns} Not significantly different from zero.
* P < 0.10
*** P < 0.001

3.3.8 Hatchery-Related Fishery Effects on Salmon

Salmon harvest management plans, such as the Proposed Action and alternatives addressed in this Environmental Impact Statement, set management objectives for individual populations or management units. The alternatives are different fishing regimes that set management objectives in terms of exploitation rates and/or escapement goals. The Puget Sound Chinook Harvest Resource Management Plan alternatives encompass 15 natural management units and 22 chinook salmon populations. Many of these units have associated hatchery programs that are managed either to enhance fisheries or supplement natural production. Achieving appropriate conservation objectives for this diverse group of units presents a highly complex technical and political task. Fisheries objectives can exert substantial control over the escapement of hatchery- and natural-origin chinook, as well as the five other salmon species.[xii]

This subsection examines some of the possible, ancillary ecological and genetic effects that may result from hatchery programs associated with the harvest regimes considered in this evaluation. These effects associated with any of the alternatives may potentially lead to different levels of escapement of natural- and hatchery-origin fish, and varying interactions between wild and hatchery-origin chinook on the spawning grounds.

3.3.8.1 Effects of Hatchery-Origin Chinook on Natural-Spawning Chinook Salmon

Artificial propagation programs may lead to beneficial effects and/or risks for natural-origin chinook salmon populations.

Benefits

Beneficial effects that may result from the use of hatchery techniques have been summarized by Waples (1996) and Cuenco et al. (1993). Hatchery supplementation may be used to reduce the short-term risk that a population on the verge of extirpation will be lost by expeditiously boosting the number of emigrating juveniles in a given brood year. Supplementation may be used to preserve or increase salmon populations while other factors causing decreased abundance are addressed. Supplementation may be used to accelerate recovery of populations by increasing abundances in a shorter time frame than may be achievable through natural production. Supplementation programs may be used to create a reserve population for a particular chinook salmon genetic profile to prevent loss of the entire

[xii] The principal factor controlling abundance is ocean cycling/productivity. Other major factors affecting abundance include dams and habitat quantity and quality.

population due to natural or human-caused catastrophes. Hatchery techniques may also be used to reseed vacant habitat capable of supporting salmon through reintroduction to streams where populations have been eliminated, assuming that the causes that led to elimination of the population are being addressed. Finally, artificial propagation may be used to provide scientific information regarding the use of supplementation in conserving natural populations.

The potential benefits of hatchery production to the recovery of the Puget Sound Chinook Salmon Evolutionarily Significant Unit were recognized by NMFS in its 1999 listing determination (FR 64 14308, March 24, 1999). Chinook salmon produced by hatcheries operating in the Elwha, Dungeness, Nooksack, Stillaguamish, and White River watersheds were listed with the natural populations in Puget Sound, because the juvenile and adult fish produced by these programs were deemed essential to the recovery of the Puget Sound Chinook Evolutionarily Significant Unit. Management of fisheries to ensure adequate escapement of returning hatchery-origin chinook salmon produced for conservation purposes will benefit recovery of the listed Evolutionarily Significant Unit.

Risks

Fisheries managed to achieve an exploitation rate appropriate for harvesting returning hatchery-origin chinook salmon may reduce the abundance and status of commingled, less productive natural-origin chinook populations. Conversely, if fishery managers choose a harvest rate that is less than the ideal harvest rate for the hatchery population, the escapement of hatchery fish will increase above broodstock requirements. Not all of the hatchery fish in the escapement return to their release point where they may be captured and removed. The fidelity of return and subsequent level of removal varies with the physical location of the hatchery, the efficiency of the trapping and removal system, weather conditions and flows, and other factors. As discussed above, straying may be the objective of wild population supplementation or reintroduction programs. However, where the primary objective of the hatchery program is to harvest the returning adults, fish that are not captured and removed may spawn naturally in areas used by the local population, or stray into other watersheds. The unintentional escapement and straying of hatchery-origin chinook salmon produced for harvest augmentation purposes may lead to adverse impacts to the survival and productivity of indigenous, naturally-spawning chinook salmon populations.

Adverse effects to natural-origin chinook salmon that may result from the use of artificial propagation may be ecological, genetic, or demographic in nature. Potential adverse effects of this nature on natural-origin chinook salmon are summarized below. These descriptions are provided to identify hatchery-related issues that may be germane to the fishery management alternatives analyzed and compared within this Environmental Impact Statement.

Ecological Effects

Hatchery-origin adults may compete with naturally-spawning fish for spawning habitat, or may interbreed with naturally-spawning fish. Adverse effects of competition may result from direct interactions, whereby hatchery-origin fish interfere with the accessibility of wild fish to limited resources; or through indirect means, such as when utilization of a limited resource by hatchery fish reduces the amount of that resource available to wild fish (Species Integration Work Group 1984).

For adult salmonids, the potential for hatchery/wild fish competition in fresh water is assumed to be greatest in the spawning areas (U.S. Fish and Wildlife Service 1994). Hatchery-origin adult salmonids may home to, or stray into, natural production areas during wild fish spawning or egg incubation periods, posing an elevated competitive and behavioral modification risk. Returning or straying hatchery fish may compete for spawning habitat. Superimposition of redds by similarly-timed or later spawners disturbs or removes previously-deposited eggs from the gravel, and has been identified as an important source of natural salmon mortality in some areas (Bakkala 1970). Adult salmonids originating from hatcheries can also compete with wild fish of the same species for mates. If the hatchery fish are a non-indigenous population, or have substantially diverged from the native population, interbreeding between hatchery- and natural-origin chinook salmon may lead to an increased potential for outbreeding depression, to the detriment of the natural-origin population.

Juvenile salmonids rearing in fresh water and estuaries compete for food and space (Species Integration Work Group 1984). The progeny of the hatchery fish that have spawned in the wild may compete for suitable habitat, reduce access to food, or cause behavior that makes wild fish more susceptible to predation (Hillman and Mullan 1989; Steward and Bjornn 1990; and Species Integration Work Group 1984).

<u>Genetic Effects</u>

Native salmon populations have developed a complex set of local adaptations that promote the productivity of the population within their local environment. Characteristics such as body size, return timing, egg size, migration timing, and many others are tailored by natural selection to adapt the population to its environment. Hatchery-reared salmon are subject to different selective pressures in the hatchery environment that may cause them to genetically diverge from their wild ancestors. When hatchery fish are imported from another basin, this difference between local and hatchery populations is exacerbated. When hatchery strays interbreed with wild fish, the resulting progeny may be less fit, and the genetic integrity of the local wild population may be permanently affected.

The genetic risks from hatchery fish spawning in the wild, or interbreeding with wild fish, are associated with reduction in the genetic variability (diversity) within and among populations (Cuenco et al. 1993; Hard et al. 1992; National Research Council 1996; and Waples 1996). Specifically, these risks involve genetic drift, inbreeding depression, or domestication. Genetic traits are carried at specific places in the genetic material of fish called *alleles*. The type and frequency of the alleles in a population constitutes the genetic diversity of the population. In the discussion that follows, the processes that cause a loss of diversity or genetic divergence within the hatchery population are considered, along with how the introduction of hatchery fish into wild populations may impact the productivity of the wild population.

Loss of Within-Population Diversity. Reisenbichler and Rubin (1999) cite five studies indicating that hatchery programs for steelhead and stream-type chinook salmon (i.e., programs holding fish in the hatchery for one year or longer) genetically change the population and thereby reduce survival for natural rearing. The authors report that substantial genetic change in fitness can result from traditional artificial propagation of salmonids held in captivity for one-quarter or more of their life. Bugert et al. (1992) documented morphological and behavioral changes in returning adult hatchery spring chinook salmon relative to natural adults, including younger age, smaller size, and reduced fecundity (number of eggs per female). Information on Puget Sound chinook salmon is limited. However, as described in Subsection 3.3.7, no decline in average age has been detected for Puget Sound chinook salmon populations for which data are available, including the Green-Duwaumish in which there has been a substantial hatchery augmentation program since the early 1900s. In most years, hatchery-origin adults constitute the majority of the naturally-spawning chinook salmon in the Green River (Puget Sound Technical Recovery Team 2003).

Leider et al. (1990) reported diminished survival and natural reproductive success for the progeny of non-native hatchery steelhead when compared to native wild steelhead in the lower Columbia River region. The poorer survival observed for the naturally-produced offspring of hatchery fish could have been due to the long-term artificial and domestication selection in the hatchery steelhead population, as well as maladaptation of the non-indigenous hatchery stock in the recipient stream (Leider et al. 1990). Chilcote (1997 and 2003) reported a strong negative correlation between the proportion of naturally-spawning hatchery steelhead and population productivity, when examining spawner-recruit relationships for a range of Oregon steelhead populations. Nickelson (2003) found negative correlations between the average number of hatchery coho released and the population productivity of wild coho in fourteen Oregon river and lake basins.

Berejikian (1995) reported that wild-origin steelhead fry survived predation by prickly sculpins (*Cottus asper*) significantly better than size-matched offspring of locally-derived hatchery steelhead that were reared under similar conditions. Alteration of the innate predator avoidance ability through domestication was suggested by the results of this study. However, Joyce et al. (1998) reported that an Alaskan spring chinook stock under domestication for four generations was not significantly different from offspring of wild spawners in the ability of individuals within this population to avoid predation. The domesticated and wild chinook groups tested showed similar growth and survival rates in freshwater performance trials.

Loss of Genetic Diversity Among Different Populations. Loss of genetic diversity among different populations is caused by the introduction of genes from outside the population (e.g., from hatchery-origin spawners or strays from other systems), at rates greater than what would naturally occur. This process can affect the genetic uniqueness of a population, and may reduce its fitness through a process called outbreeding depression. Outbreeding depression arises because natural salmonid populations adapt to the local environment, and this adaptation is reflected in the frequency of specific alleles that improve survival in that environment. When excessive gene flow occurs, alleles that may have developed in a different environment are introduced. These new alleles may not benefit the survival of the receiving population, leading to outbreeding depression. Outbreeding depression from gene flow can also occur when eggs and fish are transferred among populations, and/or when out-of-basin hatchery populations are released to spawn with the local population (Busack and Currens 1995).

Evidence indicating local adaptation of salmonid populations exists, but the only empirical data on outbreeding depression in fish involves extremely distantly-related populations (Busack and Currens 1995). Pacific Northwest hatchery programs historically contributed to the loss of genetic diversity among populations through routine transfer between watersheds of eggs and fish from different hatchery populations. The release of hatchery fish into populations different from the introduced fish has also resulted in gene flow above natural levels (genetic introgression), reducing the genetic diversity among populations. Research based primarily on findings in the Kalama River, Washington, for summer-run steelhead has suggested that interbreeding between non-indigenous Skamania hatchery stock steelhead (a highly selected, inbred stock) and native wild fish may have negatively affected the genetic diversity and long-term reproductive success of wild steelhead (Hulett et al. 1996; and Leider et al. 1990). Non-indigenous hatchery and native wild steelhead crosses may be less effective at producing adult offspring in the natural environment compared to wild fish (Chilcote et al. 1986 and 1997).

Campton (1995) examined the risks of genetic introgression to wild fish, and noted the need to distinguish the biological effects of hatcheries and hatchery fish from the indirect and biologically-independent effects of fisheries management actions. In his review of the scientific literature for steelhead, Campton found that most genetic effects detected to date appear to be caused by fisheries management practices such as stock transfers and mixed-stock fisheries, not by biological factors intrinsic to hatcheries or hatchery fish. However, loss of among-population genetic diversity as a result of these types of hatchery practices has been documented for western trout, where unique populations have been lost through hybridization with introduced rainbow trout (Behnke 1992). Phelps et al. (1994) found evidence for introgression of non-native hatchery steelhead stock into a number of natural populations within southwest Washington. However, in other areas where hatchery production has been extensive, native steelhead genotypes have been shown to persist (Phelps et al. 1994).

Hatchery programs can be managed to minimize the risk of among-population diversity reduction effects by limiting the duration of the hatchery program to a few salmon generations, using the local, natural-origin chinook population as broodstock, and by applying rearing and releasing strategies that promote high fidelity of return of adult fish to the hatchery release location.

Demographic Effects

Hatchery programs may also lead to adverse demographic effects on natural-origin populations through masking of the status of natural chinook salmon population abundance and productivity, and through overfishing.

Masking. If hatchery- and natural-origin fish are indistinguishable in appearance, the presence of hatchery-origin fish on the spawning grounds may mask the status of the wild population by causing over-estimation of the abundance and productivity of the naturally-produced population. Failure to detect the declining or critical status of natural populations may prevent or delay the implementation of conservation measures. Masking the status of natural productions was cited in listing the Puget Sound Chinook Evolutionarily Significant Unit as “threatened” under the Endangered Species Act (FR 64 14308, March 24, 1999; and Myers et al. 1998). This risk may be mitigated through application of a mark or tag to juvenile hatchery-origin chinook salmon prior to their release from the hatchery. In Puget Sound, almost all of the hatchery fish have been marked in recent years so that the hatchery chinook salmon may be readily differentiated from natural-origin fish in rearing, migration, and spawning areas.

3.3.8.2 Overfishing

Subsection 3.3.8.1 described the potential benefits and risks of hatchery fish interacting with wild fish on the spawning grounds once they have escaped the fisheries. This subsection discusses the potential effect of managing fisheries to meet harvest mortality objectives on wild and hatchery populations. Fisheries exploitation rates or escapement goals may be established for each salmon population or management unit that will best achieve its conservation objective. These harvest objectives are primarily a function of the productivity of the population and the capacity of freshwater habitat. Higher productivity populations can withstand higher exploitation rates than lower productivity populations. In the ideal case, each population will be harvested at the rate appropriate for its unique productivity and capacity. However, many fisheries take place on mixtures of populations, some of which are productive and can withstand a higher exploitation rate, and others that are less productive and have a lower ideal harvest rate. If mixed-stock fisheries are managed to achieve a high exploitation rate appropriate to productive populations, the commingled weaker populations will be over-harvested, leading to decreased spawner escapement abundances, and potentially, a declining natural-origin chinook population trend.

This mixed-stock problem is apparent where hatchery and wild fish commingle. Hatchery populations can sustain very high harvest rates, provided that escapement meets broodstock requirements. When hatchery and wild populations are commingled in fisheries, managers are faced with the decision whether to constrain fisheries and lower exploitation rates to levels appropriate to weak populations, or allow fisheries to remove the entire harvestable surplus of hatchery fish, and “overfish” some commingled natural populations. In some areas, fisheries can harvest hatchery production selectively, without undue impact on weak natural populations. Selective fisheries are implemented by the co-managers in some areas as part of the suite of regulations comprising the annual fishing regime that would be implemented through the framework of the Proposed Action or one of its alternatives (see Subsection 3.3.6 of this Environmental Impact Statement).

3.4 Tribal Treaty Rights and Trust Responsibilities

3.4.1 Introduction

There are 17 Indian tribes located in Washington State with adjudicated fishing rights in Puget Sound. The Proposed Action or alternatives to the Puget Sound Chinook Harvest Resource Management Plan could potentially affect fishing rights guaranteed by treaty and recognized in U.S. v. Washington (commonly known as the Boldt decision). This section contains a brief history of federal-tribal relations, and a general legal description of the treaty rights of Northwest tribes. It concludes with a discussion of the trust obligation of the federal government to protect those rights.

3.4.2 Federal–Tribal Relations

From the formation of the United States to the present, federal law has recognized Indian tribes as independent political entities with powers over their members and territory (Worcester v. Georgia 1832). The Constitution provides Congress with the authority to regulate commerce “among the several states, and with the Indian tribes” (United States Constitution, Article I, Section 8, clause 3). This power to regulate commerce with Indian tribes includes the exclusive authority to deal with Indian tribes respecting their rights to aboriginal lands, which have always been protected from trespass or other interference by states or private parties. Central to the protection of lands has always been, and continues to be, the need to provide for Indian hunting, gathering and fishing rights. In addition, the federal government has a legal obligation to act in the best interest of Indian tribes.

Prior to 1871, most dealings pertaining to tribal lands were accomplished pursuant to treaties entered into between the United States government and Indian tribes. The treaties typically provided for the surrender of large areas of land owned and occupied by the Indians to allow the westward expansion of non-Indians. In exchange, the United States recognized permanent homelands (reservations), and sometimes explicitly provided for off-reservation hunting and fishing rights. Treaties with Indian tribes are recognized as the supreme law of the land and trump any conflicting state law. Treaty language securing fishing rights is not “a grant of rights [from the federal government] to the Indians, but a grant of rights from them – a reservation of those not granted” (U.S. v. Winans 1905). In other words, the tribes retain rights not surrendered. Courts “interpret Indian treaties to give effect to the terms as the Indians themselves would have understood them” (Minnesota v. Mille Lacs Band of Chippewa 1999). In addition, the Supreme Court has established “that Indian treaties are to be interpreted liberally in favor of the Indians, and that any ambiguities are to be resolved in their favor” (Minnesota v. Mille Lacs Band of Chippewa 1999).

3.4.3 The Trust Responsibility

The United States government has assumed the duty of protecting Indian land and ensuring the exercise of hunting and fishing rights. This duty is generally known as the federal trust responsibility. As described by the Supreme Court, "under a humane and self-imposed policy which has found expression in many acts of Congress and numerous decisions of this Court, [the United States] has charged itself with moral obligations of the highest responsibility and trust" (Seminole Nation v. U.S. 1942). Most recently, in Department of the Interior v. Klamath Water Users Protective Association (2001), the Supreme Court noted that:

> The fiduciary relationship has been described as "one of the primary cornerstones of Indian law," F. Cohen, Handbook of Federal Indian Law 221 (1982), and has been compared to one existing under a common law trust, with the United States as trustee, the Indian tribes or individuals as beneficiaries, and the property and natural resources managed by the United States as the trust corpus.

This trust responsibility has been interpreted to require that federal agencies carry out their activities in a manner that is protective of Indian treaty rights. For example, in cases involving the management of Bureau of Reclamation water projects, the United States must exercise any discretion for the benefit of Indian tribes (see Pyramid Lake Paiute Tribe of Indians v. Morton 1973); Klamath Water Users Protective Association v. Patterson 2000; and Klamath Drainage District v. Patterson 2000). Courts have also ruled that the United States has an obligation to ensure that tribal oil and gas lessees obtain the best possible return on their leases, (Cheyenne Arapaho Tribes of Oklahoma v. U.S. 1992); and Woods Petroleum v. U.S. 1993), and to consult with the tribes before taking administrative action that may affect tribal services (see Winnebago Tribe of Nebraska v. Babbitt 1996). In Executive Order No. 13175, the President affirmed the trust responsibility of the United States, and directed all federal agencies to consult with Indian tribes when taking action affecting such rights (Executive Order No. 13175, November 6, 2000). These substantive and procedural rules, discussed below, must be considered in evaluating the Puget Sound Chinook Harvest Resource Management Plan and alternatives (Secretarial Order No. 3206, *American Indian Tribal Rights, Federal-Tribal Trust Responsibilities and the Endangered Species Act*, June 5, 1997).

3.4.4 Indian Treaty Rights in Puget Sound

In 1854 and 1855, many Indian tribes in the Pacific Northwest signed treaties with the United States that ceded much of the tribes' aboriginal territory and established several reservations for tribal occupancy. Essential for securing Indian consent to the treaties was the promise that continued access to fisheries would be guaranteed for future generations. This guarantee was included in the Treaty of Medicine Creek, in a provision typical of that found in Treaties with other Northwest tribes:

> The right of taking fish, at all usual and accustomed grounds and stations, is further secured to said Indians, in common with all citizens of the Territory, and of erecting temporary houses for the purpose of curing, together with the privilege of hunting, gathering roots and berries, and pasturing their horses on open and unclaimed lands: *Provided, however*, That they shall not take shell fish from any beds staked or cultivated by citizens.
>
> Treaty of Medicine Creek , Article III, 10 Statute 1132. *See also*, Treaty of Point Elliott, 12 Statute 927; Treaty of Point-No-Point, 12 Statute 933; Treaty of Neah Bay, 12 Statute 939; and Treaty of Olympia, 12 Statute 971, hereinafter referred to as the "Stevens Treaties".

These fishing clauses of the Stevens Treaties have been at the center of litigation for more than 100 years. In U.S. v. Winans, the Supreme Court construed the fishing rights provisions of these treaties as securing the right to cross privately-owned lands to reach usual and accustomed fishing stations within a tribe's ceded territory (U.S. v. Winans 1905). Private landowners had blocked tribal members from access that was necessary to reach a usual and accustomed fishing site. The Supreme Court rejected the argument that the Indians lost the access since no easement across the private land appeared on the face of the treaty, or on the patent issued to the private landowners territory (U.S. v. Winans 1905). The treaty was said to "impose a servitude upon every piece of land [adjacent to a usual and accustomed fishing place] as though described therein." The Supreme Court applied the same rule to guarantee access to usual and accustomed stations outside the ceded area involved in Winans (Seufert Brothers Company v. U.S. 1919). State attempts to limit the exercise of treaty fishing rights by a licensing scheme were also rejected (Tulee v. Washington 1942). Despite these favorable rulings, Indian treaty rights were ignored by the State of Washington at the time, and State officials frequently subjected tribal members to harassment and prosecution. This led to intense litigation.

In 1974, Judge Boldt ruled that the Stevens Treaties reserved to the Tribes the right to take up to 50 percent of the harvestable surplus of fish passing their "usual and accustomed grounds and stations" (U.S. v. Washington 1974). The Supreme Court affirmed the substance of the Boldt decision following several years of resistance on the part of Washington State (Washington v. Washington State Commercial Passenger Fishing Vessel Association 1979).

Subsequent proceedings determined that the treaty rights pertain to hatchery fish, shellfish and all other species found at the usual and accustomed grounds and stations of a given tribe (U.S. v. Washington, reporter volume 759, 1985; and (U.S. v. Washington 1998 and 1999). There are no restrictions on the methods that tribes may use to take fish, and the fish may be taken for any purpose (U.S. v. Washington 1974).

Private parties, the state, or the federal government may not limit access to tribal usual and accustomed grounds and stations without congressional approval (Muckleshoot v. Hall 1988; and Northwest Sea Farms v. Army Corps of Engineers 1996). The State may regulate the exercise of treaty fishing rights when necessary for conservation purposes, provided that the state regulations do not discriminate against Indian treaty fisheries (Puyallup Tribe v. Washington Department of Fish and Game 1968; Washington Game Department v. Puyallup Tribe 1973; Puyallup Tribe v. Washington Game Department 1977; and U.S. v. Washington 1975 and 1976). In other words, the State may not directly regulate Indian fisheries until after it has established the absolute conservation necessity for its action (U.S. v. Washington 1985). This authority has rarely been exercised, in part, because the Tribes and State manage fisheries cooperatively through agreements such as the one that is the subject of this Environmental Impact Statement (Secretarial Order No. 3206, *American Indian Tribal Rights, Federal-Tribal Trust Responsibilities and the Endangered Species Act*, June 5, 1997). The same principles apply when the United States regulates treaty fisheries, since the federal trust responsibility requires that the actions of the government support the exercise of treaty fishing rights.

3.4.5 Tribal Regulation and Usual and Accustomed Grounds and Stations

The tribes of Washington State, prior to western contact (Secretarial Order No. 3206, *American Indian Tribal Rights, Federal-Tribal Trust Responsibilities and the Endangered Species Act*, June 5, 1997), governed the fisheries of Puget Sound with a set of rules that were dependent upon inter-tribal relations and kinship ties between tribal groups (U.S. v. Washington 1974). Tribal authority to regulate member fishing on and off the reservation has been recognized in the modern era as well (U.S. v. Washington, 1975 and 1976; and Settler v. Lameer 1974). In recent years, tribal regulators have worked in conjunction with state and federal managers on a variety of matters that address conservation and habitat protection.

There has been a significant amount of litigation over what constitutes a particular tribe's usual and accustomed grounds and stations. Judge Boldt originally ruled that:

> . . . every fishing location where members of a tribe customarily fished from time to time at and before treaty times . . . is a usual and accustomed ground or station at which the treaty tribe reserved, and its members presently have, the right to take fish stations.
>
> U.S. v. Washington 1974.

This interpretation was applied to determine the usual and accustomed grounds and stations of a number of intervening tribes (U.S. v. Washington 1975), which continue to be refined through additional litigation (Muckleshoot Indian Tribe v. Lummi Indian Nation 1998; and Muckleshoot Indian Tribe v. Lummi Indian Nation 2000). Tribal fishermen can exercise treaty fishing rights only at the usual and accustomed fishing grounds and stations of their respective tribe. Determining tribal usual and accustomed areas can sometimes be complex due to the fact that many of the modern tribes are federally-imposed confederations of differing bands and tribes of various treaty signatories. For purposes of this Environmental Impact Statement, however, it is not critical to determine with precision which tribe may fish at a particular site. Instead, the task is to ensure that the Puget Sound Chinook Harvest Resource Management Plan and alternatives are evaluated for consistency with treaty rights and the federal trust responsibility to recognize that all locations within the action area comprise the usual and accustomed grounds and stations of one or another of the Puget Sound tribes.

3.4.6 Limitations on the Exercise of Indian Treaty Rights

Congress has the authority to abrogate or limit the exercise of Indian treaty rights, but such abrogation will be found only if there "is clear evidence that Congress actually considered the conflict between its intended action on the one hand and Indian treaty rights on the other, and chose to resolve that conflict by abrogating the treaty" (U.S. v. Dion 1986). The Supreme Court has ruled that Indian treaty rights are property rights (Menominee Indian Tribe v. United States 1968; and Hynes v. Grimes Packing Company 1949). Thus, the Fifth Amendment to the Constitution requires that the United States pay "just compensation" for the taking of Indian treaty rights (U.S. v. Shoshone Tribe of Indians 1938). Accordingly, courts will not lightly imply a finding that treaty rights have been abrogated (Menominee Indian Tribe v. U.S. 1968).

Whether the Endangered Species Act applies directly to limit the exercise of Indian treaty rights has not been resolved, and the two courts that have directly addressed the issue reached conflicting results (compare U.S. v. Dion 1985 and 1986, with U.S. v. Billie 1987; also see *Application of the Endangered Species Act to Native Americans With Treaty Hunting and Fishing Rights* 1980).

Because tribes and the federal government have vital interests in salmon recovery, the tribes and the federal government jointly developed a way to harmonize treaty rights and recovery efforts under the Endangered Species Act. The Secretaries of the Interior and Commerce signed an Order in 1997, directing both the National Marine Fisheries Service and the U.S. Fish and Wildlife Service to engage in government-to-government negotiations with affected Indian tribes when exercising their authorities under the Endangered Species Act (Secretarial Order No. 3206, *American Indian Tribal Rights, Federal-Tribal Trust Responsibilities and the Endangered Species Act*, June 5, 1997). The purpose of the Secretarial Order is to ensure that the agencies that administer the Endangered Species Act "carry out their responsibilities under the Act in a manner that harmonizes the Federal trust responsibility to tribes, tribal sovereignty, and statutory missions of the Departments, and that strives to ensure that

Indian tribes do not bear a disproportionate burden for the conservation of listed species, so as to avoid or minimize the potential for conflict and confrontation" (Secretarial Order No. 3206, Section 1). In addition, an appendix to that Secretarial Order spells out federal obligations to consult with tribes in evaluating candidate species, the listing process, section 7 consultations, habitat conservation planning, recovery planning and in carrying out law enforcement functions that follow (see Wilkinson 1997).

The National Marine Fisheries Service acknowledges that it has a "trust obligation to minimize impacts on tribes as much as possible while still meeting agency responsibilities under the Endangered Species Act. As provided in the Secretarial Order (Wilkinson 1997):

> In cases involving an activity that could raise the potential issue of an incidental take under the Act, such notice shall include an analysis and determination that all of the following conservation standards have been met:
>
> (i) the restriction is reasonable and necessary for conservation of the species at issue
>
> (ii) the conservation purpose of the restriction cannot be achieved by reasonable regulation of non-Indian activities
>
> (iii) the measure is the least restrictive alternative available to achieve the required conservation purpose
>
> (iv) the restriction does not discriminate against Indian activities, either as stated or applied
>
> (v) voluntary tribal measures are not adequate to achieve the necessary conservation purpose.
>
> Secretarial Order No. 3206, Principle 3.

Salmon recovery efforts must strive to achieve two goals: 1) the conservation and delisting of endangered and threatened species under the Endangered Species Act; and 2) the restoration of salmon populations to a level sufficient to allow for the full exercise of treaty fishing rights (letter from Assistant Secretary for Oceans and Atmosphere to Ted Strong, Chairman of the Columbia River Inter-Tribal Fish Commission, July 21, 1998). However, any conservation burden required under the Endangered Species Act must be allocated in a manner that ensures, among other things, that it does not discriminate against Indian treaty fishing, and is implemented in the least restrictive manner necessary to provide self-sustaining natural- and hatchery-produced salmon (U.S. v. Washington 1985).

The Endangered Species Act provides a basic level of protection for conservation and survival of listed species with the goal of bringing them to the point at which the measures provided by the Act are no longer necessary. The trust obligation of the federal government to the Tribes to restore salmon stocks to commercially-harvestable levels is an additive trust and treaty-based obligation above that prescribed by the Endangered Species Act (letter from Assistant Secretary for Oceans and Atmosphere to Ted Strong, Chairman of the Columbia River Inter-Tribal Fish Commission (July 21, 1998).

3.5 Treaty Indian Ceremonial and Subsistence Salmon Uses

Introduction

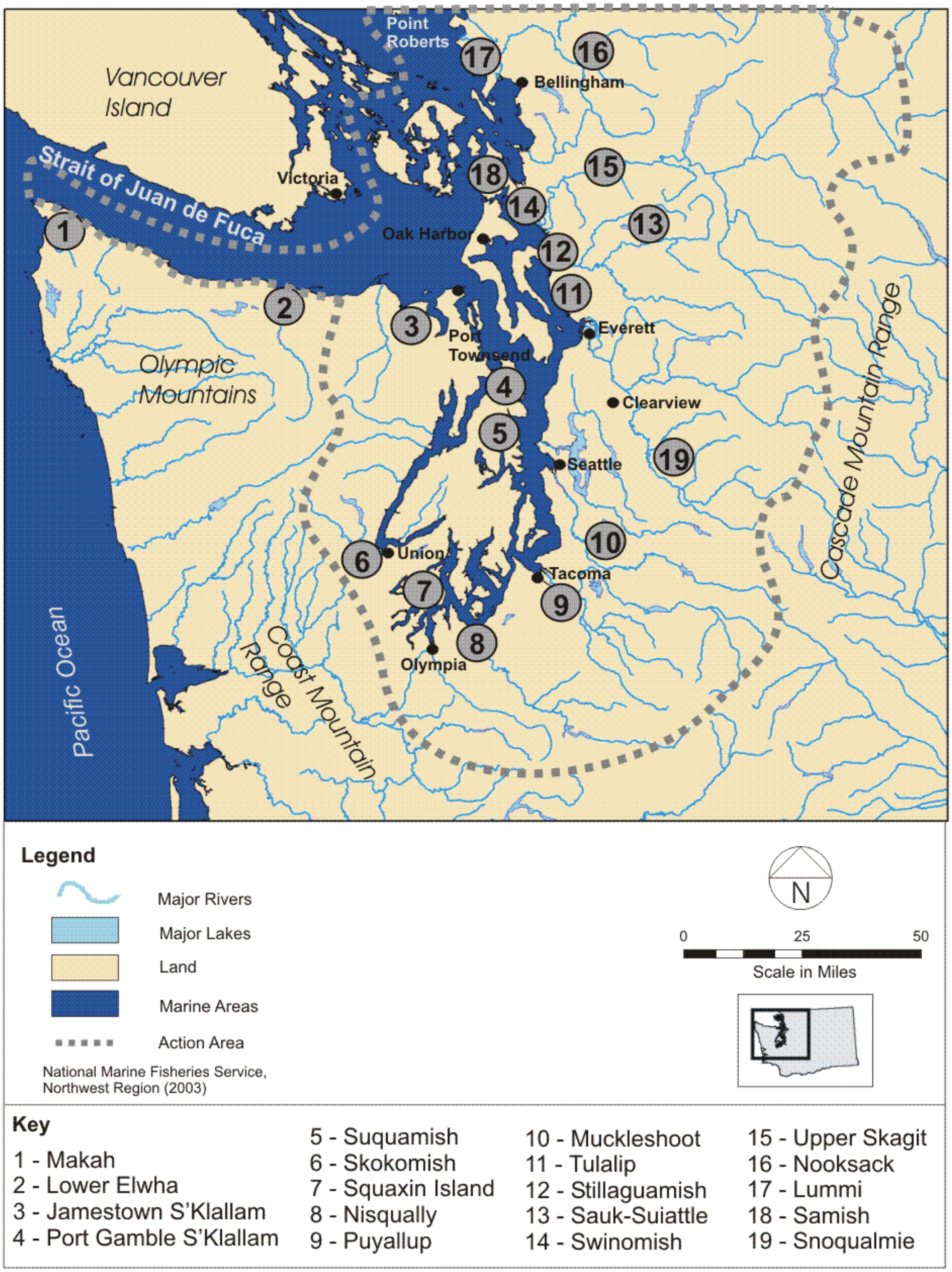
Salmon is a key resource for each of the 17 treaty Indian tribes within the Puget Sound Action Area. Tribes with adjudicated fishing rights include the Makah, Elwha Klallam, Jamestown S'Klallam, Port Gamble S'Klallam, Skokomish, Squaxin Island, Nisqually, Puyallup, Muckleshoot, Suquamish, Tulalip, Stillaguamish, Sauk-Suiattle, Swinomish, Upper Skagit, Nooksack, and Lummi. Their right to fish for salmon is previously described in Subsection 3.4. The Samish and Snoqualmie tribes are also federally-recognized tribes within the action area whose ancestors were parties to the Treaty of Point Elliott (Figure 3.5-1). These two tribes do not have federally-recognized treaty fishing rights at the present time. Although their access to fish is limited (as described in Subsection 4.5 of this Environmental Impact Statement), their utilization of salmon for ceremonial and subsistence purposes is similar to that of the tribes with adjudicated fishing rights.

Salmon is ubiquitous (omnipresent) in Indian culture within the action area. It is regularly eaten by individuals and families, and served at gatherings of elders and to guests at feasts and traditional dinners. Salmon is treated ceremoniously by Indians throughout the action area at present as it has been for centuries. Salmon is of nutritional, cultural, and economic importance to tribes. To Indians of the action area, salmon is a core symbol of tribal identity, individual identity, and the ability of Indian cultures to endure. It is a constant reminder to tribal members of their obligation as environmental stewards. Traditional Indian concepts stress the relatedness and interdependence of all beings including humans within the action area. Thus, the survival and well-being of salmon is seen as inextricably linked to the survival and well being of Indian people and the cultures of the tribes. Many Indian people within the action area share traditional stories that explain the relationship between mountains, the origins of rivers, and the origins of salmon that inhabit the rivers (Ballard 1929). In traditional stories, even the humblest of creatures play important roles in sustaining life and balance in the ecological niche that has supplied food for Indian people for generations (Ballard 1927). Stories recount the values Indian people place on supporting healthy, welcoming rivers and good salmon runs. Salmon is also a symbol used in art and other representations of tribal identity.

Definition of Terms

The word *sustainable*, or *sustaining*, as used in this subsection, refers to the way indigenous people use resources to meet their present needs without compromising the ability of future generations to meet their own needs. This use is consistent with that employed by tribal members. Many Indian people

Figure 3.5-1. Location of federally-recognized Puget Sound Indian tribes that are parties to the proposed action.



speak of current environmental concerns regarding salmon in the context of their concern for children and grandchildren.

The words *traditional* or *traditionally* in this subsection refer to continuity between the past and the present in terms of Indian perception and use of salmon, as well as Indian ideas about allocation and management. Occasionally, *traditional* refers to the ethnographic description of practices and beliefs of the action area's indigenous people at the time the United States government made treaties with western Washington Indian tribes (e.g., during the mid-nineteenth century).

The term *subsistence* is used in the anthropological sense. In part, subsistence refers to the ways in which indigenous people utilize the environment and resources provided by it in order to survive; that is, to meet the nutritional needs of members of the society. The interplay of resources, technology and work created a unique economy in which Indian people of the Strait of Juan de Fuca, Hood Canal, and North and South Puget Sound thrived. Subsistence encompasses the relationships between people and their environment, between people, and between people and their past. Salmon species provided a major part of the subsistence resource within the action area.

Ceremonial and subsistence fish refers to non-commercial fish caught by tribal members and used by tribes for either ceremonial or subsistence purposes. Fishers engaged in commercial fisheries may take a portion of their catch for *ceremonial and subsistence* use, and designate that as "take home fish." Or a tribe may open a fishery specifically to catch fish for a ceremony or other community use when there is no concurrent commercial opening.

3.5.1 Historic Fisheries

3.5.1.1 The Ethnographic Record

The ethnographic record is unequivocal: all tribes in the Puget Sound Action Area share a long tradition of fishing. The cultures and societies of Indian people within the action area at treaty time were well adapted to the riverine and marine environments of the Strait of Juan de Fuca, Hood Canal, North Puget Sound and South Puget Sound. Indian people developed economies based primarily on anadromous fish. These cultures and economies developed subsequent to the stabilization of shorelines within the action area; that is, around 5,000 years ago. After that time, the conditions of water in the rivers and streams could support the returning fish populations. The abundance and predictability of the fish supported permanent human settlement along these rivers and streams as well as along the saltwater shorelines of the Strait of Juan de Fuca, Hood Canal, North Puget Sound and South Puget Sound.

Some archaeological surveys have been conducted within the action area. Data from these sites by no means provide a comprehensive view of ancient fishing practices. Geological research demonstrates significant alterations in elevations and land deformations in parts of Puget Sound associated with a major earthquake approximately 1,100 years ago. Older sites may have been submerged at that time. The few sites that have been systematically excavated and analyzed demonstrate a long tradition of fishing. These are dated to at least 1,000 years before present, the time of the alteration in water levels (Stein 2000; and Croes 1996). Some sites indicate occupation up to and through treaty time (Stein 2003).

Fisheries, for the most part salmon fisheries, were the defining feature of the cultures and economies of indigenous people of the Strait of Juan de Fuca, Hood Canal, North Puget Sound, and South Puget Sound in late eighteenth century descriptions of the area. The entire action area was characterized by its dependence upon seafood (Gunther 1950). George Gibbs, the lawyer/ethnologist who helped to draft and negotiate the Indian treaties in western Washington, wrote that “the great staple food” of the region was salmon, and noted the extraordinary quantities available in Puget Sound and elsewhere in the region. “Salmon,” he said, “form the most important staple of subsistence” (Gibbs [1856] 1877). In anthropological terms, the relationship to salmon among indigenous people formed a “culture core.” Salmon were the focus of economic activities, technological development, and ideologies. The interface of these supported the invention and application of highly successful harvesting, processing, and storage techniques. The Indian people of the action area acquired finely-tuned local knowledge regarding salmon resources, and developed sustainable methods of harvest.

Salmon were harvested using a variety of techniques, including trolling, spearing, gaffing, and taking fish in nets. Gear included several kinds of weirs, traps, dip nets, gill nets, seines, and, in certain localities, reef nets. Technologies were developed for particular circumstances, locations, and species. Harvesting technologies were extremely successful. Efficient techniques made it possible to harvest large numbers of fish as they ascended the rivers. These techniques were designed to allow selectivity in harvest, shaping of runs, and adequate escapement to the spawning grounds. William Elmendorf, an anthropologist, produced an ethnographic monograph describing the Twana (Skokomish) people of Hood Canal, including their use of weirs, based upon his fieldwork in the 1930s and 1940s. He wrote that, “Ordinarily one or more lattice sections were removed for a time each day or at night except during dip-net operations, to allow some fish to proceed to the spawning grounds or to weirs farther upstream. The Twana people believed that the ‘salmon people’ would be angered if this was not done, and would refuse to return for the next year’s run” (Elmendorf [1960] 1992). Arthur Ballard, whose observations of South Puget Sound Indian peoples were made at the end of the nineteenth and during the early twentieth century, also discussed the practice of opening weirs (Ballard 1957). Escapement allowed sufficient fish to continue upstream to spawn. Escapement also allowed sufficient fish for Indian people fishing further upriver. Fisheries were managed with an eye to sustainability, and runs were interrupted only by unanticipated natural events such as climatic or geologic incidents. Later, runs were interrupted by dams, water diversions, and other impediments constructed by non-Indians.

Winter village sites were established along drainage systems of salmon rivers and streams. The economic lives of indigenous people were organized around the seasonal runs of fish in these streams. The abundance of these fish, along with the technologies developed to harvest, process, and store the fish, sustained families and communities year-around. Salmon were eaten fresh, were cured in a variety of ways, and were stored to be consumed later or traded. Trade and commerce in fish were extensive among Indian people in western Washington and with tribal people beyond this region. Curing methods assured that harvest could be kept over an extended time for later consumption and for inter-tribal commerce.

3.5.1.2 Tribal Areas, Reservation Locations, and the Importance of Salmon

In the mid-nineteenth century, at the time of the 1850s treaties, Indian tribes occupied river drainages and marine areas throughout the Strait of Juan de Fuca, Hood Canal, North Puget Sound and South Puget Sound. Tribal members fished in the lakes, rivers, streams, creeks, bays, inlets, and open waters of the action area. Salmon returned to and were harvested from any stream that was not otherwise impassable to the fish. In general, where there were fish, there were Indian people fishing. Anthropologist Marian Smith, who worked with the Puyallup and Nisqually people, wrote that, “Fishing was the most constant occupation and whatever a man’s economic specialty, it did not greatly interfere with the fishing routine” (Smith 1940).

Reservations established by the treaties were located on or near these drainage systems or marine areas because the framers of the treaties recognized the importance of the fisheries. For example, George Gibbs noted in 1855 in the official treaty journal that the proposed Puyallup reservation “affords a good site for a village, with ground for potato patches and a small stream at which the Indians take their winter salmon,” and that “the Indians will require the shore only, this tribe being exclusively fishing Indians” (Swindell 1942). The treaties acknowledged that tribes reserved their right to continue to fish; the treaties guaranteed access to traditional fishing grounds (see Subsection 3.4 of this Environmental Impact Statement).

3.5.1.3 Post Treaty Period Fishing

Tribal fisheries in Washington faced many obstacles during the decades following statehood in 1889. These included state fishing regulations, dam construction, river diversions, development and urbanization, and pollution. In spite of these obstacles, Indian peoples maintained their identity with salmon and exhibited resistance and resiliency in their commitment to maintain their access to salmon.

1899–1920s

In the early years following statehood, fishing continued to be a primary subsistence activity for Indian people. Indian fishermen were a common sight in and around the action area. Photographs from this period show western Washington Indians fishing or processing fish. Some of these photographs have been identified by archivists as Puget Sound Indian men fishing at weirs (1890–1895), Makah women drying fish on racks (1900), Snohomish people at Tulalip processing salmon (1907), and Lummi men trolling for salmon (1900) (American Indians of the Pacific Northwest Digital Collection). By the end of the second decade of the twentieth century, Indian rights to fish off-reservation had been disregarded repeatedly by the state. Indian people were often arrested for “unlawful fishing” by state game wardens.

Fishing regulations passed by the state prohibited use of traditional Indian fishing gear such as weirs and traps. Indians were not allowed to fish in usual and accustomed places and were often challenged by enforcement officers. Treaties were invoked by tribal members who asserted their right to fish. Dams, lacking fish passage facilities, were constructed in the years just prior to World War I. Urban populations grew, non-Indian fishing proliferated, and development destroyed prime salmon habitat. Fish runs were threatened. Tribal members predicted serious environmental consequences for fish habitat. They also saw that the decline in fish habitat and runs threatened Indian livelihoods and indigenous cultures. Tribes struggled to retain their access to salmon and their rights to harvest salmon.

1930s–1960s

In the mid-twentieth century, with increasing state regulation of fishing, salmon became less available and it became more difficult for Indian people to fish in their traditional places, or with their traditional gear. However, salmon retained their symbolic and nutritional significance to Indian people because fishing itself retained its value and importance as a focus for cultural teaching, learning, and activity. Tribal people found ways to fish and continued to value and consume fish whenever they were available. Indian people defied state laws in order to obtain traditional foods from traditional locations and affirm their core cultural identity and treaty-guaranteed right to fish. Many tribal members regularly recount stories of family members who fished under cover of darkness or confronted game wardens. Indian people went to jail and to court in the 1930s to assert their treaty rights.

In spite of the obstacles, during the depression in the 1930s many Indian people fished and ate salmon year-around. Some Indian people report that because Indians were part of a fishing culture, they fared better through this period than some of their non-Indian neighbors. Indian people continued fishing in the 1940s. Adults born and reared during this period remember being taught how to fish by elders. Some elders were still making nets and fish spears and passing the knowledge on to the youth. Indian people continued to cure and smoke fish and eat fish year-around. Youth were expected to help in all chores connected with curing fish, including helping to hang the fish in the smokehouse and keeping the fires stoked in the smokehouse. Young people were taught to maneuver canoes in the rivers, and witnessed and participated in the expression of tribal values such as the distribution of catches to elders and other family members.

1960s and 1970s

During the 1960s and 1970s, tribal fishermen continued to assert their treaty-protected rights, sometimes at considerable risk to themselves. Indian people who participated in "fish-ins" in this period were beaten or jailed for their actions in asserting treaty rights. Local knowledge of streams and fishing technologies were retained and passed on to young people during these times. Traditional methods of welcoming salmon continued throughout the period, though less publicly than at present. Ceremonies were observed by families rather than by the community at large. The struggle in some ways reinforced the value of the fish to the people and their cultures. Tribal oral and written histories have incorporated the story of the struggle for treaty-protected fishing rights (Isely 1970, Deloria 1977; Wilkinson 2000; and Wray 2002).

1974 and Later: Co-Management and the Centrality of Salmon to the Culture

The 1974 Boldt decision in U.S. v. Washington, the Ninth Circuit Court of Appeals, and the United States Supreme Court affirmed tribal treaty rights to fish, and ushered in a new era for Indian fisheries. The Boldt decision mandated that the state share management of fisheries with Indians throughout the case area. Tribes adopted new technologies. Tribal people of the area now engage in ancient fisheries with up-to-date equipment. The Indian fisheries continue to be informed by generations-old social and cultural traditions that have been passed down from generation to generation. No culture stands still. Technologies are always changing, being modified, reinvented, or refined. Core values, beliefs, and traditions and their practice in daily life, that is, the non-material components of culture, sustain community and relationships despite these material changes.

3.5.2 Contemporary Fisheries

3.5.2.1 Salmon Species, Availability, and Cultural Preferences

Six species of salmon have been fished and continue to be fished by Indians in Puget Sound, Hood Canal, and the Strait of Juan de Fuca. These are:

- Sockeye or blueback salmon (*Oncorhynchus nerka)*
- Chinook (*Oncorhynchus tschawytscha*)
- Coho or silver (*Oncorhynchus kisutch*)
- Chum (*Oncorhynchus keta*)
- Pink (*Oncorhynchus gorbuscha*)
- Steelhead (*Oncorhynchus mykiss*).

Not all species enter each river; however, all species are available in the open waters of the Strait of Juan de Fuca, Hood Canal, and Puget Sound. It is likely that there was year-around availability in these open marine waters in the past.

Species vary as to nutritional value, including fat content. Many Indian people express preferences regarding the desirability of certain species for consumption. Some species are appreciated as good smoking fish. For example, chum is a leaner fish that can be smoked and kept for a year or more. Smoked "Nisqually chum" is relished as a special treat even by those who live outside the Nisqually area. Coho are said to have similar qualities to chum for drying. Indian people look forward to the first spring chinook for fresh eating. Spring chinook is cured with a special soft smoke. Some Indian people say that salmon caught in salt water has a different flavor than that caught in fresh water, and that flavor differences vary even by the part of the river from which the salmon is harvested. Some fish of the same species are thought to be better (fatter and tastier, for example) in some rivers than in others.

3.5.2.2 Fishing Areas

The boundaries of traditional fisheries were fluid rather than confining during and before treaty time. Indigenous people in the area traveled seasonally, and often shared or traded resources and engaged in commerce outside of their winter village territories. Currently, fishing areas for individual tribes are not as fluid, and tribes fish within defined management areas. These areas have been allocated and established in accord with the Facts and Findings of U.S. v. Washington in 1974, and in subsequent court rulings. In general, tribal usual and accustomed fishing grounds and stations encompass the action area. The freshwater and marine areas within the Puget Sound Action Area are fished by one Puget Sound tribe or another.

3.5.2.3 Gear

Gear used in contemporary fisheries include: set gillnets, drift gillnets, purse seine, trap, hook and line, dip nets, trolling gear, beach seine, and round haul.

3.5.3 Salmon Uses and the Cultural Significance of Salmon

“We're *salmon* people and the Northwest is *salmon*. We still have hope” Billy Frank (Clausen 2000).

The relationship of tribal people to salmon is spiritual, emotional, and cultural as well as economic. Salmon evoke sharing, gifts from nature, responsibility to the resource, and connection to the land and the water. Salmon are strongly associated with the use and knowledge of water, use and knowledge of appropriate harvesting techniques, and knowledge of traditional processing techniques. The struggle to affirm the right to fish has made salmon an even more evocative symbol of tribal identity.

3.5.3.1 Use, Distribution and Sharing

Introduction

Indian people of the Puget Sound Action Area who fish today and carry on the salmon culture were raised in that culture and identify whole periods of their lives in relationship to the salmon. They remember teething on smoked salmon and talk about eating salmon eggs for breakfast, as a snack, or in salmon egg soup. Adult fishermen today remember catching fish, sometimes by hand, as children. As youngsters, they made a fire, and cleaned and cooked the salmon on the riverbank as a treat. Salmon is not just the primary traditional food but also a food that represents to the Indian all that is his or her history, a spiritual connection to the resource, and a responsibility to that resource. It must be present at all traditional ceremonies and functions, and is served during naming ceremonies, funerals, during one-year memorials after a death, and when students are honored. No ceremony, no gathering, is complete if salmon is not present. It is served to guests and during winter ceremonials. It is served to elders for their dinners, and shared or donated widely by fishermen with elders or family members. If a person doesn’t fish him or herself, “all it takes is saying ‘I’m really hungry for fish’ and a salmon appears.” If there is an abundance of fish, they are delivered around the reservation so everyone has a share. Some fishermen are known to fish regularly and to be ready to give some to tribal people who want to smoke fish or have some fresh fish to eat. Though between tribal people, the exchange of money for fish is not always a concern, some people make a substantial amount of their livelihood by selling smoked salmon to other members of the tribe, or to members of other tribes. Some fishermen, hit hard by the low per-pound return of commercial fisheries, have turned to “roadside sales” of fresh and smoked salmon to supplement income.

The sections below describe the role of salmon in the culture of action area tribes, and the role of salmon in the lives of many individual tribal members today. Examples here are taken primarily from interviews with tribal members. Examples are also drawn from tribal newsletters and other publications. The ways in which salmon is part of the lives of Indian people are as varied as the individual Indian people and Indian cultures of the action area. There are some important commonalities, and most items described below express those commonalities.

Personal and Family Consumption/Everyday Eating

Indian people within the action area value and eat salmon whenever it is available. This includes fresh, frozen, vacuum-packed, canned, and smoked salmon. Salmon is prepared in many ways. Some Indian people consume nearly every part of the salmon in some form, including eggs, flesh, skin, and bones. Some tribes help individual members with processing and storing salmon for home use. Some tribes have community smokehouses, pressure cookers (for canning), and machines for vacuum packing that tribal members may borrow.

Informal Interpersonal Distribution and Sharing

Sharing and informal distribution of fish help to bind the community in a system of relationships and obligations. There are many informal, everyday ways that salmon are shared and distributed within each tribe and between tribes. For example, community members who are not able to acquire salmon for themselves are given salmon by others. Indian people gift friends and neighbors on the reservation with salmon. Surplus is distributed or placed in tribal lockers and freezers for future distribution to individuals (or for traditional dinners or ceremonies). Smoked salmon is sold from the back of trucks and cars in tribal parking lots. Tribal people who have smokehouses take shares of the catch of fishermen in exchange for smoking fish for them. Fish, fresh, frozen, or smoked, is given as a gift to those who help a friend or relative with a task. Fish are commonly given to food banks for the needy, both Indian and non-Indian. The tradition of feeding others and sharing with non-Indian neighbors is one that goes back to the earliest accounts of Indian relations with Europeans and Americans within the action area. Reciprocity and exchange among kin and even non-related groups, including those with whom connections have been established throughout the action area, is a foundation of meaningful human interaction between and among Indian peoples in the area.

Formal Community Distribution and Sharing

There are formal, frequent or periodic occasions during which salmon is expected or required to be served. Among these are:

<u>Elders' dinner or luncheons</u>. Tribal fishermen contribute salmon to these meals. Tribes buy salmon or they stock donated salmon for these lunches and dinners. Salmon is served often, if not at least weekly, at luncheons. Some tribes serve lunches to elders at least three days a week. Dinners for elders are held frequently. These dinners include reciprocal intertribal dinners held for elders throughout the area. Traditional food is always present at these dinners, and salmon is an essential part of the dinners. Elders are often offered salmon to take home at the conclusion of both luncheons and dinners.

<u>Distribution to elders</u>. Tribes commonly deliver salmon to elders, who are regarded with special respect by tribal members and are not always able to fish for themselves. Some tribes make fresh salmon available at central distribution points for elders and others to take home and cook. When available, salmon make up a substantial portion of an elder's diet.

<u>Community-wide and intertribal traditional dinners</u>. Community-wide and intertribal dinners may be held for any number of reasons (e.g., funerals, celebrations, intertribal ties). Fish are contributed or the tribe sends out special boats for *ceremonial and subsistence* harvests in order to harvest salmon for these dinners. Those who fish commercially may put aside a portion of the catch for personal subsistence use, and also donate or be paid by the tribe for a portion to be stored and used for traditional community dinners at times of the year when salmon are not readily available. Tribes provide storage facilities so that catches can be kept on-hand for these dinners. Some tribes tax fishermen and use the tax money to buy additional salmon from other tribes to keep on-hand for traditional dinners.

<u>Cultural dinners with other tribes</u>. An example of a cultural dinner with other tribes is the annual Canoe Journey that involves tribes from throughout the Strait of Juan de Fuca, Hood Canal, Puget Sound, and beyond. Welcoming dinners for event participants feature salmon.

<u>Dinners for guests and invited outsiders</u> feature traditional foods. Often these meals, featuring salmon, are to honor someone or some event. Hosting guests and serving traditional food, including salmon, is an important part of traditional culture.

<u>Honoring students</u>. Salmon is used in events that honor students and others for special achievements.

<u>Food basket distribution</u>. Some tribes distribute food baskets to tribal members at Thanksgiving and Christmas, and include smoked fish in the baskets.

<u>Weddings</u>. Salmon is part of the traditional meal served whenever a wedding takes place.

<u>Health fairs</u>. Traditional foods, including salmon, are featured at health fairs. The value of a traditional diet comprised of traditional foods is emphasized among many tribal leaders and educators who voice concern with health issues, such as diabetes, prevalent among tribal people. Many of these health issues are, they believe, linked to the loss of the plant, fish, and animal diet that was available to and followed by their ancestors.

Ceremonial Uses

In addition to tribally-sponsored dinners, salmon is a key food, among other traditional foods, in ceremonies. Tribes whose fisheries are depleted buy salmon from other tribes or receive donations of fish for use or distribution for ceremonial and subsistence needs. Tribes make an effort to keep salmon on-hand or send out special boats for these occasions.

Examples of other ceremonies that require traditional meals, including salmon, are winter ceremonials, naming ceremonies, giveaways and feasts, and funerals. Winter ceremonials serve guests who have traveled from throughout the action area. These ceremonies may last many days, and are held frequently during the winter months. Naming ceremonies, as well as giveaways and feasts, which are held frequently, are common throughout the action area. Indian funerals in the action area are large gatherings typically attended by the community at large, usually by more than 100 people. Funerals are accompanied by traditional meals that include salmon. These meals may take several days of preparation. Those who cook and serve must be fed, as well. The death of a tribal member is marked by remembrances or memorials a year later. Burnings are held to feed the deceased at other times. All of these events require the use of traditional foods, including salmon.

The First Salmon Ceremony and the Cultural Foundation of Contemporary Management Practices

Traditionally, Indians throughout the action area have treated salmon ceremoniously (Gunther 1926 and 1928). These ceremonies, based on ancient teachings and practices, continue today and underscore the need to welcome the fish by providing a clean place to which the salmon will want to return. According to Indian teachings, the fish come to feed the Indian people, but they will not come back if the environment is not suitably maintained or salmon are not treated properly. Elmendorf is specific about this requirement: “Most ritually-determined acts with reference to river fishing had to do with the salmon run and were directed toward insuring its continuance. The river had to be kept clean before salmon started running. HA (an informant) defined the period as starting in early August (for the Skokomish), before the first king salmon came. From this time, no rubbish, food scraps or the like, might be thrown in the river; canoes were not baled out in the river; and no women swam in the river during menstrual seclusion. The object of these precautions was to insure that the salmon would want to come” (Elmendorf [1960] 1992). Traditional first salmon ceremonies varied from location to location, depending upon species, time of the run, and cultural differences from tribe to tribe (Gunther 1927; Stern 1934; and Smith 1940). Several of the tribes within the action area use the spring salmon (chinook) in their first salmon ceremony.

Currently, first salmon ceremonies focus on thanking the fish for returning and assuring the entire community of a successful harvest. These ceremonies also draw attention to the responsibility Indian people have for providing a clean, welcoming habitat for the returning fish. Many tribes incorporate a blessing of the Indian fishing fleets or individual fishermen or fisherwomen with these ceremonies. Some ceremonies welcome non-Indian people as witnesses who are typically served salmon dinners. This welcoming of non-Indian people to be present at first salmon ceremonies is an effort to engage more of the action area's residents in sharing responsibility for the salmon and for the habitat.

First salmon ceremonies were not always publicly, or even communally, celebrated during a period of years preceding U.S. v. Washington. Some fishermen and fisherwomen continued a more private version of this ceremony, individually sharing out the first catch of the season with other community members. This practice still continues in some tribes in addition to the public ceremony. These ceremonies, once again public, are common in many communities, especially since U.S. v. Washington and the passage of the American Indian Religious Freedom Act in 1978. The ceremony reiterates and reinforces the special relationship of the Indian people to the salmon, and their respect and concern for the well-being of the salmon. Furthermore, the ceremony exhibits cultural continuity with the past and contemporary linkages to traditional cultural practices.

Modern fisheries and fishing practices of tribes are built on long-standing traditional ideas of responsibilities to fish and habitat. These practices and ideals underlie tribal approaches to management of individual salmon runs and commitment to do what is necessary to sustain runs. As one tribal member put it, "the first salmon ceremony contains the elements of fisheries management that we use today." That is, tribes manage fisheries with the assumption that fish need a clean, welcoming environment and a respectful, nurturing approach to maintaining and restoring habitat, especially spawning grounds.

3.5.3.2 Tribes and Relationship to Salmon: Responsibility and Stewardship

During the post U.S. v. Washington period, tribes have developed fisheries that promote the centrality of fish to the community and the community's responsibility to the fish. This responsibility is, as articulated by tribal people, based upon traditional teachings. While fishermen are trained in the use of new equipment and safety regulations, the status and role of the fishermen is based upon traditional understandings of the resource and habitat. The fishermen continue to contribute to the health of the tribal members by bringing in food for the community. Tribal hatcheries and stream restoration projects take advantage of new science, but are developed in the context of local knowledge and traditional regard for responsible stewardship of the land, the rivers, and the fish runs.

Tribes are working in partnerships with local, state, and federal governments, businesses, and farmers to repair degraded habitats and the polluting effects of urbanization and agricultural practices. New fish processing plants are being developed at the same time as traditional and contemporary preservation methods are being taught and passed on to younger tribal members. Fish cured in traditional ways are still a focus of community trade in fish, carrying the added value of history and custom.

In many ways, since U.S. v. Washington, because fishing is open and religious practices are protected, fish have become even more central to tribal identities than they were 50 years ago. Fishing is not the "under cover of darkness" activity it was by necessity for so many years. But because of the difficulties encountered during those many years, salmon are not just a food or even simply a symbol of a long and proud tradition, but a reminder of the tribal struggle to assert rights. Many of those who fish today lived that struggle and pass on their commitment to their history and their right to fish to the younger generation (Deloria 1977). In the words of one tribal person, the fish "feed the Indian" not just in body, but in spirit.

3.5.3.3 The Transmission of Fishing Culture

Youngsters, as in the past, are taught from an early age to fish and to understand that they, as tribal members, have a special responsibility to the salmon and the habitat in which it thrives. Indian fishermen and women take their children fishing and remember being taken fishing by relatives when they were growing up. When children fish with older friends and relatives, they not only learn the skills of taking and processing fish, but also hear the history and tradition of the tribes and are taught how to be a responsible member of the community. For example, beach seining is a multi-generational, group activity during which elders sit on beaches watching and advising while young people harvest the fish. During the work of fishing, everyone joins in conversations about the place, the salmon, and the history of salmon fishing, and youngsters listen to the stories shared by the elders.

Fishing is considered to be an activity that is a critical part of a tribal member's identity. No matter what else one does, learning to fish is part of one's education. Specific examples of this education include:

- Young people are taught how to work with fishing gear, how to maintain gear, how to fillet fish, and how to prepare fish for curing, freezing, and canning.
- Young people are encouraged to help elders and relatives or older tribal members with smoking fish and thus learn all the skills required for traditional smoking. This includes learning to how fillet the fish, carve the sticks on which the fish are smoked, gather and split wood for the smokehouse, thread the fish on sticks, hang the fish in the smokehouse, assure proper air circulation in the smokehouse, and tend the fires.
- Elders teach younger tribal members about smoking and other traditional skills associated with fish in less direct ways. For example, an elder may sample fish smoked by a younger tribal

member and comment on flavor and degree of dryness. An elder may visit and assess a smoke house put up by a younger tribal member.

- Elders teach awareness of the environment and the place of fish in the environment. The whole landscape is a reminder of the salmon and its centrality to the culture. For example, in South Puget Sound, the elders watch the salal berries and, if there are plenty, they say there will be plenty of salmon. Because the sword fern is part of the First Salmon Ceremony, even seeing sword fern in the environment reminds one of the salmon, and elders comment on it.

3.5.3.4 Other Activities That Underscore The Significance of Salmon in Contemporary Indian Culture

One has to participate in a culture in order for it to survive. Fishing for salmon is a part of tribal life among the Indians of the Puget Sound Action Area. Tribes have developed many ways for tribal members of all ages to feel connected with the tribe and tribal culture, and to participate in community life. Fishing and responsibility for salmon and salmon habitat is a core area for participation. There are other ways to make a living, but fishing is "in the blood," Indian people say. You "develop a relationship with salmon" from the time you are a youngster. Fishing is central to the identity of the tribes within the action area. Tribal members continue to invest in boats and nets and go fishing even if fishing is not always economically viable. Indian people teach younger family members to feel responsibility to the fish. Ways other than fishing that sustain participation in the fish culture include:

School programs. The transmission of culture and the importance of salmon to tribal identity is taught through curricula and special school programs, including language programs that feature stories of salmon and first salmon ceremonies.

Headstart programs: participation in restocking programs.

Fishing derbies for children and teens.

Strategies for protection and restoration. The "Wild Stock Restoration Initiative" created in 1996 by the tribes in conjunction with the State of Washington is an example of a strategy for protection and restoration of salmon. Tribes have voluntarily reduced harvests in order to respond to the issue of endangered salmon stocks, thus showing that they are willing to live with self-imposed restrictions to get the fish back – "if we [Indians] don't take care of the fish, we too will expire." Large numbers of fisheries biologists are employed by tribes, further signifying the tribes' commitment to the resource.

Publications/public relations that depict tribal involvement with fisheries, habitat enhancement, and fisheries programs in general. Tribal partnerships with businesses and state, federal and local government to enhance fish habitat.

On-the-job options within tribes to take time off work to fish. These options recognize both the importance of the food to families and the value to tribal identity of supporting involvement with fishing.

Cultural resource management programs. Creation of culture and heritage and tribally-operated cultural resource management programs to enhance and celebrate relationship with the past and especially recognize and maintain cultural resources that support long-standing relationship to salmon.

Tribal plaques and logos on shirts, hats, and tribal stationary that feature salmon.

Art that features salmon iconography.

Museums and exhibits that feature fish technology and relationships to water and fisheries; repatriation of items of significance to salmon fisheries. Also exhibits, including historic and contemporary photographs, that honor generations of fishermen and their contributions to the tribes.

3.5.3.5 Summary

The availability of salmon as an economic base and a cultural, ceremonial, and religious staple has provided for enhanced social cohesion and promoted cultural vitality among Puget Sound tribes. Its centrality to the Indian culture has been reaffirmed by court cases like U.S. v. Washington. Some refer to it as "a calling back home." In many instances, Indian people came back to live with relatives and friends on reservations because there was economic opportunity. The enhanced fisheries opportunities demanded that new generations of fishermen and women be trained. The core group of elders and fishermen who had local knowledge of the waters, the currents, the tides, the habits of fish, and the requirement of habitat came forward to train others in this specialized cultural knowledge. New technologies were learned and taught along with the guidance of local, traditional knowledge.

Indian people express a holistic relationship to the land and the waterways, as well as to the salmon and other creatures dependent upon the health of the land and environment. Little differentiation is made between and among spirit, nature, and culture when they speak of their obligations. Tribal people characterize their relationship to salmon as a dynamic and demanding one. The relationship draws upon indigenous teachings and insights.

The obligation to salmon articulated by Indian people is one concerned with renewal, reciprocity, and balance. Salmon is of economic importance to Indian people, and it embodies cultural, ceremonial, and social dimensions of their lives to the degree that it is a significant symbol of Indian and tribal identity. Tribal identity is realized and expressed in the many daily acts in which they engage. For the Indian people within the Puget Sound Action Area, many of those acts involve or include salmon. Tribal people have a strong present connection with salmon, and share a passionate concern for the future of salmon in the marine waters, rivers, lakes, and streams in the action area.

3.6 Economic Activity and Value

This section describes current conditions and recent trends in economic activity and value associated with commercial and sport fishing for salmon and steelhead in Puget Sound. Annual average levels of salmon harvest by commercial fishermen and Puget Sound tribes are identified, and the annual average levels of fishing activity and catch by sport fishermen are also presented. The distribution of fishing activity in Puget Sound is described, including the levels of activity that occur in marine waters and fresh waters. The contribution made by salmon and steelhead fishing activity in Puget Sound to the local and regional economy also is described. Sectors of the regional economy that are most affected by fishing activity are described in terms of total sales, employment, and income generated. This information is presented for three multi-county regions that comprise the Puget Sound Action Area: the Strait of Juan de Fuca/North Hood Canal region, North Puget Sound region, and South Puget Sound/South Hood Canal region. In addition to identifying the magnitude and distribution of fishing activity, the value of this activity to persons participating in commercial and sport fishing for salmon and steelhead in Puget Sound is characterized.

Where available, data for the 10-year period between 1991 and 2000 are used to characterize trends in fishing activity and associated economic values; however, in some cases, data are available for only a portion of this time period. More detailed tables of information on fishing activity and associated economic values that include annual levels of salmon harvest and fishing activity between 1991 and 2000 are included in Appendix D to this Environmental Impact Statement, Technical Methods – Economics.

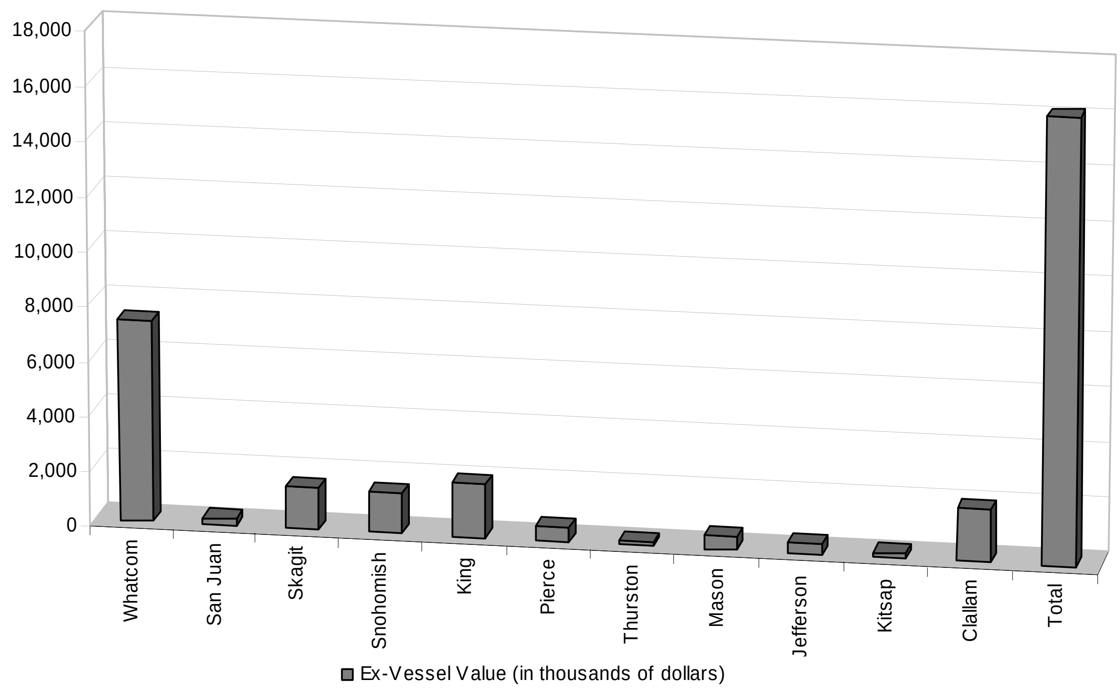
In addition to the value that salmon resources have to commercial and sport fishers and the local and regional economy, it should be recognized that these resources have value to persons that don't directly use or consume the resources. These values are often referred to as non-use or passive use values. Avoiding extinction of endangered species has been recognized as a source of passive use values (Meyer, 1974; Randall and Stoll, 1983; Stoll and Johnson, 1984). Existence values are defined as the benefit received from simply knowing the resource exists even if no use is made of it. Wild stocks of Puget Sound Chinook salmon clearly fit into this definition. As noted by Olsen et al. (1991) in his study of existence value of doubling the size of Columbia River Basin salmon and steelhead runs, "Existence value represents the benefit that individuals gain from the knowledge that doubling of salmon and steelhead runs would provide the runs with greater ecological stability and diversity." Passive use values also are considered public goods, in that the benefits can be simultaneously enjoyed by millions of people all across the region and the country (Loomis, 1996). Although nonuse values associated with the recovery of listed Puget Sound Chinook salmon are theoretically measurable and likely differ to some extent between the alternatives, existing data on recovery rates are too limited to reliably estimate these values.

3.6.1 Commercial Salmon Harvesting and Processing

3.6.1.1 Salmon Harvesting

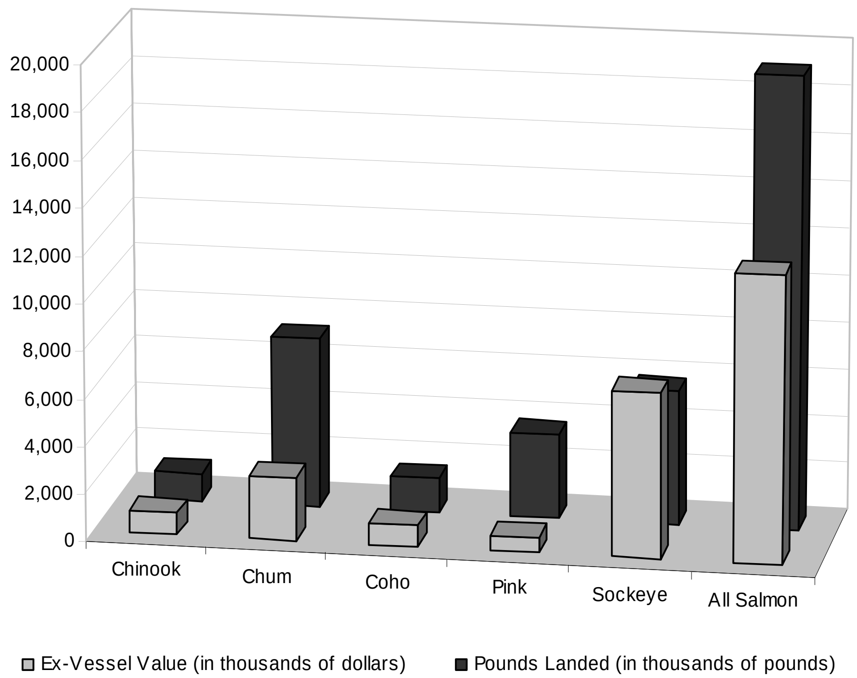
The annual average ex-vessel value (i.e., the dollar value that commercial fishermen receive for their product once it leaves the fishing vessel) of salmon landed at Puget Sound ports between 1991 and 1998, is shown by county in Figure 3.6-1. The sources of these landings include salmon harvested in Alaska, British Columbia, Coastal Oregon, and Washington, in addition to Puget Sound. The average annual value over the 8-year period was $16.2 million, with landings in Whatcom County accounting for about 45 percent of this value ($7.4 million). Ports in King County and Clallam County contributed $1.99 and $1.94 million, respectively.

Figure 3.6-1. Annual average ex-vessel value of commercial salmon landed at Puget Sound ports between 1991 and 1998, by county.



The annual ex-vessel value of commercial salmon landings from Puget Sound averaged about $12.2 million between 1991 and 2000 (Figure 3.6-2), or about 75 percent of the annual average value of salmon landings at ports in the Puget Sound area between 1991 and 1998. Landings of sockeye salmon caught in Puget Sound averaged $7.01 million annually, accounting for more than 57 percent of the average ex-vessel value of all salmon landings. Landings of chum salmon averaged $2.68 million annually (about 22% of the average annual value). Landings of chinook, coho, and pink salmon, which are only harvested during odd-numbered years, averaged less than $1.0 million annually over the 10-year period from 1991 through 2000.

Figure 3.6-2. Annual average catch (tribal and non-tribal) and ex-vessel value of commercially-caught salmon in Puget Sound between 1991 and 2000.



The annual average commercial catch (both tribal and non-tribal) of salmon harvested in Puget Sound is also shown in Figure 3.6-2. In terms of pounds landed, chum salmon accounted for the largest percentage of the salmon harvest, averaging 7.22 million pounds per year over the period 1991 though 2000. This share represents about 38 percent of the average annual salmon landings (19.2 million pounds) over the 10-year period. Average annual landings of sockeye salmon accounted for 5.71 million pounds (about 30% of the average annual salmon landings), pink salmon accounted for 3.62 million pounds (about 19%), coho salmon accounted for 1.47 million pounds (about 8%), and chinook salmon accounted for 1.16 million pounds (about 6%). More than 83 percent of the commercially-caught Puget Sound salmon in 2001 was taken by commercial fishermen using purse seines, and about 15 percent was taken by commercial fishermen using gillnets (see Economics Table D-7 in Appendix D).

Salmon landings from Puget Sound and the ex-vessel value of these landings decreased substantially over the 10-year period 1991 through 2000 (see Economics Table D-2 in Appendix D). During the period 1991 through 1995, total annual landings averaged about 27.4 million pounds, and the ex-vessel value of these landings averaged about $18.3 million. Between 1996 and 2000, total annual landings averaged about 11.0 million pounds, and the ex-vessel value of these landings averaged about $6.0 million. The decline in landings and ex-vessel value was particularly sharp in 1999 and 2000.

Figure 3.6-3 shows the percentage of the annual average commercial harvest (both tribal and non-tribal) of Puget Sound salmon by Marine Catch Area. (Figure 3.6-4 identifies the geographic boundaries of Marine Catch Areas.) In terms of pounds landed, Marine Catch Area 7 accounted for the largest share of the salmon harvest, averaging 55 percent of the total pounds of salmon landed annually in marine waters of Puget Sound between 1991 and 2000. More than 84 percent of the salmon caught in Marine Catch Area 7 were pink salmon and sockeye salmon (see Economics Table D-3 in Appendix D). Marine Catch Area 12 had the second-largest share of salmon caught, accounting for 17 percent of the 19.34 million pounds landed, on average, between 1991 and 2001. Marine Catch Areas 4, 6, and 9 each accounted for less than 1 percent of the average annual amount of salmon landed in Puget Sound between 1991 and 2000.

Figure 3.6-3. Percent of the annual average commercially-caught salmon in Puget Sound between 1991 and 2000, by marine catch area (in pounds landed).

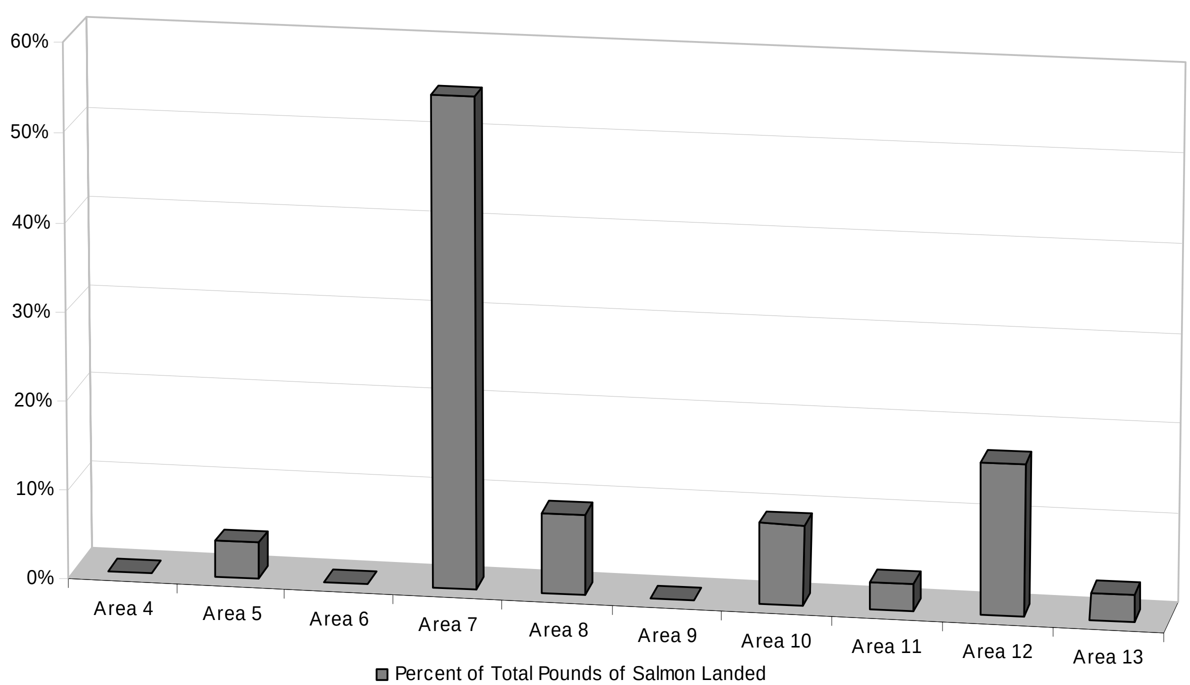


Figure 3.6-5 shows the annual average commercial harvest (both tribal and non-tribal) caught in freshwater areas of Puget Sound, most of which is tribal harvest. The Skagit River system accounted for 29 percent of the commercial harvest in freshwater areas between 1991 and 2000. The next most productive freshwater areas included the Nisqually (16%), Nooksack-Samish River (14%), Green-

Duwamish River (14%), and the Puyallup River (14%). In terms of species taken (see Economics Table D-4 in Appendix D), chum salmon accounted for the largest share (about 41%) of the commercial harvest (pounds landed) in freshwater areas, followed by coho (29%), chinook (18%), pink (12%), and sockeye (less than 1%).

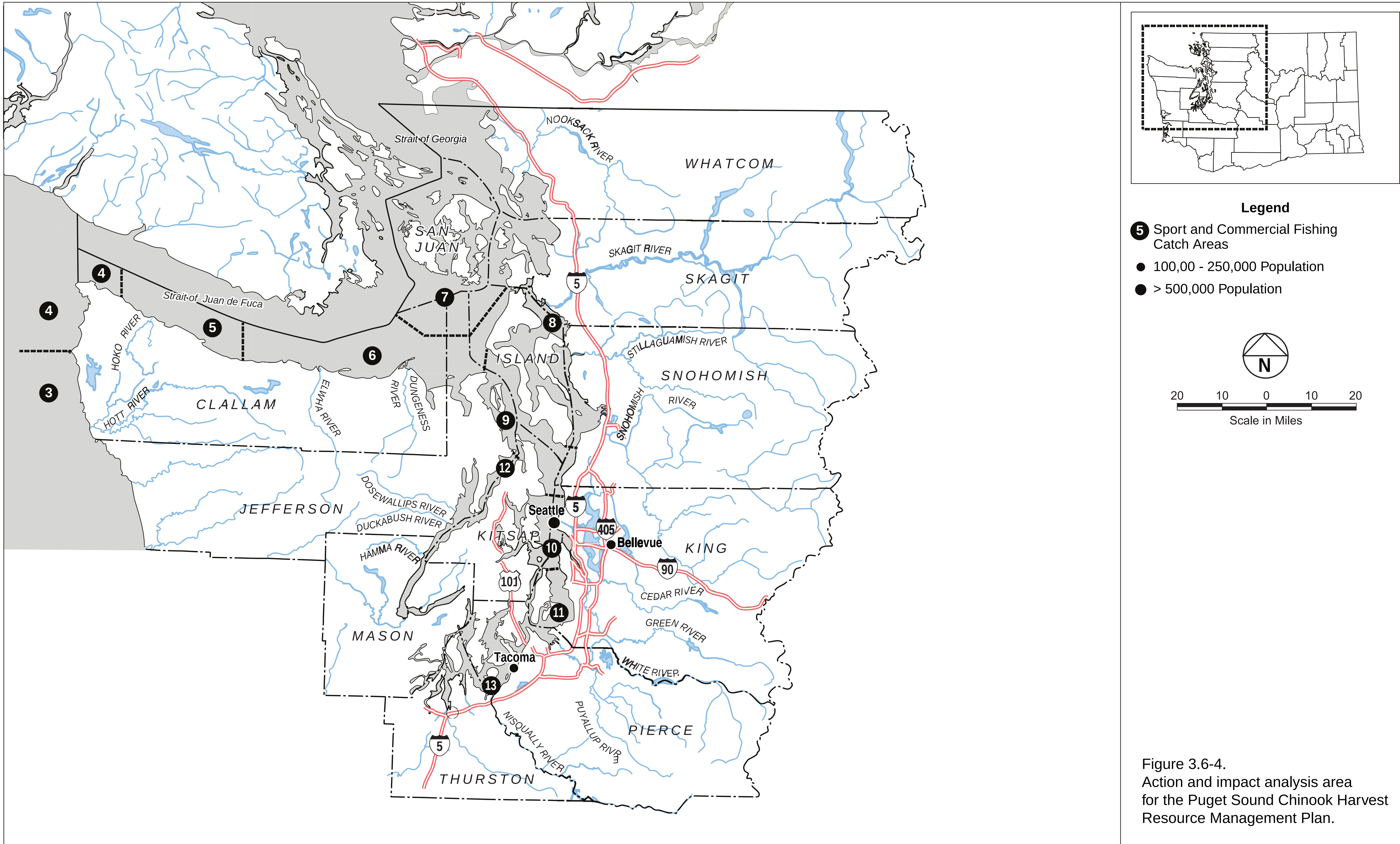
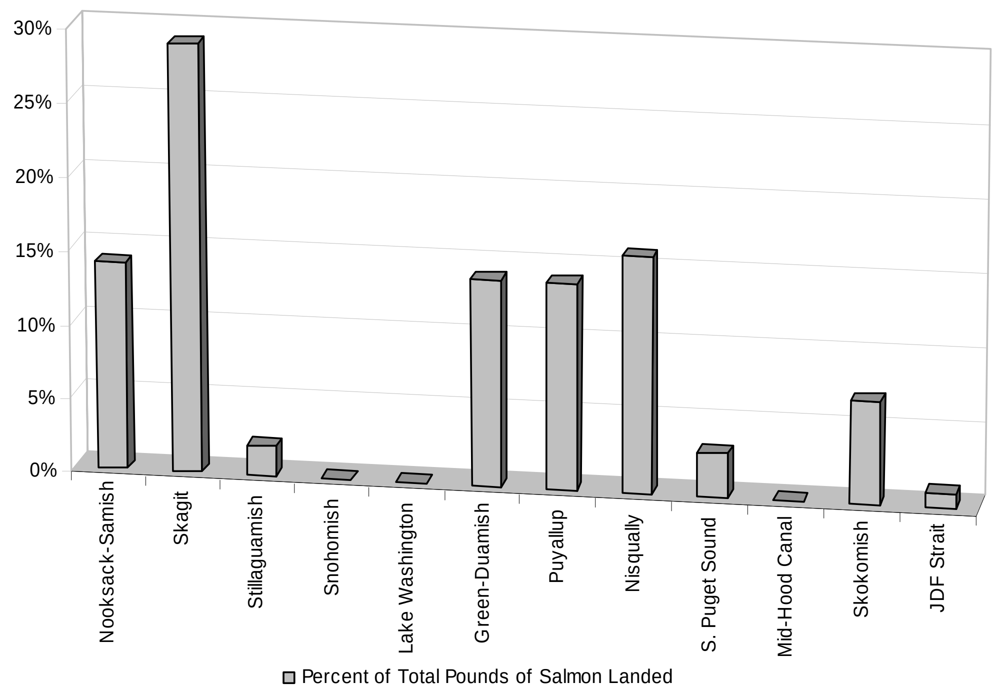


Figure 3.6-4.
Action and impact analysis area for the Puget Sound Chinook Harvest Resource Management Plan.

Figure 3.6-5. Percent of annual average commercially-caught (tribal and non-tribal) harvest of salmon in freshwater areas of Puget Sound.



The number of non-tribal licenses issued for commercial salmon fishing in Puget Sound has declined each year over the period 1991 though 2000, with the exception of the year 2000 when the same number of permits were issued as in 1999 (see Economics Table D-5 in Appendix D). In 1991, 1,512 licenses were issued for commercial salmon fishing in Puget Sound, of which about 94 percent were issued to Washington residents. By 2000, the number of licenses issued had declined to 987, of which about 96 percent were issued to Washington residents.

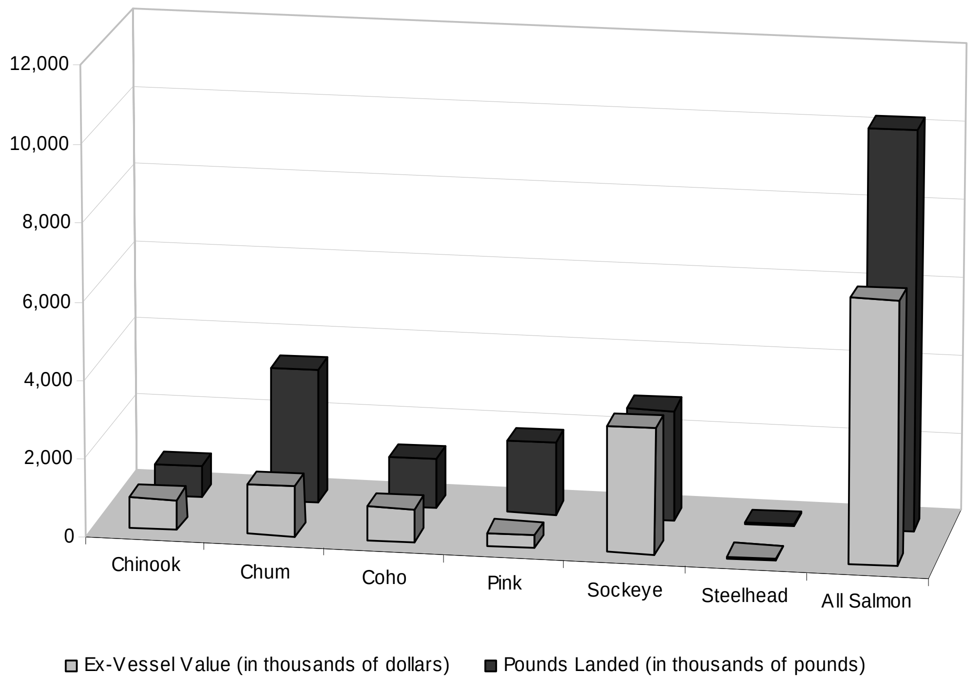
To evaluate the regional effects of fishing activity, counties that border Puget Sound are grouped into three regions: North Puget Sound, consisting of Whatcom, Skagit, Snohomish, Island and San Juan counties; South Puget Sound/South Hood Canal, consisting of King, Pierce, Thurston, Mason, and Kitsap counties; and the Strait of Juan De Fuca/North Hood Canal, consisting of Clallam and Jefferson counties (see Figure 3.2-2). About 56 percent of the 9.9 million pounds of salmon landed in 2001 was taken by commercial fishermen who live in the North Puget Sound region, and about 38 percent of the pounds landed was taken by commercial fishermen who live in the South Puget Sound/Hood Canal region (see Economics Table D-6 in Appendix D). Commercial fishermen who reside in the Strait of Juan de Fuca/North Hood Canal region accounted for about 4 percent of the salmon harvested in 2001, and residents from outside the Puget Sound region accounted for the remaining 2 percent of the salmon harvest in 2001.

The economic value of the Puget Sound commercial salmon fishery can be measured in terms of its monetary value to producers and consumers. Producers include the commercial fishers, including operators (or permit holders) and crewmembers, and fish processors. Consumers include the public that consumes salmon. Revenues received by the commercial fishers for their harvest represent gross economic value, also referred to as ex-vessel value. Net economic value is the amount of total revenues received by the vessel operators less the costs of production, including wages, operational expenses such as fuel and equipment, and fixed costs such as insurance and depreciation.

As discussed in a 1988 study of the economic value of non-tribal salmon fisheries (Washington Department of Community Development 1988), many non-tribal commercial fishermen fishing for salmon in Puget Sound are part-time or occasional fishermen and operate at a loss, indicating negative net economic values. In some cases, the operating losses associated with salmon fishing are offset by profits from fishing for non-salmon species. Based on a literature review of existing studies (National Marine Fisheries Service [NMFS] 2002), the net economic value of commercial salmon fishing along the West Coast ranges from about 7 percent to about 53 percent of the ex-vessel value. These values reflect "average" conditions over different time periods and across different gear types and species. Recent analyses of net economic values for commercial salmon fisheries in the Pacific Northwest prepared by The Research Group (personal communication with Hans Radtke ~~pers. comm.~~, The Research Group, October 21, 2003) indicate that net economic values for commercial salmon fishing and processing are roughly 50 percent of the ex-vessel value for harvesting and 20 percent of the ex-vessel value for processing. These estimates also represent averages across different vessel types and species. Based on the average annual ex-vessel value of $12.2 million for salmon commercially-caught (both tribal and non-tribal) in Puget Sound over the 10-year period 1991 through 2000, the net economic value is estimated at $8.5 million.

The net economic value to consumers of the Puget Sound salmon fishery is represented by the effect of harvesting Puget Sound salmon on salmon prices. Based on a literature review conducted for a 2002 study (National Marine Fisheries Service 2002), reductions in the supply of commercially-caught salmon have been found to affect the price of salmon to consumers; however, this effect depends on many factors, including the quantity of change in supply.

Figure 3.6-6. Annual average catch and ex-vessel value of salmon harvested by tribes in Puget Sound (1991-2000).



In summary, the annual ex-vessel value of salmon commercially-caught (tribal and non-tribal) in Puget Sound averaged about $12.2 million over the 10-year period between 1991 and 2000. This value represents about 75 percent of the ex-vessel value of all salmon landed at ports in the Puget Sound area; salmon caught elsewhere, including Alaska and Canada, also are landed at ports in the Puget Sound area. The value of the Puget Sound commercial salmon fishery has declined sharply over the 10-year period, from $24.4 million in 1991 to $5.9 million in 2000. Sockeye salmon is the most valuable salmon fishery to both tribal and non-tribal commercial fishermen, accounting for about 50 percent of the annual average value to tribal fishermen, and about 57 percent to non-tribal commercial fishermen. About 83 percent of salmon landings by non-tribal commercial fishermen is caught using purse seines. Of the salmon caught in the marine waters of Puget Sound, about 57 percent are caught in Marine Catch Area 7; about 29 percent of salmon caught in fresh waters around the Puget Sound are caught in the Skagit River system. The net economic value of the annual average harvest of Puget Sound salmon between 1991 and 2000 is estimated at $8.5 million.

3.6.1.2 Processing of Commercial Salmon Catch

Salmon processing in the Puget Sound region, as well as within Washington as a whole, consists primarily of cleaning, gutting, heading, and icing operations, and, to a much lesser extent, smoking and curing operations (Washington Department of Community Development 1988). Salmon canneries have not operated in the region since the early 1990s, with the exception of small, speciality operations focused on pink salmon (personal communication with Richard Ranta, National Marine Fisheries Service, April 4, 2003).

Processors and buyers of salmon include persons who purchase salmon from tribal and non-tribal commercial fishermen, and either process the product themselves or sell it to a third party for processing. Based on information compiled by the Pacific Fishery Management Council (1999), about 195 processors/buyers operated in the Puget Sound region and purchased salmon between 1994 and 1998. King County and Whatcom County had the largest number of reported processors/buyers, with 33 and 29 processors/buyers, respectively. Other counties in the Puget Sound region with a significant number of processors/buyers include Clallam County (27), Pierce County (23), Mason County (16), and Skagit, and Snohomish counties (each with 14 processors/buyers).

During 2002, 127 tribal and non-tribal buyers of salmon purchased 23 million pounds of salmon directly from Puget Sound gillnet and purse seine vessels. The top seven buyers (all of whom purchased at least one million pounds of salmon) accounted for 62 percent of the purchases. According to industry representatives, the number of buyers has declined over the years because of heavy Alaska production and poor market conditions. At least one major buyer did not operate in 2002 (personal communication with Stephen Freese, National Marine Fisheries Service, March 14, 2003).

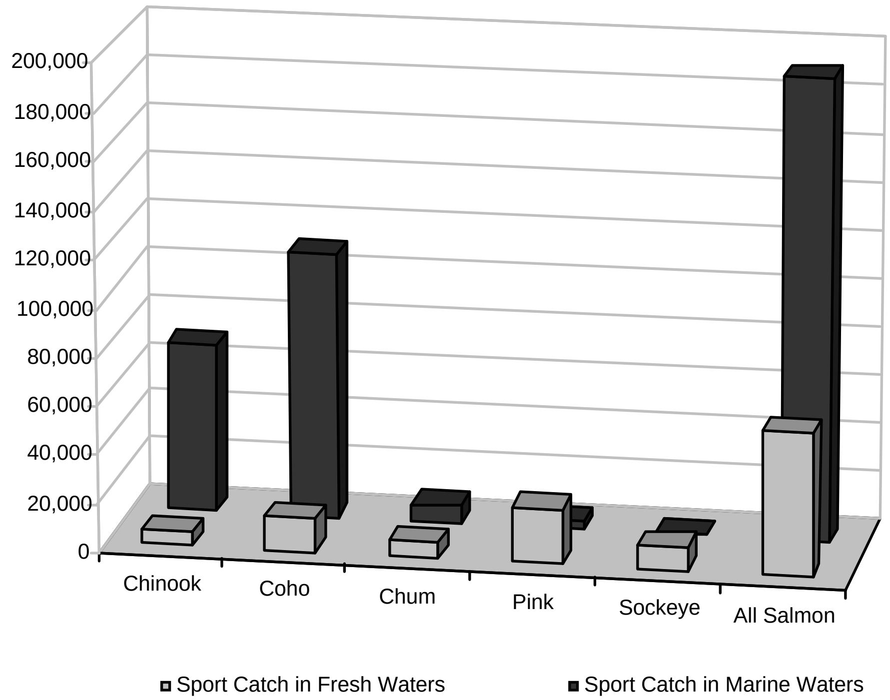
Additional information on the contribution made by processors and buyers to the regional economies is described in Subsection 3.6.3, Regional Economic Activity.

3.6.2 Sport Fishing Activity, Catch, and Value

Sport fishing for salmon and steelhead is a very popular recreational activity in the Puget Sound region. Between 1991 and 2000, the number of sport fishing trips for salmon and steelhead averaged about 578,000 trips annually (see Economics Table D-10 in Appendix D). The most popular areas are, in descending order of popularity, Marine Catch Areas 11, 5, 10, 9, and 8. (Marine Catch Areas are identified on Figure 3.6-3.) The number of sport fishing trips for salmon and steelhead declined substantially over the 10-year period, with an estimated 923,700 trips taken in 1991, decreasing to only 319,200 trips taken in the year 2000.

Figure 3.6-7 shows the annual average catch of salmon by species in marine and freshwater areas of Puget Sound between 1991 and 2000. About 76 percent of all fish caught by sport anglers were in marine waters. In terms of the distribution by salmon species, chinook and coho salmon are the primary species caught by sport anglers, and are predominantly caught in the marine waters of Puget Sound, whereas pink, chum salmon, and sockeye salmon are predominantly caught in freshwater areas.

Figure 3.6-7. Annual average sport catch (number of fish caught) of salmon in marine and freshwater areas of Puget Sound, by species (1991-2000).



Economics Table D-12 in Appendix D shows the proportion of the 2001 sport catch of salmon in marine waters of Puget Sound caught by anglers who reside in the three regions of the Puget Sound Action Area, and from outside the area. As shown, 52 percent of the 2001 sport catch of salmon was taken by anglers who live within the South Puget Sound/South Hood Canal region, and about 30 percent was caught by anglers who reside in the North Puget Sound region. Major launching areas and marinas used by anglers in the three regions are shown on Figure 3.6-8 (North Puget Sound), Figure 3.6-9 (South Puget Sound/South Hood Canal), and Figure 3.6-10 (Strait of Juan de Fuca/North Hood Canal).

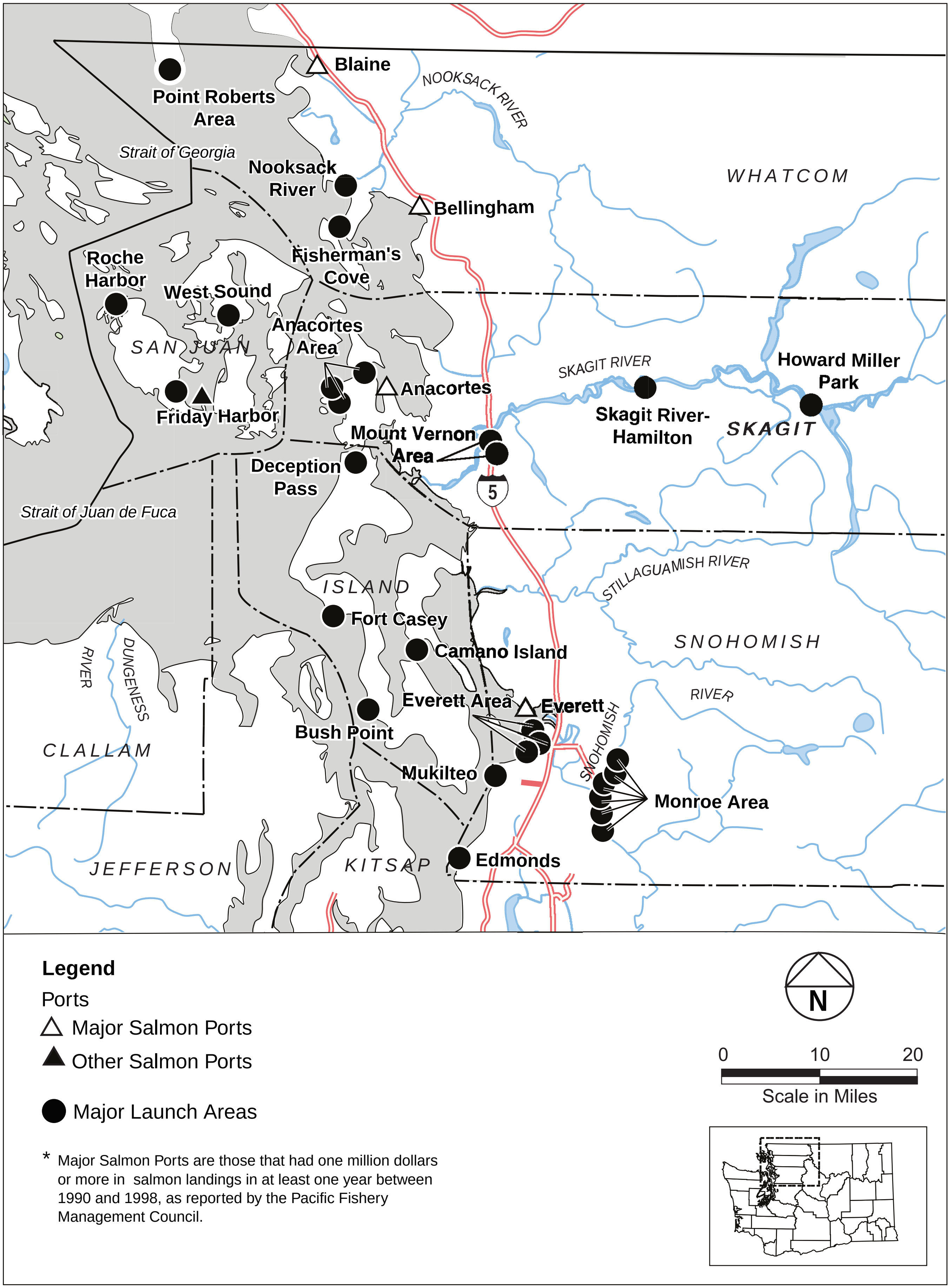


Figure 3.6-8. Salmon ports and major launch areas in North Puget Sound region.

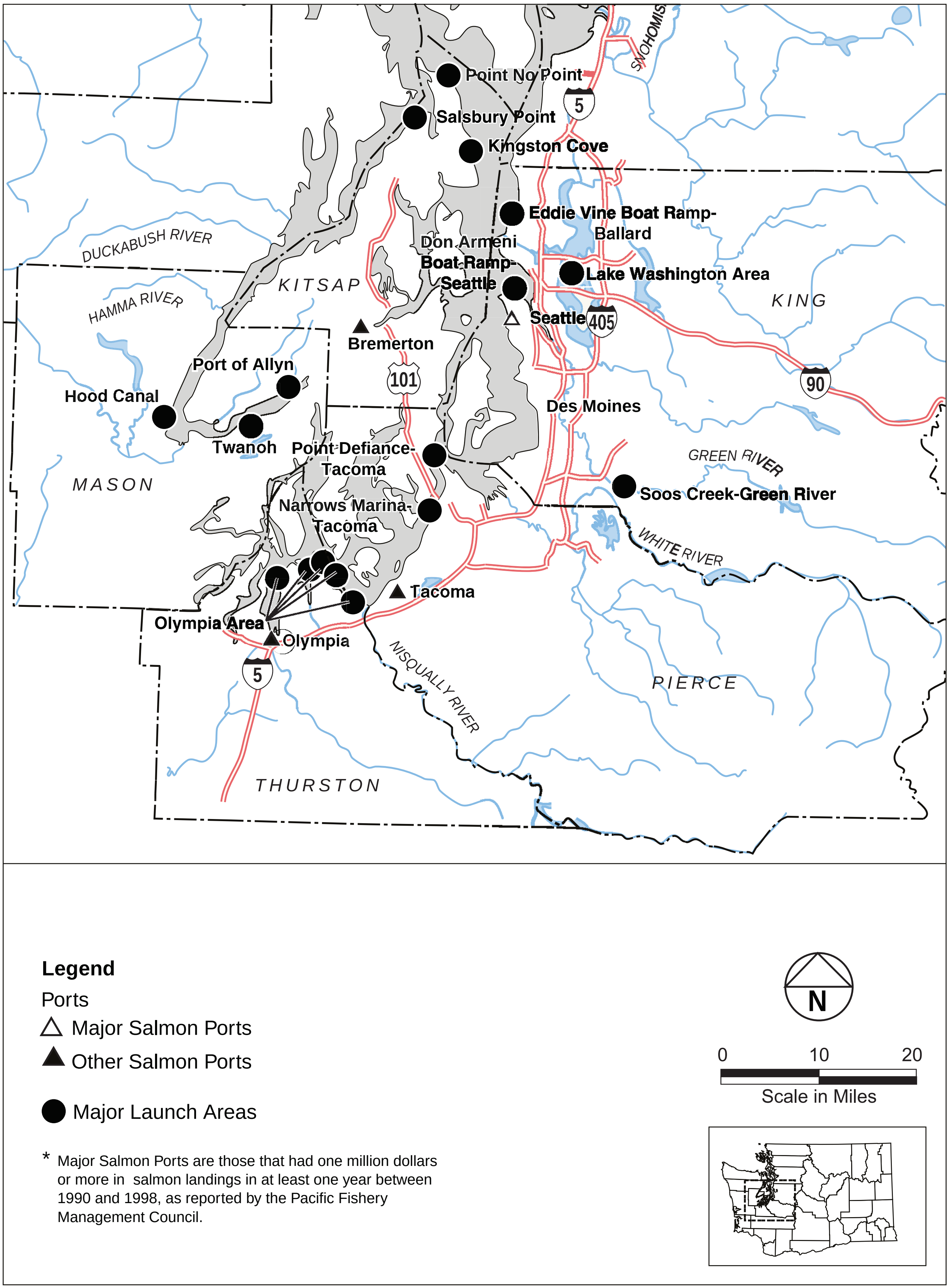


Figure 3.6-9. Salmon ports and major launch areas in South Puget Sound/South Hood Canal region.

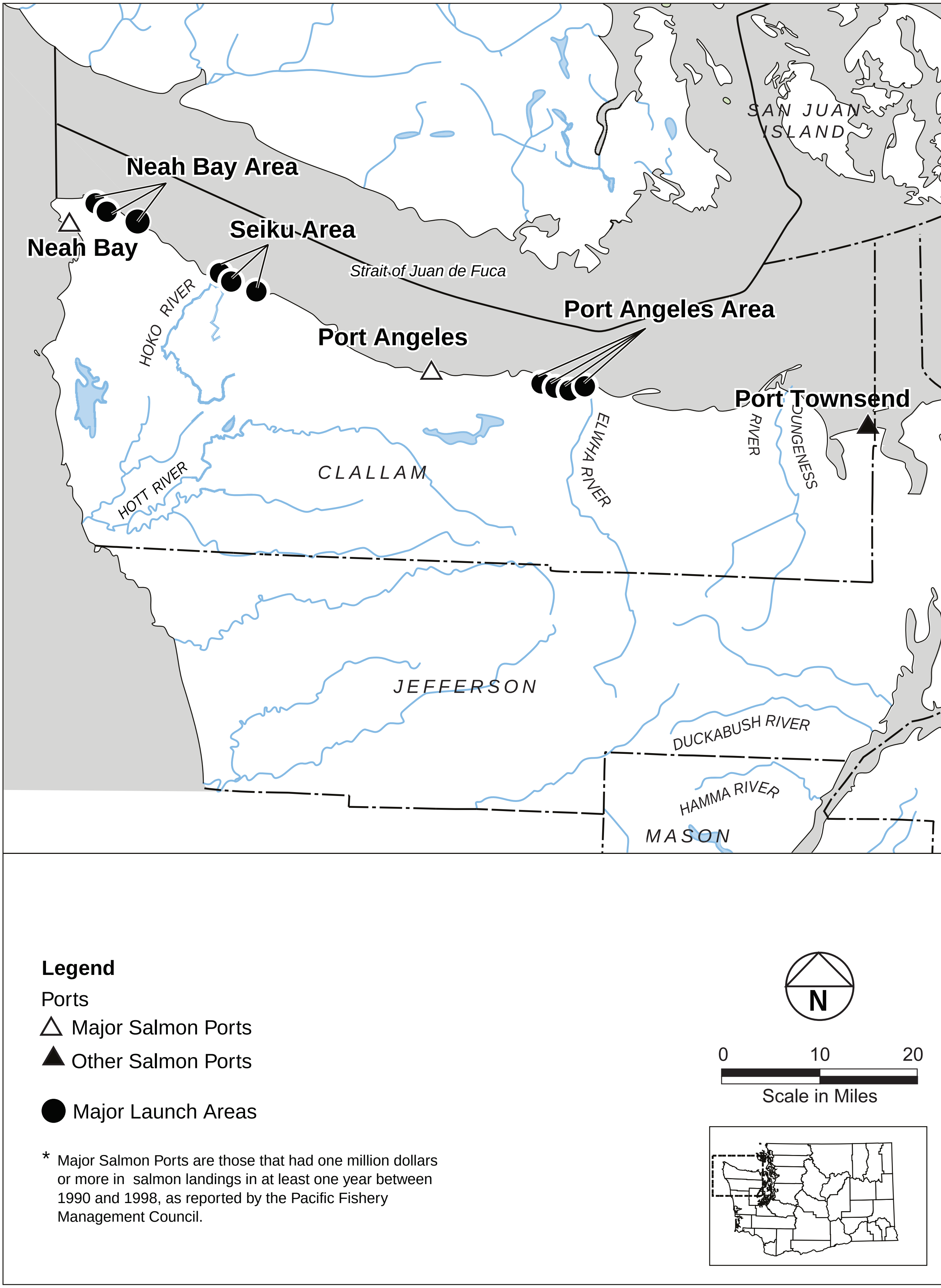


Figure 3.6-10. Salmon ports and major launch areas in the Strait of Juan de Fuca/North Hood Canal region.

Similar to the commercial salmon fishery, the economic value of the Puget Sound sport salmon fishery can be measured by the value it generates for consumers and producers. Consumers include sport anglers that engage in salmon fishing, both in marine waters and fresh waters. Producers are those businesses that provide goods and services to anglers participating in salmon sport fishing, including guides, charter boat operators, and other businesses such as bait and tackle stores, lodging places, food stores and restaurants, and miscellaneous retail stores.

Even though sport-caught salmon do not have a market price, the value to anglers can be measured by their willingness to pay (WTP) for fishing trips. Willingness to pay includes what anglers actually pay (i.e., angler spending) plus the additional amount that they would be willing to pay to continue sport fishing for salmon. The amount that anglers would be willing to pay over and above what they actually pay measures the net economic value (or the value received) to anglers. The net economic value of the sport fishery to producers (e.g., charter boat operators, guides, and other sport fishing-related businesses) can be measured by the net income (or profit) generated by sales to recreational anglers.

Based on two previous studies (The Research Group 1991 and Gentner et al. 2001) of expenditures associated with sport fishing in marine and fresh waters in the Pacific Northwest, spending by anglers who sport fish for salmon and steelhead *in marine waters* of Puget Sound is estimated to average about $55 per angler day for fishing from the shore, $50 per angler day for fishing from private boats, and $156 per angler day for fishing from charter boats (in 2000 dollars). Expenditures associated with sport fishing for salmon and steelhead *in fresh waters* of Puget Sound are estimated at about $66 per angler day. Based on the average number of sport fishing trips (assumed to be equivalent to angler days) taken during the period 1991 through 1998 (578,000 trips, roughly split evenly between marine and fresh waters), annual trip-related spending associated with sport fishing for salmon and steelhead in the Puget Sound area averaged $35.1 million. Washington-resident anglers are estimated to account for about 95 percent of all sport fishing for salmon and steelhead in Puget Sound.

As indicated above, the net economic value of the recreational salmon fishery is comprised of the additional (or net) willingness by anglers to pay to fish for salmon, plus the net income to charter boat operators, guides, and other businesses that provide goods and services to recreational anglers. Based on a study of sport fishing for salmon and steelhead in the Pacific Northwest (Olsen et al. 1991), the net economic value of sport fishing for salmon and steelhead in Puget Sound waters (including tributaries) was estimated at about $47 per angler day (in 1989 dollars). When adjusted to 2000 dollars using the consumer price index, this dollar amount is $65 per angler day. Based on the average number of sport fishing trips (assumed to be equivalent to angler days) taken between 1991 and 2000 (578,000 trips), the annual average net economic value associated with sport fishing for salmon and steelhead in Puget Sound waters is estimated at $37.6 million. The annual average net income to sport fishing-related businesses is estimated at $6.5 million, based on angler spending of $35.1 million and an average net income coefficient (derived from the Impact Model for Planning [IMPLAN] data for the Puget Sound Region) of 18.4 percent for sport fishing-related businesses. This profit margin overestimates, to a limited extent, the net income to sport fishing-related businesses because the coefficient used in the calculation includes sources of income such as rents and dividends that are not directly related to sales of sport fishing-related goods and services.

In summary, the number of sport fishing trips for salmon and steelhead in Puget Sound waters averaged about 578,000 trips annually between 1991 and 2000. The number of trips declined sharply over the 10-year period, from 923,700 trips in 1991 to 319,200 in 2000. Chinook and coho salmon are the primary species caught by sport anglers, and these are predominantly caught in marine waters of Puget Sound. Anglers who reside in the South Puget Sound/South Hood Canal region caught about 52 percent of the 2001 sport catch of salmon; anglers who reside in the North Puget Sound region caught about 30 percent of the 2001 sport catch of salmon; anglers who reside in the Strait of Juan de Fuca/North Puget Sound region caught about 9 percent of the 2001 sport catch of salmon; and persons who live outside the Puget Sound region caught the remaining 9 percent of the catch. Trip-related spending by sport anglers fishing for salmon and steelhead in the Puget Sound area is estimated to average about $35.1 million annually between 1991 and 2000. The net benefits to anglers of sport fishing for salmon and steelhead in the Puget Sound area are estimated to have averaged about $37.6 million annually between 1991 and 2000. Net income to sport fishing-related businesses is estimated to have averaged about $6.5 million annually between 1991 and 2000.

3.6.3 Regional Economic Activity

This section describes the level of economic activity within the Strait of Juan de Fuca/North Hood Canal region, North Puget Sound region, South Puget Sound/South Hood Canal region, and the action area as a whole to provide context for evaluating the effects of commercial and sport fishing for salmon in Puget Sound. Economic activity in these three regions is characterized by levels of industrial output, employment, and personal income. As shown in Tables 3.6-1 through 3.6-6, economic data are presented for major industrial sectors and for the individual industrial sectors that would be most affected by changes in sport fishing activity and commercial fishing/processing that would result from the Proposed Action or alternatives. Economic conditions are characterized using 2000 data available from secondary sources through the IMPLAN economic input-output model database (Minnesota

IMPLAN Group 2002). The underlying sources for the IMPLAN data generally include U.S. Department of the Census County Business Patterns data, U.S. Department of Labor ES-202 data, and Bureau of Economic Analysis Regional Economic Information System data (Minnesota IMPLAN Group 2000).

3.6.3.1 Strait of Juan de Fuca/North Hood Canal Region

Clallam County and Jefferson County border the Strait of Juan de Fuca and North Hood Canal and comprise this region of the Puget Sound Action Area. As shown in Table 3.6-1, the Strait of Juan de Fuca/North Hood Canal region generated $3.5 billion in industrial output (i.e., sales of goods and services) in 2000, which accounted for about 0.9 percent of statewide industrial output. Manufacturing; services; and finance, insurance, and real estate (FIRE) were dominant within the Strait of Juan de Fuca/North Hood Canal region sectors, together accounting for 54 percent of total regional output in 2000. Among the specific sectors potentially affected by the Proposed Action or alternatives (Table 3.6-2), the eating and drinking places sector was the largest, generating $102.4 million in revenue in 2000. The commercial fishing and fish/seafood processing (i.e., canned and cured seafood and prepared fresh or frozen fish or seafood) sectors generated $37.7 million and $15.8 million, respectively, in output, together representing 1.5 percent of industrial output in the Strait of Juan de Fuca/North Hood Canal region.

In 2000, employment within the Strait of Juan de Fuca/North Hood Canal region, including full- and part-time jobs, totaled about 45,500 jobs (Table 3.6-3), representing 1.8 percent of total employment within the three regions and 1.3 percent of statewide employment. Among major industrial sectors, the largest employers included the services sector (29.6% of regional employment), and the wholesale and retail trade sector (20.8%). Among the potentially affected sectors, eating and drinking places provided 6.7 percent of jobs in the Strait of Juan de Fuca/North Hood Canal region, and food stores generated 3.6 percent of jobs in this region (Table 3.6-4). Commercial fishing and fish/seafood processing generated 449 and 110 jobs, respectively, together accounting for 1.2 percent of employment in the Strait of Juan de Fuca/North Hood Canal regional economy.

As measured by employee compensation, proprietary income (i.e., payments received by self-employed persons as income), and other property income (i.e., payments from interest, rents, royalties, dividends, and corporate profits), the Strait of Juan de Fuca/North Hood Canal region-wide income totaled almost $1.9 billion in 2000 (Table 3.6-5), with the majority of the income produced by the government, FIRE, and services sectors. Among the potentially affected sectors, the food stores sector and eating and drinking places sector together accounted for $99.2 million in income, or 5.4 percent of total income within the Strait of Juan de Fuca/North Hood Canal region (Table 3.6-6).

3.6.3.2 North Puget Sound

The North Puget Sound region includes Whatcom, Skagit, Snohomish, Island, and San Juan counties. As shown in Table 3.6-1, the North Puget Sound region generated $52.2 billion in industrial output in 2000, which accounted for about 14 percent of statewide industrial output. Manufacturing was the dominant sector in the North Puget Sound region, producing 39 percent of its total output in 2000. Among the specific sectors potentially affected by the Proposed Action or alternatives, the eating and drinking places sector was the largest, generating $1.0 billion in output (Table 3.6-2). The commercial fishing and fish/seafood processing sectors generated $240.6 million and $270.7 million, respectively, together representing about 1.0 percent of North Puget Sound regional output. Similar to the Strait of Juan de Fuca/North Hood Canal region, commercial fishing and processing in the North Puget Sound region are minor industries relative to the overall level of industrial output within the regional economy.

In 2000, employment within the North Puget Sound region totaled about 480,800 jobs (Table 3.6-3), representing 18.6 percent of total employment within the three-region action area and 13.4 percent of statewide employment. Among major industrial sectors, the largest employers included the services sector (25.1% of regional jobs), and the wholesale and retail trade sector (21.4%). Among the potentially affected sectors, eating and drinking places provided 5.9 percent of jobs within the North Puget Sound region, and the miscellaneous retail sector generated 3.3 percent of regional jobs (Table 3.6-4). Commercial fishing and fish/seafood processing generated 2,373 and 1,696 jobs, respectively, together accounting for 0.8 percent of North Puget Sound regional employment.

Regionwide, income totaled almost $24.2 billion in 2000 (Table 3.6-5), with the majority of the income produced by the manufacturing, government, and FIRE sectors. Among the potentially affected sectors, the service stations and automobile dealers sector and the eating and drinking places sector together accounted for $1.0 billion in income, or 4.2 percent of total income within the North Puget Sound region (Table 3.6-6).

3.6.3.3 South Puget Sound/South Hood Canal

Five counties comprise the South Puget Sound/South Hood Canal region: King, Pierce, Thurston, Mason, and Kitsap. As shown in Table 3.6-1, the South Puget Sound/South Hood Canal region generated $194.1 billion in industrial output in 2000, representing 52.3 percent of statewide output. The services and manufacturing sectors were dominant within the South Puget Sound/South Hood Canal region, together accounting for about half of regional output in 2000. Among the specific sectors potentially affected by the Proposed Action or alternatives, the eating and drinking places sector was the largest, generating $4.9 billion in output (Table 3.6-2). The commercial fishing and fish/seafood processing sectors generated $368.2 million and $1.1 billion, respectively, in output, together representing about 0.7 percent of total Puget Sound regional output. Similar to the Strait of Juan de Fuca/North Hood Canal and North Puget Sound regions, commercial fishing and processing in the South Puget Sound/South Hood Canal region are minor industries relative to the overall level of industrial output within the regional economy.

In 2000, employment within the South Puget Sound/South Hood Canal region totaled nearly 2.1 million jobs (Table 3.6-3), representing 79.6 percent of total employment within the three regions of the action area, and 57.3 percent of statewide employment. The largest employers among major industrial sectors included the services sector (32.9% of regional jobs), and the wholesale and retail trade sector (21.2%). Among the potentially affected sectors, eating and drinking places provided 5.2 percent of regional jobs, and the miscellaneous retail sector generated 4.0 percent of regional jobs (Table 3.6-4). Commercial fishing and fish/seafood processing generated 3,345 and 5,312 jobs, respectively, together accounting for 0.4 percent of South Puget Sound/South Hood Canal regional employment.

Table 3.6-1. County, regional, and state industrial output by major industrial sector in 2000 (in millions of 2000 dollars).

Region/ County	Agriculture, Forestry and Fishing	Construction and Mining	Manufacturing	Transportation, Communications and Utilities	Wholesale and Retail Trade	Finance, Insurance and Real Estate	Services	Government	Total
Strait of Juan de Fuca/North Hood Canal:									
Clallam	$71.88	$328.27	$415.20	$116.33	$305.16	$408.86	$402.89	$338.75	$2,387.10
Jefferson	$35.84	$149.79	$291.73	$48.43	$100.89	$173.88	$187.42	$103.48	$1,091.46
Total	$107.72	$478.06	$706.93	$164.76	$406.05	$582.74	$590.31	$442.23	$3,478.56
North Puget Sound:									
Whatcom	$448.16	$1,200.06	$4,085.56	$484.51	$1.065.76	$1,081.40	$1,326.03	$484.29	$10,175.77
Skagit	$328.11	$730.36	$2,917.95	$350.06	$654.13	$591.01	$734.66	$410.48	$6,716.76
Snohomish	$362.01	$3,480.96	$13,133.07	$1,171.81	$3,307.42	$3,855.22	$3,797.15	$2,625.38	$31,733.01
Island	$32.68	$311.01	$111.37	$94.47	$225.90	$572.44	$358.71	$1,128.86	$2,835.44
San Juan	$26.58	$173.97	$48.41	$55.82	$65.69	$184.93	$156.77	$47.40	$759.55
Total	$1,197.54	$5,896.36	$20,296.36	$2,156.67	$5,318.9	$6,285.00	$6,373.32	$4,696.41	$52,220.53
South Puget Sound/South Hood Canal:									
King	$890.28	$13,526.95	$35,840.25	$16,252.61	$25,882.38	$26,220.05	$45,958.83	$9,925.25	$174,495.60
Pierce	$245.30	$3,333.16	$4,796.27	$2,149.89	$4,044.56	$4,498.52	$5,586.95	$5,384.24	$30,038.89
Thurston	$186.61	$904.87	$896.60	$566.50	$1,513.75	$1,307.32	$1,737.58	$2,297.11	$9,410.33
Mason	$53.86	$166.79	$352.71	$53.40	$149.94	$237.88	$190.21	$217.01	$1,421.79
Kitsap	$145.39	$943.97	$372.15	$381.52	$994.76	$1,240.29	$1,739.94	$2,963.14	$8,781.16
Total	$1,521.44	$18,875.74	$42,257.98	$19,403.92	$32,585.39	$33,504.06	$55,213.51	$20,786.75	$194,138.92
Three-Region Total	*$2,826.7*	*$25,250.16*	*$63,261.27*	*$21,725.35*	*$38,3120.34*	*$40,371.80*	*$62,177.14*	*$25,925.39*	*$249,838.01*
Statewide Total	$8,216.14	$33,982.75	$84,991.94	$31,118.31	$49,159.25	$50,885.03	$77,160.95	$35,474.86	$370,990.24

Source: Minnesota IMPLAN Group 2002.

Table 3.6-2. County, regional, and state industrial output by specific industrial sectors in 2000 (in millions of 2000 dollars).

Region/ County	Commercial Fishing	Canned and Cured Seafood	Prepared Fresh or Frozen Fish or Seafood	Food Stores	Service Stations and Automobile Dealers	Eating and Drinking Places	Miscellaneous Retail	Hotels and Lodging Places	Amusement and Recreation Services
Strait of Juan de Fuca/North Hood Canal:									
Clallam	$24.88	$0.66	$10.90	$49.56	$41.98	$67.17	$26.12	$27.15	$25.54
Jefferson	$12.79	$0	$4.23	$21.98	$9.96	$35.19	$8.24	$19.15	$5.06
Total	$37.67	$0.66	$15.13	$71.54	$51.94	$102.36	$34.36	$46.3	$30.6
North Puget Sound:									
Whatcom	$69.40	$1.17	$118.72	$147.86	$105.11	$208.50	$78.40	$62.94	$41.59
Skagit	$48.89	$16.02	$81.10	$64.65	$144.65	$136.96	$59.96	$26.28	$67.08
Snohomish	$105.40	$10.91	$38.89	$353.59	$597.03	$624.97	$269.64	$50.20	$156.06
Island	$3.60	$2.78	$1.10	$32.15	$29.79	$55.50	$34.75	$17.14	$5.74
San Juan	$13.28	$0	$0	$16.58	$3.11	$19.51	$8.91	$60.97	$5.08
Total	$240.57	$30.88	$239.81	$614.83	$879.69	$1,045.44	$451.66	$217.53	$275.55
South Puget Sound/South Hood Canal:									
King	$235.69	$72.96	$961.79	$1,214.00	$1,429.24	$3,645.79	$3,348.39	$878.50	$656.50
Pierce	$36.66	$0	$7.04	$347.09	$655.68	$757.96	$327.75	$79.22	$187.12
Thurston	$15.13	$0.37	$3.81	$105.23	$111.45	$191.13	$76.44	$31.30	$59.75
Mason	$6.98	$0	$30.23	$25.63	$16.66	$37.86	$7.55	$8.00	$37.64
Kitsap	$73.74	$0.34	$0.49	$144.69	$168.13	$238.87	$79.04	$37.91	$43.59
Total	$368.20	$73.67	$1,003.36	$1,836.64	$2,381.16	$4,871.61	$3,839.17	$1,034.93	$984.60
Three-Region Total	*$646.44*	*$105.21*	*$1,258.30*	*$2,523.01*	*$3,312.79*	*$6,019.41*	*$4,325.19*	*$1,298.76*	*$1,290.75*
Statewide Total	$902.14	$122.71	$1,362.10	$3,626.67	$4,575.73	$7,996.43	$5,345.88	$1,950.83	$1,541.24

Source: Minnesota IMPLAN Group 2002.

Table 3.6-3. County, regional, and state employment[1] by major industrial sector in 2000.

Region/ County	Agriculture, Forestry and Fishing	Construction and Mining	Manufacturing	Transportation, Communications and Utilities	Wholesale and Retail Trade	Finance, Insurance and Real Estate	Services	Government	Total
Strait of Juan de Fuca/North Hood Canal:									
Clallam	1,275	2,766	2,449	989	6,845	2,252	9,348	6,108	32,032
Jefferson	585	1,329	1,369	246	2,607	958	4,113	2,264	13,469
Total	1,860	4,095	3,818	1,235	9,452	3,210	13,461	8,372	45,501
North Puget Sound:									
Whatcom	5,397	9,307	10,227	3,329	21,410	5,647	26,517	11,714	93,549
Skagit	4,826	5,586	6,783	2,073	13,452	3,161	15,247	8,757	59,886
Snohomish	5,570	27,121	56,852	6,885	60,887	19,165	68,042	39,011	283,534
Island	873	2,692	898	501	5,664	2,839	7,840	13,095	34,403
San Juan	570	1,492	305	307	1,638	932	3,092	1,067	9,403
Total	17,236	46,198	75,065	13,095	103,051	31,744	120,738	60,633	480,775
South Puget Sound/South Hood Canal:									
King	14,649	98,028	155,447	83,631	317,774	114,394	507,713	165,824	1,457,460
Pierce	5,474	26,053	23,541	11,948	71,294	24,311	100,654	74,103	337,378
Thurston	3,133	7,391	4,658	2,874	21,191	6,497	31,246	42,911	119,901
Mason	680	1,422	2,233	447	3,476	1,305	4,553	3,780	17,896
Kitsap	1,898	7,633	2,984	2,363	21,608	6,761	31,760	44,093	119,100
Total	25,834	140,527	188,863	101,263	435,343	153,268	675,926	330,711	2,051,735
Three-Region Total	*44,930*	*190,820*	*267,746*	*115,593*	*547,846*	*188,222*	*810,125*	*399,716*	*2,578,011*
Statewide Total	137,115	261,023	371,402	156,152	762,495	245,736	1,084,962	564,136	3,583,022

Source: Minnesota IMPLAN Group 2002.
[1] Employment includes full- and part-time jobs.

Table 3.6-4. County, regional, and state employment[1] by specific industrial sectors in 2000.

Region/ County	Commercial Fishing	Canned and Cured Seafood	Prepared Fresh or Frozen Fish or Seafood	Food Stores	Service Stations and Automobile Dealers	Eating and Drinking Places	Miscellaneous Retail	Hotels and Lodging Places	Amusement and Recreation Services
Strait of Juan de Fuca/North Hood Canal:									
Clallam	286	7	74	1,102	714	1,995	911	642	801
Jefferson	163	0	29	531	158	1,056	364	420	203
Total	449	7	103	1,633	872	3,051	1,275	1,062	1,004
North Puget Sound:									
Whatcom	779	11	742	2,911	1,715	5,973	2,912	1,155	1,574
Skagit	557	135	485	1,498	1,852	3,812	2,151	573	1,954
Snohomish	843	80	212	7,580	6,844	16,500	9,176	978	4,583
Island	44	24	7	756	405	1,664	1,416	374	244
San Juan	150	0	0	388	54	514	330	1,101	256
Total	2,373	250	1,446	13,133	10,870	28,463	15,985	4,181	8,611
South Puget Sound/South Hood Canal:									
King	2,110	491	4,562	21,606	14,468	74,215	65,481	13,040	22,175
Pierce	424	0	56	7,333	7,317	20,184	10,948	1,535	5,933
Thurston	196	3	25	2,350	1,469	5,233	2,711	571	1,874
Mason	92	0	169	574	301	1,109	348	211	1,065
Kitsap	523	3	3	3,077	2,258	6,605	3,078	801	1,435
Total	3,345	497	4,815	34,940	25,813	107,346	82,566	16,158	32,482
Three-Region Total	*6,167*	*754*	*6,364*	*49,706*	*37,555*	*138,860*	*99,826*	*21,401*	*42,097*
Statewide Total	9,315	889	7,015	75,619	56,009	194,661	133,101	34,303	52,370

Source: Minnesota IMPLAN Group 2002.
[1] Employment includes full- and part-time jobs.

Table 3.6-5. County, regional, and state personal income[1] by major industrial sector in 2000 (in millions of 2000 dollars).

Region/ County	Agriculture, Forestry and Fishing	Construction and Mining	Manufacturing	Transportation, Communications and Utilities	Wholesale and Retail Trade	Finance, Insurance and Real Estate	Services	Government	Total
Strait of Juan de Fuca/North Hood Canal:									
Clallam	$58.75	$117.00	$151.82	$49.44	$180.06	$247.40	$221.22	$288.63	$1,314.32
Jefferson	$23.38	$48.50	$89.34	$25.89	$58.38	$106.15	$92.28	$92.16	$536.05
Total	$82.13	$165.5	$241.16	$75.33	$238.44	$353.55	$313.50	$380.79	$1,850.37
North Puget Sound:									
Whatcom	$167.30	$472.98	$778.74	$218.26	$618.56	$651.13	$747.19	$421.89	$4,076.24
Skagit	$166.43	$190.71	$526.55	$154.03	$380.02	$356.08	$433.05	$365.09	$2,888.42
Snohomish	$205.63	$1,365.10	$4,070.20	$552.80	$1,937.45	$2,322.69	$2,172.78	$2,217.95	$14,844.58
Island	$20.50	$104.93	$43.79	$47.74	$132.57	$354.45	$190.23	$1,075.12	$1,969.34
San Juan	$22.33	$59.60	$16.16	$27.40	$39.92	$113.03	$80.83	$40.86	$400.13
Total	$582.19	$2,193.32	$5,435.44	$1,000.23	$3,108.52	$3,797.38	$3,624.08	$4,120.91	$24,178.71
South Puget Sound/South Hood Canal:									
King	$613.02	$5,691.66	$12,399.57	$8,161.81	$14,965.09	$15,866.53	$31,608.10	$8,418.53	$97,724.30
Pierce	$166.07	$1,300.58	$1,607.93	$959.54	$2,338.59	$2,651.81	$3,299.57	$4,757.66	$17,081.74
Thurston	$88.11	$335.22	$287.89	$277.29	$923.54	$794.75	$1,025.08	$2,179.09	$5,910.96
Mason	$25.46	$57.55	$128.80	$24.64	$87.88	$146.51	$107.87	$176.72	$755.43
Kitsap	$112.10	$353.18	$130.52	$191.91	$588.59	$747.46	$963.30	$2,823.69	$5,910.74
Total	$1,004.76	$7,738.19	$14,554.71	$9,615.19	$18,903.69	$20,207.06	$37,003.92	$18,355.69	$127,382.17
Three-Region Total	*$1,669.08*	*$10,097.01*	*$20,231.31*	*$10,690.75*	*$22,250.65*	*$24,357.99*	*$40,941.50*	*$22,857.39*	*$153,411.25*
Statewide Total	$4,175.18	$13,435.35	$26,996.56	$14,959.04	$28,509.56	$30,744.60	$49,595.20	$30,217.67	$198,633.15

Source: Minnesota IMPLAN Group 2002.
[1] Personal income includes employee compensation, proprietor income, and other property income.

Table 3.6-6. County, regional, and state personal income[1] by specific industrial sectors in 2000 (in millions of 2000 dollars).

Region/ County	Commercial Fishing	Canned and Cured Seafood	Prepared Fresh or Frozen Fish or Seafood	Food Stores	Service Stations and Automobile Dealers	Eating and Drinking Places	Miscellaneous Retail	Hotels and Lodging Places	Amusement and Recreation Services
Strait of Juan de Fuca/North Hood Canal:									
Clallam	$22.60	$0.04	$1.44	$37.15	$25.04	$29.96	$16.39	$14.05	$14.91
Jefferson	$11.63	$0.00	$0.51	$16.48	$5.94	$15.60	$5.17	$10.07	$2.83
Total	$34.23	$0.04	$1.95	$53.63	$30.98	$45.56	$21.56	$24.12	$17.74
North Puget Sound:									
Whatcom	$24.91	$0.18	$22.45	$110.85	$62.69	$95.01	$49.18	$34.16	$23.50
Skagit	$44.40	$3.22	$17.79	$48.47	$86.27	$63.42	$37.62	$13.83	$39.60
Snohomish	$95.50	$3.24	$10.89	$265.09	$356.07	$297.54	$169.15	$26.98	$92.02
Island	$3.28	$0.49	$0.25	$24.10	$17.76	$24.62	$21.80	$9.02	$3.16
San Juan	$12.06	$0.00	$0.00	$12.43	$1.86	$9.30	$5.59	$33.18	$2.69
Total	$180.15	$7.13	$51.38	$460.94	$524.65	$489.89	$283.34	$117.17	$160.97
South Puget Sound/South Hood Canal:									
King	$213.68	$25.20	$347.16	$910.16	$852.41	$1,936.09	$2,100.67	$491.64	$378.69
Pierce	$33.30	$0.00	$1.70	$260.22	$391.05	$359.28	$205.61	$42.61	$109.06
Thurston	$13.76	$0.09	$0.55	$78.89	$66.47	$89.29	$47.96	$17.01	$34.89
Mason	$6.35	$0.00	$7.97	$19.22	$9.94	$17.03	$4.74	$4.04	$22.31
Kitsap	$105.07	$0.05	$0.07	$108.48	$100.27	$111.01	$49.58	$20.08	$25.25
Total	$372.16	$25.34	$357.45	$1,376.97	$1,420.14	$2,512.70	$2,408.56	$575.38	$570.20
Three-Region Total	*$586.54*	*$32.51*	*$410.78*	*$1,891.54*	*$1,975.77*	*$3,048.15*	*$2,713.46*	*$716.67*	*$748.91*
Statewide Total	$818.70	$37.04	$428.19	$2,718.95	$2,728.99	$3,956.59	$3,353.77	$1,066.14	$888.12

Source: Minnesota IMPLAN Group 2002.
[1] Personal income includes employee compensation, proprietor income, and other property income.

Total income within the South Puget Sound/South Hood Canal region was almost $127.4 billion in 2000 (Table 3.6-5), with the majority produced by the services, FIRE, and wholesale and retail trade sectors. Among the potentially affected sectors, the eating and drinking places sector and the miscellaneous retail sector together accounted for $4.9 billion in income, or 3.9 percent of total income within the South Puget Sound/South Hood Canal region (Table 3.6-6).

3.6.3.4 Three-Region Summary

Together, the three regions (Strait of Juan de Fuca/North Hood Canal, North Puget Sound, and South Puget Sound/South Hood Canal) generate a substantial portion of Washington's total industrial output. Led by the manufacturing and services sectors, the three regions generated a total of $249.8 billion in output in 2000, accounting for more than two-thirds of the statewide total (Table 3.6-1). Among the sectors potentially affected by the Proposed Action or alternatives within the three-region action area, the eating and drinking places sector was the largest in the year 2000, generating $6.0 billion in output, representing 75.3 percent of the sector's statewide output (Table 3.6-2). The commercial fishing sector in the three-region action area generated output valued at $646.4 million, representing 71.7 percent of the statewide total, and the area's fish/seafood processing sector produced $1.3 billion in output, or 91.8 percent of the state's total output for that sector.

Industries within the three-region action area provided about 2.6 million jobs in 2000, accounting for 72.0 percent of Washington's total employment (Table 3.6-3). The leading major employment sector within the three-region area was the services sector, generating 31.4 percent of all jobs within the three-region area. Within the employment sectors potentially affected by the Proposed Action or alternatives, key employment sectors include the eating and drinking places sector, producing 5.3 percent of total jobs within the three-region action area, and the miscellaneous retail sector, generating 3.9 percent of jobs (Table 3.6-4). Commercial fishing within the three-region action area provided 6,167 jobs in 2000, an amount that represented two-thirds of statewide commercial fishing jobs. The fish/seafood processing sector within the three-region action area produced 7,128 jobs, or 90.2 percent of the state's total fish/seafood processing jobs.

The three-region action area generated $153.4 billion in income in 2000, with the services, FIRE, and government sectors producing the majority of the income (Table 3.6-5). Income generated within the three-region action area accounted for 77.2 percent of statewide income. For the potentially affected sectors, eating and drinking places and miscellaneous retail businesses together generated 3.8 percent of total income within the three-region action area.

In summary, the three regions in the Puget Sound Action Area (Strait of Juan de Fuca/North Hood Canal, North Puget Sound, and South Puget Sound/South Hood Canal) account for 67 percent of statewide output of goods and services (industrial output). The Strait of Juan de Fuca/North Hood Canal region accounts for 1.8 percent of the employment within the three-region action area. Manufacturing, services, and the FIRE sector are the major sectors within the Strait of Juan de Fuca/North Hood Canal region; the commercial fishing and fish/seafood processing sectors comprise about 1.5 percent of the industrial output of the Strait of Juan de Fuca/North Hood Canal region. The North Puget Sound region accounts for 18.7 percent of the employment within the three-region action area. Manufacturing is the dominant sector within the North Puget Sound region, accounting for 39 percent of the region's industrial output; the commercial fishing and fish/seafood processing sectors comprise about 1.0 percent of the industrial output of the North Puget Sound region. The South Puget Sound/South Hood Canal region accounts for 79.6 percent of the employment within the three-region action area. The services and manufacturing sectors are the major sectors within the South Puget Sound/South Hood Canal region; the commercial fishing and fish/seafood processing sectors comprise about 0.7 percent of the industrial output of the South Puget Sound/South Hood Canal region.

3.7 Environmental Justice

3.7.1 Background

Executive Order 12898 signed February 11, 1994, requires each Federal agency to:

> . . . make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations.
>
> U.S. Environmental Protection Agency (1998a).

The presidential memorandum to all federal agencies accompanying the Executive Order established that the U.S. Environmental Protection Agency (EPA), "when reviewing environmental effects of the proposed action of other Federal agencies under Section 309 of the Clean Air Act, 42 U.S.C. section 7609, shall ensure that the involved agency has fully analyzed environmental effects on minority communities and low-income communities, including human health, social and economic effects." To assist other federal agencies to fully comply with this Executive order, EPA has prepared guidance for conducting Environmental Justice analyses.

The U.S. Environmental Protection Agency, working with the Enforcement Subcommittee of the National Environmental Justice Advisory Council (NEJAC), has developed technical guidance for conducting Environmental Justice assessments, in order to achieve consistency between analyses. That 1998 guidance provides the basis for the assessment presented here.

An Environmental Justice analysis is intended to determine potential human health or environmental effects that could have significant and disproportionate adverse effects on low-income and/or minority populations potentially impacted by proposed federal actions. The Environmental Justice analysis should also determine whether such populations or communities have been sufficiently involved in the decision-making process.

The Environmental Justice discussion in this assessment is presented in three parts: a description of methodology; a discussion of opportunities for minority self-identification and involvement in the decision-making process; and resultant conclusions concerning a baseline for Environmental Justice assessment.

3.7.2 Methodology

The methodology employed here considers the range of analytical procedures identified in the U.S. Environmental Protection Agency's Environmental Justice guidelines, and the particular circumstances of the present assessment, then selects an appropriate methodology from within the guidance framework provided by the NEJAC.

3.7.2.1 Establish the Target Area

A *target area* is the geographical study area that is potentially affected by the Proposed Action or alternatives analyzed in this Environmental Impact Statement. For this assessment, the *target area* is defined by the counties that border Puget Sound and the Strait of Juan de Fuca, and is synonymous with the Puget Sound Action Area discussed elsewhere in this Environmental Impact Statement. These 12 counties are shown on Figure 3.2-2, and include:

Clallam	Snohomish	Pierce
Jefferson	Island	Thurston
Whatcom	San Juan	Mason
Skagit	King	Kitsap

3.7.2.2 Identify the Population Areal Unit

A *population areal unit* is the geopolitical unit containing populations which in aggregate are used to define the *target area*. For this analysis, the *population areal unit* used is each *county*.

3.7.2.3 Identify the Target Population

In this assessment, a *target population* includes the potentially affected residents of each county within the *target area*. Because this Environmental Impact Statement analyzes alternative plans for management of salmon harvest in Puget Sound and the Strait of Juan de Fuca, the primary target populations for analysis will be non-tribal commercial, sport and tribal fishermen harvesting these stocks. Once salmon are landed, there may also be secondary effects on associated peoples within the target area.

3.7.2.4 Identify the Reference Area

A *reference area* is the area used as a benchmark of comparison when determining whether a *target area* would suffer from disproportionate effect(s) to its identified minority or low-income populations. The *reference area* for the Environmental Justice analysis in this assessment is the State of Washington.

3.7.2.5 Define Disproportionate Effect

A *disproportionate effect* is an incidence (or prevalence) of an effect, a risk of an effect, or likely exposure to environmental hazards that would potentially cause adverse effects on a minority and/or low-income population that *significantly exceeds* that experienced by a comparable *reference* *population.* U.S. Environmental Protection Agency guidelines with respect to *measurement of significance* are applied to *identified effects* in Section 4.7 of this assessment.

3.7.2.6 Identify Environmental Justice Area(s) of Concern

An *Environmental Justice Area of Concern* is defined as a *target area* that has been demonstrated to experience *disproportionate effects* and has a *significant* minority or low-income population relative to an appropriate *reference area.*

A *Potential Environmental Justice Area of Concern* is a *target area* that contains a *significant* minority and/or low-income population, but the existence of disproportionate effects has not yet been shown.

3.7.3 Public Outreach to Identify Significant Minority and/or Low-Income Groups

As part of the public scoping process for an Environmental Impact Statement on the ~~2004~~ Resource Management Plan that is proposed for implementation during the 2005-2009 fishing seasons, the National Marine Fisheries Service (NMFS) attempted to directly notify the potential target populations for this assessment: non-tribal commercial, sport and tribal fishermen. NMFS contacted local sport and commercial fishing organizations, magazines and newsletters by email, facsimile (FAX), or telephone to notify them that public comment was being sought. In this way, a diverse population located over a broad geographic area was reached quickly and efficiently.

Representatives of the Puget Sound treaty tribes are actively participating as members of the team tasked with completing the Environmental Impact Statement on the 2003 Resource Management Plan, and the Environmental Impact Statement on the ~~2004~~ fishing plan that is proposed for implementation during the 2005-2009 fishing seasons. Tribal representatives provided information necessary for the Environmental Impact Statement and document review, and sought input from the broader tribal communities.

3.7.4 Low Income Populations

U.S. Environmental Protection Agency guidelines offer a range of measures useful for identification of low-income populations. This analysis identifies potential low-income populations by comparing *percentages of persons below the poverty threshold* in each targeted county against a U.S. Environmental Protection Agency-recommended absolute threshold of 20 percent or more below the poverty level, based on U.S. Bureau of the Census data (U.S. Environmental Protection Agency 1998a). U.S. Environmental Protection Agency guidance notes:

> An advantage of using the poverty thresholds as benchmarks for low-income status is that associated data adhere to Federal statistical standard.
>
> U.S. Environmental Protection Agency (1998a).

Poverty percentages for target counties from the U.S. Bureau of the Census are provided in Table 3.7-1.

Table 3.7-1. Percentage of persons below the poverty level, by county, within the target area.

County	Percent of Persons Below Poverty Level [1]
Clallam	12
Jefferson	11
Island	7
San Juan	9
Whatcom	14
Skagit	11
Snohomish	7
King	8
Pierce	10
Thurston	9
Mason	12
Kitsap	9

[1] Developed from U.S. Census 2000, Summary File 3.

None of the target counties identified in Table 3.7-1 exhibit poverty levels equal to or greater than 20 percent.

3.7.5 Racial Minorities

U.S. Environmental Protection Agency guidance has recommended that ~~a~~ minority populations in the State of Washington be determined *significant* if they~~it~~ represent~~s~~ 15.72 percent or more of the population for any specified *population areal unit* within a target area (E.O. 12898; U.S. Environmental Protection Agency 1998a). Data on racial minorities, by target county, are presented in Table 3.7-2.

Table 3.7-2. Percentage of minority persons by county, by race, within the target area. [1]

County	Black/ African American	American Indian/Alaska Native	Asian	Native Hawaiian Pacific Islander	Other	Total
Clallam	1	5	1	–	1	8
Jefferson	–	2	1	–	–	3
Island	2	1	4	–	2	9
San Juan	–	1	–	–	1	2
Whatcom	1	3	3	–	3	10
Skagit	–	2	1	–	7	10
Snohomish	2	1	6	–	2	11
King	5	1	11	–	3	19
Pierce	7	1	5	1	2	16
Thurston	2	2	5	1	2	12
Mason	1	4	1	1	2	9
Kitsap	3	1	5	1	2	12

[1] Developed from U.S. Census 2000, Summary File 3.

~~None of the counties identified in~~ According to Table 3.7-2, King and Pierce counties exceed the state minority criteria ~~contain racial minorities that qualify for targeted Environmental Justice analysis, based on the criteria identified above.~~ of 15.72 percent of the county population.

~~While this county-by-county assessment did not identify any *significant* minorities, t~~Two further fishing-related inquiries were conducted, to determine whether *significant* minority salmon-fishing groups might be distributed across counties within the target area as a whole and might require targeted Environmental Justice analysis.

First, expert opinion regarding the possible prevalence of *significant* non-tribal racial minorities among salmon fishermen in the target area was sought through literature search and oral inquiry. U.S. Fish and Wildlife Service survey data, collected in 1996, indicate that 91 percent of resident sport anglers in the State of Washington are white, "other races" represent 8 percent, and participation in sport fishing by African-Americans was not significant enough for reliable tabulation (U.S. Fish and Wildlife Service 1998). These findings are generally consistent with national angling characteristics (U.S. Fish and Wildlife Service 2000).

Experts from federal and state agencies responsible for management of commercial non-tribal salmon fisheries in the target area were also contacted. They indicated that they did not collect data on race of fishermen, and knew of no substantial aggregations of minority fishermen in the state, with the exception of Indians (personal communication with Jim Segar, Pacific Marine Fisheries Council, and Lee Hoines, Washington Department of Fisheries and Wildlife, December 2002). (Also Subsection 3.7.3, above.)

Based on these inquiries, NMFS concluded, and EPA concurred (personal communication with Mike Letourneau, EPA, July 1, 2004), that non-tribal minority impacts would not be disproportionate in the counties within the target area.

In the second area of inquiry, Indian tribes were specifically identified as having *significant* status under Environmental Justice proceedings. Their status is discussed below in Subsection 3.7.6.

3.7.6 Indian Tribes

U.S. Environmental Protection Agency guidance regarding Environmental Justice extends beyond statistical threshold analysis to explicitly consider Environmental Justice effects on Indian tribes.

> Federal duties under the Environmental Justice E.O. ("Executive Order"), the Presidential directive on government-to-government relations, and the trust responsibility to Indian tribes may merge when the action proposed by a federal agency or EPA potentially affects the natural or physical environment of a tribe. The natural or physical environment of a tribe may include resources reserved by treaty or lands held in trust; sites of special cultural, religious or archaeological importance, such as sites protected under the National Historic Preservation Act or the Native American Graves Protection and Repatriation Act; other areas reserved for hunting, fishing, and gathering (usual & accustomed), which may include "ceded" lands that are not within reservation boundaries. Potential effects of concern . . . may include ecological, cultural, human health, economic, or social impacts when those impacts are interrelated to impacts on the natural or physical environment.
>
> U.S. Environmental Protection Agency (1998b).

Seventeen treaty tribes have ongoing treaty-based fishing activities within the *target area* that may be potentially affected by the Proposed Action or alternatives considered in this assessment. Two additional tribes are federally-recognized and demonstrate historic linkages with fisheries. Consequently, tribal effects will be a specific focus of the Environmental Justice analysis provided in Section 4.7. The 17 treaty tribes, together with the county in which their reservations are located, are presented in Table 3.7-3. Fishing activities of these tribes often extend more broadly, due to treaty-based *usual and accustomed* fishing areas sometimes located at a distance from reservation lands. The term *usual and accustomed* is contained in the treaties between the United States and the 17 treaty fishing tribes considered in this assessment (see Subsection 3.4.4 of this Environmental Impact Statement).

> *Usual and accustomed places* (are) Those areas in, on and around the freshwater and saltwater areas within the Western District of Washington, which were understood by the Indian parties to the Stevens treaties to be embraced within the treaty terms "usual and accustomed" "grounds," "stations" and "places."
>
> United States v. Washington (1974).

The two additional federally-recognized tribes are also identified in the table.

General information respecting these tribes and their use of the salmon resource is presented in Subsections 3.4 and 3.5 of this Environmental Impact Statement.

Table 3.7-3. Tribes considered in the environmental justice analysis.

Tribe	County Location of Reservation
Treaty Fishing Tribes:	
Makah	Clallam
Lower Elwha	Clallam
Jamestown	Clallam
Port Gamble	Jefferson
Suquamish	Kitsap
Skokomish	Mason
Squaxin Island	Mason
Nisqually	Thurston
Puyallup	Pierce
Muckleshoot	King
Tulalip	Snohomish
Stillaguamish	Snohomish
Swinomish	Skagit
Upper Skagit	Skagit
Sauk Suiattle	Skagit
Lummi	Whatcom
Nooksack	Whatcom
Additional Federally-Recognized Tribes:	
Samish	Whatcom/ Island
Snoqualmie	King

3.8 Wildlife

This affected environment section includes descriptions of the marine wildlife and benthic invertebrate resources important in predicting impacts that could occur as a result of the Proposed Action or alternatives. This section focuses primarily on the seabird and marine mammal species that are known or thought to be directly or indirectly impacted by commercial fisheries, but also provides a succinct overview of all wildlife resources that might be encountered by any Puget Sound commercial and sport fishery. Important information gaps are identified.

3.8.1 Marine Habitats

The diversity and distribution of marine wildlife in Puget Sound and the Strait of Juan de Fuca are strongly influenced by the distribution of marine habitats, and nearshore terrestrial habitats that provide substrate for resting or breeding. These habitat types in Puget Sound have been variously classified depending on the intended use of the system. Buchanan et al. (2001) developed a classification more reflective of the distribution and composition of marine organisms. Buchanan et al. (2001) recognizes *estuarine habitat* as tidal flats and river mouths like Padilla Bay and mouth of the Nooksack River. *Nearshore marine habitats* include the marine areas of Puget Sound between high tide and the end of the photic zone (66 feet depth), and *inland marine deeper water* as waters greater than 66 feet deep. Further, Buchanan et al. (2001) classified the deeper water of the Strait of Juan de Fuca west of a line from the mouth of the Elwha River north to Race Rocks on the southeastern tip of Vancouver Island (see Figure 3.3.14) as *marine shelf* due to the influence of oceanic currents on the western half of the strait. While Buchanan et al. (2001) are not the only scientists to develop a habitat classification system (e.g., Dethier 1990), this classification system was developed specifically for determining habitat relationships of wildlife inhabiting Oregon and Washington (Johnson and O'Neill 2001); therefore, it is the system followed in this assessment.

The inland marine deeper water habitat comprises nearly 2 million acres in Puget Sound and the Strait of Juan de Fuca. At least 63 species of marine birds and marine mammals are known to frequent this habitat zone, although 40 percent are found only during the winter (Johnson and O'Neill 2001). The seabirds most closely associated with this habitat include white-winged/black scoters, Bonaparte's/Heermann's/Thayer's/glaucous-winged/glaucous gulls, pigeon guillemots, common murres, rhinoceros auklets, tufted puffins, marbled/ancient murrelets, Brandt's/double-crested/pelagic cormorants, western/Clark's grebes, and Pacific/common/red-throated loons (Table 3.8-1), most of which reach their highest abundance during the winter months (Angell and Balcomb 1982; and Nysewander et al. 2001a; Table 3.8-2) when most commercial salmon fishing has concluded. This zone also provides foraging habitat for seven species of marine mammals: harbor seal, California sea lion, Steller sea lion, harbor porpoise, Dall's porpoise, minke whale, and killer whale (Johnson and O'Neill 2001; Table 3.8-1).

The marine shelf habitat of the western half of the Strait of Juan de Fuca generally supports the same marine mammals found in inland marine deeper water. The proximity of these waters to the open ocean allows the intrusion of more open ocean species such as humpback whales and Pacific white-sided dolphins (Table 3.8-1). The seabirds most commonly found in this habitat type within the strait include Pacific loon, western/Clark's grebe, northern fulmar, sooty/short-tailed shearwater, red-necked/red phalarope, Thayer's/western/glaucous-winged/Sabine's gull, black-legged kittiwake, common/Arctic tern, common murre, Cassin's/rhinoceros auklet, and tufted puffin (Nysewander et al. 2001a; Table 3.8-1).

The marine nearshore habitat comprises nearly the entire shoreline of Puget Sound, Hood Canal, San Juan Islands, Strait of Juan de Fuca, and Strait of Georgia. About 75 species of marine birds are associated with this habitat, including nearly all the same species found in deeper water habitat. Important additions to the avian assemblage in this habitat include red-necked grebes, brown pelicans, surf scoters, red-breasted mergansers, mew/herring gulls, and Caspian/common terns (Table 3.8-1). The marine mammals most commonly associated with this habitat type are the sea lions, harbor seal, ~~and~~ harbor porpoise, minke whale, killer whale and humpback whale. ~~Resident gray whales and wintering sea otters can be found at the western end of the Strait of Juan de Fuca~~ Both resident and migratory gray whales occur from Cape Flattery to Port Townsend, and sea otters can be found in marine nearshore habitat in the Strait of Juan de Fuca from Cape Flattery to Pillar Point.

Table 3.8-1. Presence and association of marine birds and mammals with the marine habitats of Puget Sound.

Species	Bays and Estuaries	Inland Marine Deeper Waters	Marine Nearshore	Marine Shelf
Loons				
Red-throated Loon	◆	◆	◆	♦
Pacific Loon	◆	◆	◆	◆
Common Loon	◆	◆	◆	♦
Grebes				
Horned Grebe	◆	♦	♦	♦
Red-necked Grebe	◆	♦	◆	♦
Eared Grebe	♦		♦	
Western/Clarke's Grebe	◆	◆	◆	◆
Fulmars and Shearwaters				
Northern Fulmar				◆
Sooty Shearwater	♦	♦	♦	◆
Short-tailed Shearwater		♦	♦	◆
Pelicans				
Brown Pelican	◆		◆	
Cormorants				
Double-crested Cormorant	◆	◆	◆	
Brandt's Cormorant	◆	◆	◆	♦
Pelagic Cormorant	◆	◆	◆	♦
Geese/Swans				
Snow Goose	♦			
Canada Goose	♦		♦	
Brant	◆	♦	♦	
Tundra Swan	♦			
Trumpeter Swan	♦			
Dabbling Ducks				
Northern Pintail	◆		♦	
American Wigeon	◆	♦	♦	
Mallard	♦	♦	♦	
Green-winged Teal	♦			
Gadwall	♦			
Sea Ducks				
Greater Scaup	◆	♦	♦	
Lesser Scaup	♦			
Harlequin Duck	♦		◆	
Long-tailed Duck	♦	♦	◆	
Black Scoter	◆	◆	◆	♦
Surf Scoter	◆	♦	◆	♦
White-winged Scoter	♦	◆	◆	♦
Common Goldeneye	♦		♦	
Barrow's Goldeneye	♦		♦	
Bufflehead	◆		♦	

Table 3.8-1. Presence and association of marine birds and mammals with the marine habitats of Puget Sound *(continued)*.

Species	Bays and Estuaries	Inland Marine Deeper Waters	Marine Nearshore	Marine Shelf
Mergansers				
Common Merganser	◆		♦	
Red-breasted Merganser	◆		◆	
Osprey				
Osprey	♦		♦	
Eagles				
Bald Eagle	♦	♦	♦	♦
Oystercatcher				
Black Oystercatcher	♦			
Phalaropes				
Red-necked Phalarope	♦	♦	♦	◆
Red Phalarope			♦	◆
Gulls				
Bonaparte's Gull	◆	◆	◆	♦
Heermann's Gull	◆	◆	◆	♦
Mew Gull	◆	♦	◆	♦
Ring-billed Gull	◆	♦	♦	♦
California Gull	◆	♦	♦	♦
Herring Gull	◆	♦	◆	♦
Thayer's Gull	◆	◆	◆	◆
Western Gull	◆	♦	◆	◆
Glaucous-winged Gull	◆	◆	◆	◆
Glaucous Gull	◆	◆	◆	♦
Sabine's Gull			♦	◆
Black-legged Kittiwake			♦	◆
Terns				
Caspian Tern	◆		◆	
Elegant Tern	◆		◆	♦
Common Tern	◆	♦	◆	◆
Arctic Tern	♦	♦	♦	◆
Alcids				
Common Murre	♦	◆	◆	◆
Pigeon Guillemot	♦	◆	◆	♦
Marbled Murrelet	♦	◆	◆	♦
Ancient Murrelet		◆	◆	◆
Cassin's Auklet		♦	♦	◆
Rhinoceros Auklet	♦	◆	♦	◆
Tufted Puffin		◆	♦	◆

Table 3.8-1. Presence and association of marine birds and mammals with the marine habitats of Puget Sound *(continued)*.

Species	Bays and Estuaries	Inland Marine Deeper Waters	Marine Nearshore	Marine Shelf
Marine Mammals				
Pinnipeds				
Steller Sea Lion		⬥	◆	◆
California Sea Lion	⬥	⬥	◆	⬥
Harbor Seal	◆	◆	◆	◆
Northern Elephant Seal		⬩	⬩	◆
Otter				
Sea Otter			◆	⬥
River Otter	◆		⬥	
Baleen Whales				
Minke Whale		◆	⬥	⬥
Gray Whale	◆	⬥	◆	◆
Fin Whale				◆
Humpback Whale				◆
Toothed Whales and Dolphins				
Killer Whale	⬩	◆	◆	◆
Pacific White-sided Dolphin		⬩		◆
Short-finned Pilot Whale		⬩		◆
Risso's Dolphin		⬩		⬥
Harbor Porpoise	⬩	◆	◆	◆
Dall's Porpoise		◆	⬩	◆

Source: Johnson and O'Neill 2001

Present ⬩ Generally Associated ⬥ Closely Associated ◆

1 Table 3.8-2. Seasonal abundance of birds and marine mammals in Puget Sound.

	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Marine Birds												
Loons	⬩				⬩	⬩	⬥	⬥	⬥	◆	◆	⬥
Grebes	⬩	⬩	⬩	⬩	⬩	⬥	◆	**◆**	**◆**	**◆**	⬥	⬩
Shearwaters	⬩	⬩	⬩	⬩	⬩							⬩
Fulmars					⬩	⬩	⬩	⬩	⬩	⬩	⬩	⬩
Pelicans	⬩	⬩	⬩									⬩
Cormorants	⬥	⬥	⬥	⬥	⬥	⬥	⬥	◆	◆	⬥	⬥	⬥
Herons	⬥	⬥	⬩	⬩	⬥	⬥	◆	◆	◆	◆	◆	⬥
Geese/Swans	⬥				⬩	⬥	◆	**◆**	**◆**	**◆**	**◆**	◆
Dabbling Ducks	⬥	⬩	⬩	⬩	⬥	⬥	**◆**	**◆**	**◆**	**◆**	**◆**	⬥
Bay Ducks					⬥	◆	◆	**◆**	**◆**	**◆**	**◆**	⬥
Sea Ducks	⬥	⬩	⬩	⬩	⬥	⬥	**◆**	**◆**	**◆**	**◆**	◆	◆
Mergansers	⬩			⬩	⬥	⬥	◆	**◆**	**◆**	**◆**	◆	⬥
Osprey	⬩	⬩	⬩	⬩	⬩	⬩	⬩	⬩	⬩	⬩	⬩	⬩
Eagles	⬥	⬥	⬥	⬥	⬥	⬥	◆	**◆**	**◆**	**◆**	◆	⬥
Oystercatcher	⬥	⬥	⬥	⬥	⬥	⬥	⬥	⬥	⬥	⬥	⬥	⬥
Phalaropes	⬩	⬩	⬩	⬥	⬥	⬥	⬩					⬩
Gulls	⬥	⬥	⬥	⬥	◆	**◆**	◆	◆	◆	**◆**	◆	⬥
Terns	⬥	⬩	⬩	⬩	⬥	◆	⬥	⬩			⬩	⬥
Alcids	**◆**	**◆**	**◆**	◆	◆	◆	◆	⬥	⬥	⬥	⬥	◆
Marine Mammals												
Harbor Seal	**◆** ~~◆~~	**◆** ~~◆~~	**◆**	**◆**	**◆**	**◆** ~~◆~~	**◆** ~~◆~~	**◆** ~~◆~~	**◆** ~~◆~~	**◆** ~~◆~~	**◆** ~~◆~~	**◆** ~~◆~~
Elephant Seal	⬩ ~~◆~~	⬩	⬩	⬩ ~~⬥~~	⬩ ~~⬥~~	⬩ ~~⬥~~	⬩	⬩	⬩	⬩	⬩	⬩ ~~◆~~
California Sea Lions	◆ ~~⬥~~	⬩	⬩	⬩	◆	◆	◆ ~~◆~~	◆ ~~**◆**~~	◆ ~~**◆**~~	◆ ~~**◆**~~	◆ ~~**◆**~~	◆ ~~◆~~
Steller Sea Lions	⬩	⬩	⬩	⬩	⬩	⬩	⬩	⬩	⬩	⬩	⬩	⬩
Minke Whale	⬥	⬥	**◆**	**◆**	**◆**	◆	⬩	⬩	⬩	⬩	⬩	◆
Gray Whale	⬥	⬥ ~~◆~~	⬥ ~~◆~~	⬩ ~~**◆**~~	⬩ ~~**◆**~~	⬥	⬩	⬩	⬩	⬥ ~~⬩~~	⬥ ~~⬩~~	⬥ ~~⬩~~
Harbor Porpoise	⬥ ~~**◆**~~	⬥ ~~**◆**~~	⬥ ~~**◆**~~	⬥ ~~**◆**~~	⬥ ~~**◆**~~	⬥ ~~**◆**~~	⬥ ~~**◆**~~	⬥ ~~**◆**~~	⬥ ~~**◆**~~	⬥ ~~**◆**~~	⬥ ~~**◆**~~	⬥ ~~**◆**~~
Dall's Porpoise	⬥	⬥	◆	◆	◆	⬥	⬥	⬥	⬥	⬥	⬥	⬥
Killer Whale	⬥ ~~⬩~~	◆ ~~⬥~~	◆ ~~◆~~	◆ ~~**◆**~~	◆ ~~**◆**~~	◆ ~~◆~~	◆ ~~⬩~~	◆ ~~⬩~~	⬥ ~~⬩~~	⬥ ~~⬩~~	⬥ ~~⬩~~	⬥ ~~⬩~~

2 Sources: Angell and Balcomb 1982; ~~and~~ Nysewander et al. 2001a and personal communication with
3 Steve Jeffries, WDFW, Research Scientist, July 30, 2004.
4 Occasional ⬩ Common ⬥ Very Common ◆ Abundant **◆**

Based solely on the importance of estuarine tidal flats to wintering and migrating waterfowl and shorebirds, this habitat ranks as one of the richest and most diverse in the state of Washington. Some of the most prominent species include the double-crested cormorant, great blue heron, American wigeon, northern pintail, snow goose, sanderling, western sandpiper, several species of gulls, osprey, and bald eagle (Table 3.8-1). Harbor seals commonly forage in the tidal channels.

3.8.2 Marine Birds

The breeding seabird population in the United States' waters of Puget Sound and the Strait of Juan de Fuca comprises about 38,000 pairs. More than 90 percent of these birds are rhinoceros auklets, glaucous-winged gulls (or intergrades with western gulls), and pigeon guillemots. The only other breeding seabirds are double-crested and pelagic cormorants, marbled murrelets, and a very few tufted puffins (Speich and Wahl 1989). These birds, plus variable numbers of non-breeding common murres and Brandt's cormorants, comprise the summer (June-August) seabird community (Table 3.8-2).

The winter marine bird community is dramatically larger with the influx of tens of thousands of scaups, dabbling ducks, western grebes, common murres, scoters, and loons (Table 3.8-2). Manuwal et al. (1979) and Wahl et al. (1981) estimated that 200,000 common murres alone migrated into Washington's inland waters in September 1978, although those numbers may be considerably less today (Nysewander et al. 2001a).

3.8.2.1 Rhinoceros Auklet

Rhinoceros auklets are one of the few seabirds that breed within the inland waters of Washington. Speich and Wahl (1989) estimated that approximately 34,000 of these birds nest annually at Protection Island, and about 2,500 nest on nearby Smith Island in the eastern end of the Strait of Juan de Fuca (see Figure 3.3-14 in Subsection 3.3 of this Environmental Impact Statement). Survey efforts by Nysewander et al. (2001a) (based on summer aerial surveys) suggest the summer population of rhinoceros auklets has gradually declined since Speich and Wahl's 1978 to 1982 colony surveys. During the summer (July), rhinoceros auklets are generally confined to deeper water regions of the northern two-thirds of greater Puget Sound (mainly Marine Catch Areas 6, 7, and 9; Figure 3.3-1), within 30 to 50 miles of the Protection Island and Smith Island breeding colonies. Rhinoceros auklets are especially abundant near offshore banks and tide-rips where they forage mainly on Pacific sandlance and Pacific herring (Leschner 1976). Pierce et al. (1994~~6~~) found that 92 percent of the 2,383 rhinoceros auklets recorded during August 1994 surveys in the San Juan Islands were located more than 2,000 feet from the nearest shoreline. Localized densities of 381 birds per square mile have been recorded (WDFW 2002).

By winter, most rhinoceros auklets have migrated out of greater Puget Sound, likely to Washington’s outer coast (Angell and Balcomb 1982). Some, however, overwinter in south Puget Sound (Paulson 1980 as cited in Angell and Balcomb 1982).

Rhinoceros auklets have been incidentally entangled in purse seine nets during the Puget Sound coho fishery (Anderson 1993), and in gillnets in the Puget Sound sockeye/pink salmon fishery (Wolf et al. 199~~5~~6; Thompson et al. 1998; and Melvin et al. 1999). The 1994 non-treaty sockeye gillnet fishery entangled an estimated 787 rhinoceros auklets in Marine Catch Areas 7 and 7A (Wolfe et al. 1995). Thompson et al. (1998) determined that 79 percent of the rhinoceros auklets confirmed killed in the 1993 and 1994 sockeye and chum fisheries in Marine Catch Areas 7, 7A, 10, 11, and 12 were hatch-year (i.e., born that year; 63%) or subadult (i.e., non-breeding; 16%) birds, likely originating from the Protection Island and Smith Island colonies. The large percentage of hatch-year birds probably reflects the high number of these young birds on the water at the peak of the sockeye fishery (Wilson and Manuwal 1986; and Thompson et al. 1998).

3.8.2.2 Common Murre

Common murres do not nest within Washington’s inland waters, although a few non-breeders can be found in the summer (WDFW 2002). They are, however, the predominant winter alcid in the greater Puget Sound area, with tens of thousands of birds originating from the Oregon and Washington outer coasts. Manuwal et al. (1979) and Wahl et al. (1981) estimated that 200,000 birds entered the Strait of Juan de Fuca in September 1978. Most of these birds, however, were gone by November, likely moving north through the Strait of Georgia (although about 80,000 remained through the winter). Hamel and Parrish (2001) radio-tracked Tatoosh Island murres and found them to move inland to the eastern end of the Strait of Juan de Fuca where, presumably, food resources are more predictable and waters more calm than the outer coast. Surveys conducted by Wahl et al. (1981) in 1978–1979 indicated that the most important winter habitat for murres occurs throughout the Strait of Juan de Fuca, through Rosario Strait, to the Strait of Georgia (Marine Catch Areas 4, 5, 6, and 7; Figure 3.3-14). Aerial surveys conducted between 1992 and 1999 (Nysewander et al. 2001a) found similar results for wintering common murres with the exceptional note of high murre concentration on the British Columbia side of the Strait of Juan de Fuca near Victoria, and relatively high densities in Admiralty Inlet (northern Marine Catch Area 9).

Common murre populations in the Pacific Northwest have been greatly impacted by several events over the past few decades (Carter et al. 2001). Breeding activity was greatly reduced from colony abandonment during the El Nino events of 1982–1983, 1987–1988, and 1992–1993. Further, major oil spills in 1988 (*NESTUCCA*) and 1991 (*TENYO MARU*) collectively killed between 34,000 and 50,000 murres. Military activity, aircraft overflights, and entanglement in gillnet fisheries have also been implicated in common murre population declines within Washington State (Carter et al. 2001). Annual declines of 32.9 percent were reported between 1979 and 1986, and 13.3 percent between 1979 and 1995. The Washington breeding population, estimated at 53,000 in 1979 (Carter et al. 2001), was reduced to an estimated 13,600 by 1995 (*TENYO MARU* Oil Spill Natural Resources Trustees 2000) with the steepest decline coinciding with the 1982–1983 El Nino coupled with military activity and fishing boat disturbance documented in 1984 and 1985 (Speich et al. 1987; and Carter et al. 2001).

Nysewander et al. (2001a) found higher densities of common murres in the deeper water regions of greater Puget Sound, which is not surprising given the ability of these birds to dive to depths of nearly 600 feet (Piatt and Nettleship 1985). Similarly, Pierce et al. (1994~~6~~) found 95 percent of 5,889 common murres sighted in Marine Catch Area 7 were more than 2,000 feet from shore. Because of their deep-diving capability, common murres are able to exploit a variety of prey. Nevertheless, schooling baitfish such as Pacific herring, Pacific sand lance, northern anchovy, Pacific whiting, smelt, and market squid universally dominate their diet (Manuwal and Carter 2001). Wilson and Thompson (1998) found murres in the San Juan Islands to have fed largely on Pacific herring, Pacific sand lance, salmon smolts, and Pacific tomcod.

Gillnet-associated deaths have been identified as a chronic mortality factor for common murres in Washington (Carter et al. 2001). The 1994 non-treaty sockeye gillnet fishery entangled an estimated 2,700 common murres in Marine Catch Areas 7 and 7A (Wolfe et al. 1996~~5~~). Thompson et al. (1998) determined that 63 percent of the common murres confirmed killed in the 1993 and 1994 sockeye and chum fisheries in Marine Catch Areas 7, 7A, 10, 11, and 12 were adults (which may reflect a large number of failed or non-breeding adults within the marine catch areas at the peak of the sockeye fishery). It is likely that many, if not most, of the murres killed in Puget Sound gillnet fisheries originate not from the lightly populated (13,600 in 1995; *TENYO MARU* Oil Spill Natural Resources Trustees 2000) and later-breeding Washington colonies, but from the much larger (breeding population averaging about 700,000 birds during the 1990s; personal communication with Roy Lowe, U.S. Fish and Wildlife Service, Refuge Biologist, February 25, 2003) and earlier (one month) nesting Oregon colonies. The hatch-year chicks killed in the 1993 and 1994 sockeye fisheries likely originated from Oregon, as much the fishery occurred prior to the fledging of chicks at the Washington colonies (Thompson et al. 1998).

3.8.2.3 Pigeon Guillemot

The pigeon guillemots are perhaps the most widespread nesting seabirds in Puget Sound and the Strait of Juan de Fuca. They are especially prevalent along the Washington shoreline of the Strait of Juan de Fuca from Crescent Bay east to Admiralty Inlet (Marine Catch Area 6), within the San Juan Islands (Marine Catch Area 7), and in the South Puget Sound region (Marine Catch Area 13; see Figure 3.3-7). They are conspicuously absent west of Crescent Bay, Hood Canal, and Puget Sound's scattered estuarine and beach areas. Speich and Wahl (1989) estimated the breeding population to be about 3,600 at 121 breeding locations. Since that time, Evenson et al. (2003~~1~~) have identified more than 350~~00~~ new breeding locations. These sites, along with the original 121, support nearly 16~~5~~,000 guillemots based on surveys conducted in 2003~~0~~ (Evenson et al. 2001 and 2003). It is unclear whether the difference in population estimates between Speich and Wahl (1989) and Evenson et al. (2001) reflects a population increase or decrease, or simply an increase in survey effort or difference in survey protocol, although Evenson et al.'s results suggest they may have concentrated more effort on the smaller-sized colonies (62% of the colonies surveyed in 2000 supported less than or equal to 25 birds) perhaps missed by Speich and Wahl (1989). This will be determined in the future when standardized surveys are repeated. However, comparable data from aerial surveys during winter along selected nearshore waters in Washington state suggested some degree of decline (55%) over 20 years (Nysewander et al. 2001a) for this species.

Pigeon guillemots generally forage along the shallow nearshore zone for epibenthic fish such as gunnels, blennies, pricklebacks, and sculpins (Drent 1965, Koelink 1972). Ewins (1993) compiled dietary information from 11 different studies and found salmonids to be completely absent. Pigeon guillemots are cavity-nesters and generally nest in rock rubble, but will use driftwood piles, bird and mammal burrows, and artificial structures such as wharves, bridges, navigation aids, drainage pipes, and even spent shell casings (Speich and Wahl 1989). When cavities are in short supply, they will excavate their own burrows in loose earth or sandy banks (Speich and Wahl 1989; and Vermeer et al. 1993). They generally nest within small "colonies" or isolated pairs, although there are several colonies in Puget Sound and the Strait of Juan de Fuca that support more than 50 pairs (Evenson et al. 2001).

Pigeon guillemots have been incidentally captured in coho purse seine fisheries off Kingston-Edmonds (Anderson 1993). However, entanglement of guillemots in the Marine Catch Area 7/7A sockeye salmon gillnet fisheries is apparently rare compared to rhinoceros auklets and common murres (Pierce et al. 1994~~6~~; and Melvin et al. 1997, 1999). Only one pigeon guillemot was one captured during 642 observed net sets during the 1996 test sockeye gillnet fishery (Melvin et al. 1999).

3.8.2.4 Gulls and Terns

Seventeen species of gulls and terns at least occasionally inhabit greater Puget Sound, but only four species – glaucous-winged and western gull, and Caspian and arctic tern – nest here (Speich and Wahl 1989). Speich and Wahl (1989) estimated the greater Puget Sound breeding population of glaucous-winged gulls to be 20,000 with more than 11,000 on Protection Island (located in Marine Catch Area 6) alone (Figure 3.3-14). These gulls nest in a variety of situations throughout greater Puget Sound, from large colonies to isolated pairs using both natural and man-made substrates. The presence of western gull breeding populations in Washington inland waters is somewhat confusing. Speich and Wahl (1989) did not identify western gull breeding colonies *per se* in greater Puget Sound, but they did refer to Hoffman et al.'s (1978) contention that they hybridize with glaucous-winged gulls in the inland waters of Washington State. Angell and Balcomb (1982) did state that a small population of western gulls nests among the glaucous-winged gulls on Protection Island, and Nysewander et al (2001a) noted some western/glaucous-winged intergrade gulls during their surveys. A small colony of arctic terns have nested at Jetty Island off Everett (Angell and Balcomb 1982), and approximately 1,000 Caspian terns nested on the ASARCO slag piles along the Commencement Bay shoreline in 2000 (personal communication with Christopher Thompson, Washington Department of Fish and Wildlife, Research Biologist, February 26, 2003; Figures 3.3-1 and 3.3-7).

The Nysewander et al. (2001a) surveys found gulls and terns to comprise by far the largest component (73%) of the summer marine bird population. Besides glaucous-winged gulls, this summer population is supplemented with a sizable population of Heermann's gulls and smaller numbers of non-breeding Bonaparte's, California, ringed-billed, and mew gulls (Angell and Balcomb 1982). Heermann's gulls breed in Mexico during the winter months and spend their off-season in more northern climes (Angell and Balcomb 1982).

The winter gull and tern population is comprised largely of resident glaucous-winged gulls and wintering Thayer's, mew, and Bonaparte's gulls. California and ring-billed gulls, and common terns are common spring and fall migrants (Angell and Balcomb 1982). Most gulls exhibit a more nearshore life history strategy reflecting their inability to dive to more than marginal depths. Nysewander et al. (2001a) found gull distributions to be quite variable, but to average more than a dozen times higher in nearshore habitat than offshore. Nevertheless, large flocks of glaucous-winged and Heermann's gulls are commonly seen feeding on surfacing herring in deeper channel waters. Nysewander et al. (2001b) estimated that the gull densities between surveys conducted in 1978 and 1979 (Wahl et al. 1981) and their surveys conducted between 1992 and 1999 (Nysewander et al. 2001a) had declined 43 percent. However, Carter et al. (1995a~~2002~~) stated that breeding glaucous-winged gull numbers are either stable or increasing. The numbers of breeding glaucous-winged gulls in the San Juan Islands vicinity, covered in a recent survey effort in 2001, appear to have declined by approximately 60% overall, with 3,568 gulls seen in 2001 where 8,851 were seen during the 1973-82 period. The reasons behind these declines are probably a mixture of changes over the last 20 years: (1) Increases in avian predators have disrupted the breeding success of surface nesters like gulls; (2) reductions in winter food availability at dumps and waste treatment facilities affect survival of juvenile gulls; (3) decreases in the abundance of forage fish stocks near breeding areas affect survival; (4) increased protection of breeding areas at Smith and Protection Islands may have resulted in movement of breeding efforts. Areas where breeding populations are stable or increasing may be due to stable or abundant food resources (personal communication with Dave Nysewander, WDFW, Wildlife Biologist, July 30, 2004).

Gulls and terns are apparently not susceptible to net entanglement from Puget Sound commercial fisheries based on the results from studies in Puget Sound (Anderson 1993; Melvin and Conquest 1996; Pierce et al. 1994~~6~~; and Melvin et al. 1997). They are, however, occasionally hooked in the sport fisheries (Noviello 1999). However, during Noviello's (1999) study to determine rates of bird and marine mammal encounters in the Puget Sound sport fisheries (Marine Catch Areas 4, 5, 8, and 10), only 4 bird captures were recorded in 1,090 apparent "hook-ups" – all immature gulls. All were released apparently unharmed.

3.8.2.5 Grebes, Loons, and Cormorants

~~Four~~Six species of grebes – western, Clark's, red-necked~~, and~~ horned, eared and pied-billed – winter in or are seen near the marine waters of greater Puget Sound. The three most common species are the western, Clark's and horned,~~,~~ with western grebes comprising about 85 percent of all grebes (Nysewander et al. 2001a). Together, the~~ four~~ three grebe species comprise about 4 percent of all wintering marine birds (Nysewander et al. 2001a). Western grebes generally rest in large flocks in deep waters, then scatter at night to feed on schooling baitfish (Clowater 1998). They are most common in the protected inlet and bay waters of Puget Sound, and tend to avoid the open waters of the straits. Angell and Balcomb (1982) showed grebes arriving in the Puget Sound area in November and peaking December to February (Table 3.8-2). Morgan (1989~~7~~) and Clowater (1998), however, found western grebe populations in the Strait of Georgia to reach high numbers in October, and then gradually build to a peak in March. Courtney et al. (1997) surveyed various locations of Puget Sound in Fall 1996. Both found western grebes to be one of the more common marine birds, comprising more than 20 percent of all marine bird sightings. Consequently, considerable numbers of western grebes can be found in Puget Sound and the Strait of Juan de Fuca coincident with the fall chum fishery. Between surveys conducted 1978 to 1979 (Wahl et al. 1981), and 1992 to 1999 (Nysewander et al. 2001a), these birds have apparently experienced severe (95%) population declines in the greater Puget Sound (Nysewander et al. 2001b). Recorded loon densities on aerial surveys conducted each winter by WDFW between 1999 and 2003 have shown some differentiating trends by species. Common Loon densities, even though low, have shown some slight recovery while Red-throated Loons have exhibited even more significant and dramatic decreases since 1999 (Nysewander et al. 2003), making this loon species the one loon species of most concern regarding declines.

Three species of loons winter in Washington inland marine waters. The most common, the red-throated loon, occurs in several habitats, but generally prefers nearshore waters where they forage along tidal fronts. In contrast, the Pacific loon feeds in the deeper offshore inland marine waters, primarily on herring. Common loons are intermediary, using both nearshore and offshore habitats. Loons are primarily a winter resident in Puget Sound and the Strait of Juan de Fuca with large numbers first arriving in October (Angell and Balcomb 1982; and Morgan 1989~~7~~). Collectively, the greater Puget Sound population of loons has declined 79 percent since 1978–79 (Nysewander et al. 2001b).

Cormorants are year-around residents of greater Puget Sound. Only two, the double-crested and pelagic cormorants, nest within the marine inland waters of Washington, although non-breeding Brandt's cormorants (an outer coast nester) contribute significantly to the summer greater Puget Sound population (Nysewander et al. 2001a). Speich and Wahl (1989) stated that about 1,100 double-crested cormorants nest in the inland waters, most of them in three colonies at the south end of Rosario Strait (Marine Catch Area 7/7A; Figure 3.3-1). Approximately twice as many pelagic cormorants nest in greater Puget Sound, most at the Protection Island and Smith Island colonies at the east end of the Strait of Juan de Fuca (Marine Catch Area 6). Nysewander et al. (2001a) found double-crested and pelagic cormorants to occur mainly in nearshore waters close to drying perches (their feathers are not waterproof), but Brandt's cormorants were commonly found in deeper offshore waters in winter. Nysewander et al. (2001b) found little change in overall wintering cormorant populations in Washington inland marine waters between 1992 and 1999. They found a significant 53 percent decline since 1978–79, 62 percent among double-crested cormorants alone. Chatwin et al. (2002) saw similar declines in breeding populations of pelagic and double-crested cormorants in the nearby Strait of

Georgia, attributing these declines to variable herring populations, and harassment by bald eagles and recreational boaters.

Although common in nearshore waters in the summer (Angell and Balcomb 1982; Table 3.8-2), especially in Marine Catch Area 7, cormorants have not been recorded as a bycatch in the Puget Sound salmon driftnet fishery, although they have been recorded as entangled in fishing nets elsewhere (Terres 1991). Large numbers of grebes and loons occur in Puget Sound, Hood Canal, and the Strait of Juan de Fuca coincident with the fall chum fishery, yet information on these birds as a bycatch of this fishery is lacking. It is unknown whether this is due to low susceptibility to entanglement on the part of the birds (western grebes forage at night when gillnet fishing has ceased), or a lack of interaction studies during October and November.

3.8.2.6 Sea Ducks

Thousands of sea ducks (including diving ducks that use marine waters) winter each year in the inland waters of Washington. The most common of these are the scoters, buffleheads, goldeneyes, scaups, long-tailed ducks, and harlequin ducks (Nysewander et al. 2001a). Scoters alone comprise nearly half of all sea ducks during the winter and migration periods (Nysewander et al. 2001a). Most are either surf or white-winged scoters; black scoters comprise less than 10 percent of all sea ducks. Overall, scoters ~~have~~ declined 57 percent~~ since~~ between 1978–79 and 1999 (Nysewander et al. 2001b), and the decline has continued even lower over the last five years~~, with nearly all of this decline occurring in South Puget Sound~~ (Nysewander et al. 2003~~1b~~). Examination of scoter densities recorded by aerial surveys in five different subregions of greater Puget Sound show that densities have remained low in the northern areas while declining in all other subregions, except that of central Puget Sound around the greater Port Orchard area. Buffleheads comprised 23 percent of the sea ducks recorded between 1991 and 1999 (Nysewander et al. 2001a), and goldeneyes about 17 percent. Both have declined about 20 percent since 1978–79. Common goldeneyes were found to be more common than Barrow's goldeneyes except at certain bay locations. Scaups made up 8 percent of the sea ducks recorded during surveys by Nysewander et al. (2001a), with greater scaups comprising the overwhelming majority of the two species (the other the lesser scaup). Both scaup species have declined significantly since 1978–79 (72%; Nysewander et al 2001b). Puget Sound represents the southern end of the long-tailed duck's winter range. Long-tailed ducks comprise about 1 to 2 percent of the winter sea duck population, and are largely found in the eastern end of the Strait of Juan de Fuca and around the San Juan Islands (Marine Catch Areas 6 and 7; Nysewander et al. 2001a~~0~~). Although they do not occur in great numbers within the inland marine waters of Washington, the ~~few~~ sea ducks that do winter here have declined 92 percent (Nysewander et al. 2001b).

Declines in the sea duck species described above may represent a movement northward into the Canadian Strait of Georgia (where sea duck surveys have not been conducted in recent years), rather than major population declines. However, surveys conducted at other sea duck wintering locations do suggest a universal decline in this group. Only the harlequin ducks, which occur in low numbers during winter, have significantly increased (189%) in Puget Sound between the late 1970s and the 1990s (Nysewander et al. 2001b). But even these birds have fallen off considerably since peaking in 1996 at a little over a 1,000 individuals (Nysewander et al. 2001a).

Buffleheads, goldeneyes, and scaup feed largely on blue mussels, snails, and small crabs, although scaup also supplement their diet with sea lettuce and seasonally forage on herring spawn (Vermeer and Ydenberg 1989~~7~~). Scoters and long-tailed ducks feed chiefly on small clams and snails, with some crustaceans and herring eggs when available (Vermeer and Ydenberg 1989~~7~~). Harlequin duck diets in marine waters are much more diversified. Vermeer (1983) found snails, limpets, small fish, fish eggs, crabs, chitons, algae, and clams all of relative importance.

Sea ducks do not appear as bycatch in the Puget Sound gillnet fisheries, probably because they do not begin arriving in the Puget Sound area until November (Angell and Balcomb 1982; and Morgan 1987), when the annual salmon fishery has nearly concluded.

3.8.3 Marine Mammals

The inland marine waters of Washington support a diverse group of marine mammals. Year-around residents include harbor seals, minke whales, harbor porpoise, Dall’s porpoise, and killer whales. All these animals occur primarily in north Puget Sound, the Strait of Juan de Fuca, and around the San Juan Islands (Marine Catch Areas 4B, 5, 6, 7, and 9; Figures 3.3-1 and 3.3-14), except harbor seals, which are well distributed throughout Puget Sound. ~~Regular winter~~Seasonal visitors include California and Steller sea lions. Groups of male sea otters winter in the western end of the Strait of Juan de Fuca between Neah Bay and Port Angeles. More infrequent visitors include humpback and gray whales and elephant seals, although the latter may become a more important regional member, including possibly breeding on islands in the Strait of Juan de Fuca in the future as its west coast population continues to expand (Jeffries et al. 2000). Oceanic species that occasionally enter the Straits of Juan de Fuca include Pacific white-sided and Risso’s dolphins. Short-finned pilot whales also used to visit the area in the past (Angell and Balcomb 1982, Green et al. 1992), and on at least one occasion a group of false killer whales reached Puget Sound (Baird et al. 1989). Virtually all the marine mammals forage in subtidal and deeper waters, especially the tidal channels. However, harbor seals and sea lions will also forage intertidally, and resident minke whales and wintering sea otters occur relatively close to shore.

3.8.3.1 Harbor Seal

Harbor seals are year-around residents and the most common marine mammal inhabiting the inland waters of Washington. Unlike many other marine wildlife species, observed harbor seal abundance in Washington has increased an estimated 7- to 10-fold since 1970, and 3-fold since 1978 (Jeffries *et al.* 2003)~~s have experienced an average annual population growth of 6 to 8 percent during the 1980s and 1990s~~. An inland waters population estimated in 1978 at 2,600 by Everitt et al. (1979) had grown to more than 14,000 by 1999 (Jefferies *et al.* 2003~~1~~). Food habit studies have shown that the significance of salmon in the diets of Puget Sound harbor seals depends on location and season. Besides salmon, harbor seals prey on herring, Pacific whiting, anchovy, tomcod, flounder, sticklebacks, and eelpouts (Scheffer and Sperry 1931; Scheffer and Slipp 1944; Keyes 1968; Calambokidis et al. 1979~~8~~; Lance et al. 2001; and London et al. 2002). A recent study at Gedney Island (near Everett; Figure 3.3-1) showed that these Puget Sound harbor seals were preying almost exclusively on Pacific whiting and Pacific herring (National Marine Fisheries Service 1997). Similarly, London et al. (2002) found Pacific whiting and Pacific herring to dominate the diet of harbor seals in Hood Canal. Regardless, London et al. (2002) concluded that harbor seals do have the capability to negatively impact recovering salmon runs where escapement is small (e.g., Hood Canal chum salmon), and London et al. (2002) did identify salmon remains in 24.5 percent of 608 scat samples collected in Hood Canal.

Harbor seals can dive to 295 feet and remain underwater for 20 minutes (Angell and Balcomb 1982), but prefer to haul out on rocky shores, intertidal reefs, sandbars, mudflats, docks, log booms, buoys, and other structures. For this reason, they are distributed across both nearshore and deeper water habitat zones.

As with harbor seals elsewhere in the world (Northridge 1991; Lennart et al. 1994), Puget Sound harbor seals have been entangled in set and drift gillnets. In Puget Sound, Pierce et al. (1996) estimated that 15 harbor seals were entangled in the Marine Catch Area 7A gillnet fishery in 1994, based on an observed capture of two live (and released) and one dead seal during a study of that fishery.

3.8.3.2 California Sea Lion

California sea lions breed at island rookeries off southern California, the west coast of Baja California, and in the Gulf of California. A post-exploitation (mainly for meat and oil) population of about 1,000 animals breeding in California in the 1920s (Cass 1985) had increased to between 161,000 and 181,000 by 1994 (Barlow et al. 1995). After the breeding season, males migrate north to Oregon, Washington, and British Columbia. Annual populations peak off the Washington coast during March and May at numbers between 3,000 and 5,000 (Gearin et al. 2001). In recent years, peak abundances of over 5,000 California sea lions have been recorded on the Olympic Peninsula in the fall from September to December (personal communication with Steve Jeffries, WDFW, Research Scientist, July 30, 2004). The percentage of California sea lions using inland marine waters of Washington has varied considerably. Systematic counts of Puget Sound California sea lions began in 1979, but intensified after the 1985 to 1986 season amid concerns of impacts these pinnipeds were having on steelhead stocks passing through the Hiram Chittendon Locks in Seattle (Pfeifer 1987; and Pfeifer et al. 1989). More than 1,000 animals were recorded in Puget Sound during 1986 (1,031), and 1995 (1,234), while counts between 1998 and 2001 ranged between 177 and 323 (Gearin et al. 2001). However, these smaller Puget Sound counts have corresponded with higher counts on the outer coast, suggesting a change in use away from inland waters (Gearin et al. 2001). Haulout sites include ~~North~~ Waadah Island near Neah Bay in the Strait of Juan de Fuca, logbooms at Everett Harbor in north Puget Sound~~, and Eagle Island~~, bouys or floats at Edmonds~~ Scuba Float~~, Commencement Bay, Shilshoe Bay, ~~and 22 channel~~ as well as all navigation bouys from the Nisqually River to Port Townsend~~buoys in south Puget Sound~~ (Jefferies et al. 2000).

Although California sea lions often feed in the deeper inland waters of Washington, and commonly dive to extreme depths in oceanic waters, they are more closely associated with nearshore environments. Important prey in Washington include Pacific whiting, herring, squid, spiny dogfish, gadids, and salmonids (Everitt et al. 1981; and Gearin et al. 1986, 1988). Scat samples from near Everett and at Shilshole Bay show that Pacific whiting and herring dominate their diet (Gearin et al. 2001). While only 6 percent of the scats collected near Everett contained salmonids, 25 percent did from the Shilshole Bay sample. However, Shilshole Bay is located at the entrance to the Lake Washington Ship Canal where the Hiram Chittendon Locks concentrate migrating winter-run steelhead, which these sea lions heavily exploit.

California sea lions are clearly susceptible to gillnet mortality along the Washington Coast and areas outside Washington. In Washington, an estimated four to 42 California sea lions were killed annually in the Columbia River, Willapa Bay and Grays Harbor (Beach *et al.* 1985). The California set-gillnet fishery for halibut and angel sharks is estimated to have killed about 1,000 California sea lions annually between 1994 and 1998, based on an observed mortality of more than 100 animals (NMFS 2000a).

However, while monitoring the 1994 Puget Sound sockeye gillnet fishery in Marine Catch Areas 7 and 7A, Pierce et al. (1996) noted little interaction with California sea lions, and no entanglements. ~~For the most part, California sea lions do not arrive in Puget Sound until after most salmon fisheries are complete.~~ Two fisheries ~~that are still~~ open when the California sea lion abundance increases ~~s arrive,~~ and with which the sea lions interact include the late season river chum salmon and the winter run steelhead fisheries. Although sea lion entanglement in gillnets has not been reported, a small number of these animals are legally harvested by tribal fishermen (usually to protect fisheries and fishing gear) under subsistence regulations pursuant to tribal treaties (personal communication with Will Beattie, Northwest Indian Fisheries Commission, December 19, 2003).

3.8.3.3 Gray Whale

Nearly the entire Eastern North Pacific stock of gray whale, recently estimated at 26,635 individuals (Hobbs and Rugh 1999), passes twice annually along Washington's outer coast, in transit between Mexican breeding lagoons and Alaskan summer feeding grounds. Calambokidis described four patterns of gray whale use in Washington (personal communication with John Calambokidis, Cascadia Research, Senior Research Biologist, December 16, 2002). The first is the regular migrating herd that passes quickly through Washington outer coast waters. The second involves a group of about 250 whales that have taken up residency between northern California and southeastern Alaska. Although these whales move around considerably within this range, they do not partake in the annual migration to Alaska. A few of these whales can be found in the Strait of Juan de Fuca as far east as Protection Island, but most typically spend their time in Neah Bay (Figure 3.3-14). The third group is composed of what are thought to be migration stragglers, such as sick whales that do not complete the migration and find themselves exhausted and emaciated in south and central Puget Sound. These whales, generally 1 to 12 annually, suffer high mortality rates. The fourth group is comprised of about a half-dozen identified whales that annually (since 1991) spend March to May in the shallow, mud-bottomed areas of Saratoga Passage, Port Susan, Port Gardner, and Everett (Marine Catch Area 8; Figure 3.3-1), where they feed on dense populations of ghost shrimp.

Gray whales have been entangled in a variety of fishing gear (Hill and DeMaster 1999) including gillnets (Gearin et al. 1994; and Cameron and Forney 1999). Single gray whales were killed in the Makah set-gillnet fishery (Marine Catch Area 4) in 1990 and 1995, and a third was entangled but released unharmed in 1996 (personal communication with Patrick Gearin, NOAA-National Marine Mammal Laboratory, Research Biologist, December 30, 2002). Healthy gray whales are most likely to be encountered in Marine Catch Areas 4 and 8, but not Area 7 where most gillnet fishing in Puget Sound presently occurs.

3.8.3.4 Killer Whale

Killer whales in the Pacific Northwest are classified in three ~~two~~ distinct forms: resident, ~~and~~ transient and offshores. The resident form is further divided into ~~three~~ two population segments: northern~~,~~ and southern.~~, and offshore~~. It is the southern residents, composed of three pods (J, K, and L) that frequent the San Juan Islands and the Strait of Juan de Fuca, and enter Puget Sound on a semi-regular basis. The southern residents, like the other resident forms, feed almost exclusively on fish, especially salmon (Ford et al. 1998; Wiles 2004). These killer whale populations were exploited in the 1960s and early 1970s by the marine display trade. From a low of 70~~67~~ in 1974~~3~~, this population grew to 98~~7~~ individuals in 1996 (Wiles 2004). However, the number of animals in these groups declined dramatically to only 80~~78~~ by 2001. Attributing the decline to increased vessel traffic (including whale watching), declining salmon populations, and polychlorinated biphenyl (PCB) contamination (Ross et al. 2000;~~ and~~ Taylor 2001 and Wiles 2004), several groups petitioned in 2001 for listing the southern resident group as an entity (threatened or endangered) under the Endangered Species Act (ESA). In 2002, NMFS did not find that a listing was justifiable, but did designate the population as "depleted" under the Marine Mammal Protection Act, citing recent declines that may be attributed to pollution, prey reduction, and disturbance. In late 2003, NMFS was ordered by a federal judge to review its decision not to list the whales under the ESA. In April, 2004, the Washington Fish and Wildlife Commission added the killer whale to Washington's endangered species list.

The transient form of killer whales is morphologically and behaviorally different from resident whales. In general, transients travel in smaller groups (usually less than 7~~6~~), are less vocal, range from northern California to southeastern Alaska, and prey mostly on marine mammals (Bigg et al. 1987; and Ford et al. 1998). Harbor seals and harbor porpoise apparently constitute most of their diet in coastal and inland waters of the Pacific Northwest (Ford et al. 1998). The number of transients~~ in 1995 was~~ is currently estimated at 300-400~~179~~ whales (Wiles 2004). Transients occur regularly in the Strait of Juan de Fuca, the San Juan Islands, and northern Puget Sound.

Although mortalities have occurred with fishery interactions in Alaska (Small and DeMaster 1995), there are no recent reports (e.g., Anderson et al. 1993; Melvin and Conquest 1996; Pierce et al. 1996; and Melvin et al. 1997, 1999) that suggest Puget Sound gillnet fisheries pose an entanglement threat to killer whales.

3.8.3.5 Harbor Porpoise and Dall's Porpoise

The distribution of harbor porpoise in the inland marine waters of Washington is dramatically different compared to what it once was. Today, harbor porpoise are rarely observed in southern Puget Sound where they were once considered common (Scheffer and Slipp 1948). Pollutants, vessel traffic, fisheries, and other factors (including competition with an increasing population of Dall's porpoise) are thought to have contributed to this change in distribution (Osmek et al. 1995, 1996). In contrast, harbor porpoise population densities in the Strait of Juan de Fuca and the San Juan Islands appear to have remained stable. The most recent estimate for this region is 3,509 animals, about two-thirds found in the Strait of Juan de Fuca (Calambokidis et al. 1997; and Laake 1997a,b).

Inland water harbor porpoise inhabit nearshore and offshore waters (Pierce et al. 1996), where they feed largely on schooling fishes, such as herring, and cephalopods such as squid and octopus (Wilke and Kenyon 1952; and Angell and Balcomb 1982). Salmon do not appear to be an important component of their diet. Harbor porpoise are, however, encountered in Washington gillnet fisheries. In 1988, at least 102 harbor porpoise were killed in the outer coast Marine Catch Area 4 and 4A gillnet fishery (Figure 3.3-14), and another 52 were taken between 1989 and 1992 (Osmek et al. 1996). Only two porpoise were taken in Marine Catch Areas 4B and 5 between 1988 and 1993, and two were entangled (one released) in the 1994 sockeye gillnet season in Marine Catch Area 7 (Osmek et al. 1996; and Pierce et al. 1996). Melvin et al. (1999) report that two harbor porpoise were captured (fate unknown) in a 1996 test sockeye fishery in Marine Catch Area 7. NMFS observers monitored the northern Washington marine set gillnet fishery during 1994-1998 and in 2000. There was no observer program in 1999, however, the total fishing effort was only 4 net days (in inland waters) and no marine mammal takes were reported. No mortalities were observed in the inland portion of the fishery between 1994 and 2000 (Carretta et al. 2004).

Dall's porpoise are commonly found in the Strait of Juan de Fuca and through Admiralty Inlet (Marine Catch Areas 4B, 5, 6, 7, and 9), but rarely extend farther south into Puget Sound than Possession Bar (Marine Catch Area 9), or north into the Strait of Georgia (Marine Catch Area 7A; see Figure 1.1-1) (Angell and Balcomb 1982). Nysewander et al.'s (2001a) observations suggest that movements of Dall's porpoise into South Puget Sound is most likely to occur during winter. The most recent estimate for this region is a weighted average of 1,509 animals after combining porpoise abundance surveys in 1991 and 1996 (Carretta et al. 2004).

During 1994 boat surveys in Marine Catch Area 7, Pierce et al. (1996) observed 18 Dall's porpoise, all in Haro Strait (Figure 3.3-1). Seventeen (94%) of these were greater than one mile offshore (averaging more than 3 miles), indicating their preference for deep-water habitats. Morejohn (1979) described their diet as predominately deep-water schooling fish and squid. Although diet information from inland waters is limited (Scheffer and Slipp 1948), Dall's porpoise inhabiting the Strait of Juan de Fuca likely feed on Pacific whiting, Pacific herring, and squid. Although animals from the California/Oregon/Washington stock are often captured in oceanic drift gillnet and trawl fisheries (Perez and Loughlin 1991; and Cameron and Forney 1999), there is little evidence of interaction with inland water salmon gillnet fisheries. Dall's porpoise have been killed incidental to gillnet fisheries in southern Puget Sound (personal communication with Steve Jeffries, WDFW, Research Scientist, July 30, 2004). ~~The only report is of~~In 1996, three Dall's porpoise were incidentally taken in a ~~1996~~ test sockeye fishery in Marine Catch Area 7 (Melvin et al. 1999).

3.8.3.6 Sea Otter

In 1969 and 1970, 59 sea otters were translocated from Alaska to the Washington outer coast (Bowlby et al. 1988; and Jameson and Jeffries 2001). ~~This population grew to an estimated 555 individuals in 2001~~In 2003, surveys for sea otter in Washington resulted in a count of 672 animals (Jameson and Jeffries 2003~~1~~). ~~Virtually the entire sea otter population inhabits the nearshore zone of the outer coast, although a large group of males has been observed since 1995 wintering along the south shore of the Strait of Juan de Fuca, 20 to 30 miles east of Tatoosh Island, in the vicinity of Sekiu and Pillar Point, respectively (Jameson and Jeffries 2000). A single otter was observed near Pillar Point (Marine Catch Area 5) in summer 2000 (Jameson and Jeffries 2000), and confirmed sightings of wandering single otters were recorded near Olympia and Tacoma (Marine Catch Areas 11 and 13; see Figure 3.3-7) in summer 2001 (Jameson and Jeffries 2001).~~Sea otters occur along the Washington coast from Destruction Island to Pillar Point. Seasonal shifts in the distribution of sea otter have been observed as the population has increased with 50 to 100 otters entering the Strait of Juan de Fuca and moving east to between Slip Point and Pillar Point (Marine Catch Area 5). Confirmed sightings of individual sea otters from inland waters includes individuals near Freshwater Bay, San Juan Islands, Dumas Bay, Nisqually Reach, Totten Inlet, Budd Inlet, and Hammersly Inlet (Marine Catch Areas 7, 11 and 13); see Figure 3.3-7)(Richardson and Allen 2000).

Sea otters have been entangled in gillnet fisheries outside Washington, but encounters within Puget Sound are rare. Wendell et al. (1985) estimated that net entanglement killed an average of 80 sea otters per year off California in the 1970s and 1980s. Lennart et al. (1994) estimated that the set-net gillnet fishery for Pacific angel shark and California halibut killed 33 sea otters during the second half of 1990. Currently, non-treaty gillnet fishing is prohibited within the sea otter range in Washington. ~~One~~

~~otter was taken in the outer coast Marine Catch Area 4 gillnet fishery in 1989 (Figure 3.3-14)(Kajimura 1990).~~ In Washington from 1988 to 2001, a total of 11 sea otters were incidentally killed in set net fisheries for chinook salmon in Marine Catch Areas 3 and 4. In addition, to incidental mortality in gillnet fisheries (Richardson and Allen 2000).

3.8.4 Benthic Invertebrates

Kozloff (1996) described the intertidal and subtidal communities found in the marine waters of Washington. His habitat divisions relevant to the inland waters of Washington include the intertidal and subtidal zones with rocky, sandy, or muddy sand substrates, and salt marsh. All are discussed below.

The rocky shores of greater Puget Sound support a diversity of marine invertebrates with a community composition that changes quickly with water depth. Marine invertebrates that occur in the upper reaches of the rocky intertidal zone include periwinkle snails, limpets, shore crabs, and barnacles. These invertebrates are able to withstand long periods exposed to open air and corresponding changes in temperature. As the water deepens, Nucella snails, hermit crabs, blue mussels, goose barnacles, Pisaster sea stars, and chitons dominate the intertidal community. The lower limit of the intertidal is also occupied sea anemones, sea urchins, northern abalone, and scallops. The rocky subtidal includes sea stars, anemones, urchins, abalone, and scallops, but also species unable to withstand periods of air exposure, such as octopus, broken-back shrimp, and sea slugs.

Marine invertebrates that typically inhabit the sandy intertidal zone include sand dollars, crangon shrimp, basket whelks, and burrowing sea cucumbers. Moon snails are also common in this zone, preying on a variety of clams including bent-nosed, sand, tellina, and heart cockles. Intertidal zones with muddy sand substrates support an even more diverse clam population including gaper, geoduck, littleneck, Manila, bent-nosed, butter, soft-shelled, and heart cockle. Ghost shrimp supplant the crangon shrimp. Burrowing shore crabs extend their distribution from this habitat up into the salt marshes. Invertebrates characterizing the deeper water subtidal zone of both these habitats include brittle stars, mediaster sea stars, sea pens, and Dungeness, red, and helmet crabs.

None of the major Puget Sound/Strait of Juan de Fuca marine salmon fishing types (drift and set-gillnet, seine, troll, or sport) occur on the sea floor in a manner that would significantly disturb benthic invertebrate communities. The one exception is beach seine fisheries in Hood Canal and South Puget Sound, where nets are cast out and dragged back in to the beach. However, these fisheries are small in size, limited to the nearshore shallow zone, and occur in beach areas without potential snagging rocks (where few invertebrates live on the seafloor surface). Thus, the impact of beach seine fisheries on marine invertebrates is probably insignificant.

3.8.5 Threatened and Endangered Species

The National Marine Fisheries Service is consulting with the U.S. Fish and Wildlife Service and with itself on the effects of the Proposed Action or alternatives on these listed species. NMFS is incorporating these evaluations into the NEPA process in order to coordinate the environmental review processes as required by NEPA (40 CFR Part 1502.25). The biological evaluations and biological opinion are included in Appendix H.

3.8.5.1 Marbled Murrelet

The marbled murrelet was listed as threatened under the Endangered Species Act in 1992 after decades of population decline. Ralph et al. (1995) identified several possible causes for this decline, including loss of forest nesting habitat due to logging, mortality from gillnets and oil spills, and high predation rates. Marbled murrelets forage in nearshore marine waters and nest in inland old-growth and mature conifer forests (Hamer and Nelson 1995). Booth (1991) concluded that 82 to 87 percent of this forest that existed in 1840 has now been eliminated. Speich et al. (1992) estimated the Washington marbled murrelet population at 5,000 individuals, with 2,600 of these birds occurring in the Strait of Juan de Fuca, San Juan Island, and Puget Sound waters. Beissinger (1995), Beissinger and Nur (1997), and Nysewander et al. (2001b) have concluded that the marbled murrelet population has declined significantly since that time.

Thompson (1997) conducted surveys for marbled murrelets along the Strait of Juan de Fuca (Marine Catch Areas 4 and 5) in 1996 and 1997, and found about 20 to 50 birds between Neah Bay and Pillar Point, and a large aggregation of 500 to 1,000 between Pillar Point and Port Angeles (Figure 3.3-14). The highest densities of birds were found 656 feet offshore. The San Juan Islands and Rosario Straits area (Marine Catch Areas 7 and 7A) has the highest concentrations of marbled murrelets in greater Puget Sound. On August 15, 1995, Ralph et al. (1996) observed between 404 and 467 murrelets during systematic boat surveys of the islands. Burrows Bay (east of the San Juan Islands in Marine Catch Area 7) apparently supports significant numbers (100 to 200) of murrelets from August to October (Courtney et al. 1997; Stein and Nysewander 1999; and Raphael et al. 2000). Courtney et al. (1997) surveyed Admiralty Inlet and Hood Canal south to Quatsop Point and found numbers of marbled murrelets varying between 205 and 476. Surveys conducted in waters east of Whidbey Island (Skagit Bay, Saratoga Passage, and Everett Bay) – Marine Catch Area 8 – by Courtney et al. (1997) showed a decline from more than 250 birds in 1995 to about 125 in 1996. South Puget Sound has been surveyed by Courtney et al. (1997), Raphael et al. (2000), and Nysewander et al. (2001a), none of whom found murrelets in any abundance.

Because marbled murrelets have been incidentally caught in the Puget Sound salmon gillnet fisheries (Pierce et al. 1994, Erstad et al. 1994; Northwest Indian Fisheries Commission 1994; Lummi Nation 1994; and Gearin et al. 1994), Pierce et al. (1996) monitored the 1994 Puget Sound sockeye gillnet fishery (Marine Catch Areas 7 and 7A) to quantify the impact to murrelets. After observing more than 2,200 gillnet sets (7% of the total sets), and recording only one marbled murrelet entanglement, the authors estimated that the fishery may have killed approximately 15 murrelets. Melvin et al. (1997) recorded one murrelet entanglement in 642 sets (at Burrows Bay) of modified test gillnets designed to reduce seabird mortality.

3.8.5.2 California Brown Pelican

The California brown pelican is a colonial nester in Mexico and southern California that wanders north as far as British Columbia during the non-breeding period. The population segment that nests in California represents about 10 percent of the total population, and nesting colonies are currently confined to a few locations in the Channel and Santa Barbara Islands. These colonies suffered dramatic declines in the 1960s from the effects of chlorinated hydrocarbons (DDT, DDE). Eggshell thinning from these pesticide derivatives resulted in dramatic nesting failures to such an extent that the 1969 and 1970 nesting seasons were virtually shut down (Anderson et al. 1975; Anderson and Gress 1983; and Carter et al. 1992). Consequently, the California population of brown pelican was federally listed as endangered in 1970. The population was further impacted in the mid-1970s by crashes in stocks of their principal prey, northern anchovy. Since that time, the brown pelican population has recovered dramatically with the West Anacapa Island (Channel Islands) colony supporting 4,000 to 6,000 nesting attempts annually, and the nearby Santa Barbara Island colony supporting 400 to 700 nesting attempts.

Since recovery, brown pelicans have become more prevalent along the Washington coast, especially during the fall. By 1991, more than 7,000 brown pelicans were observed using the Washington coast, mostly in the vicinity of the Columbia River and Grays Harbor (Jaques 1994). Angell and Balcomb (1982) stated that brown pelicans make only rare appearances in Puget Sound. Brown pelicans feed primarily on schooling baitfish, especially anchovy, and are not known to interact with salmon fisheries.

3.8.5.3 Bald Eagle

The bald eagle was listed as threatened under the Endangered Species Act in 1978 after decades of persecution (despite the Bald Eagle Protection Act of 1940), nest failure due to chlorinated hydrocarbon (DDT) contamination, loss of prey due to declining salmon runs, and habitat loss due to logging and human development. The summer population of bald eagles prior to European settlement of Washington was estimated at about 6,500 birds (Stinson et al. 2001). By 1980, this population had declined to only 105 pairs (103 in western Washington). Increased protection and recent recovery efforts since then have resulted in a dramatic increase in the state's breeding population. In 1998, the number of occupied nests had increased to 664 (active pairs), and the number of nesting territories to 817. These populations are continuing to grow toward a predicted carrying capacity of 733 active pairs (Stinson et al. 2001). One of the more dramatic population increases occurred in the San Juan Islands where five nesting territories in 1962 had grown to 102 by 1998 (Stinson et al. 2001). Collectively, the 12 counties encompassing Washington's inland marine waters currently support 76 percent (617) of the state's bald eagle nesting territories. Overall, the Washington nesting population exhibits the high productivity expected of a growing population. One exception, however, is the Hood Canal nesting population, which, despite increasing from three to 33 pairs between 1980 and 1998, has consistently exhibited low reproductive success (Mahaffy et al. 2001). Studies of this population were initiated in the late 1990s (Mahaffy et al. 2001) after high levels of polychlorinated biphenyls (PCBs) and other contaminants were found, but the results were inconclusive. (PCBs were used in a variety of industrial and electrical applications, including as hydraulic fluid. Hydraulic fluid leaks and spills from shipyards and industrial-complex machinery are likely sources of Puget Sound PCB contamination.)

Between 1982 and 1989, approximately 1,000 to 3,000 bald eagles wintered annually in Washington, 80 percent coming from Alaskan and Canadian breeding areas. While the majority of these birds concentrate on major salmon rivers (especially the Skagit, Nooksack, and Columbia Rivers), the Puget Sound shorelines annually support 400 to 600 of these birds (Taylor 1989).

Watson and Pierce (1998) concluded that coastal eagles preyed more on birds, while inland (river) eagles foraged more on fish. Differences in surface behavior of fish and abundance of waterfowl and seabirds may account for these differences. However, Retfalvi (1970) found rockfish and lingcod important in the diets of San Juan Island bald eagles, and diet studies by Knight et al. (1990) and Watson and Pierce (1998) did show that both groups of bald eagles prey on a wide variety of fish and birds (perhaps a close reflection of what is available). Common bird prey included glaucous-winged gulls, scoters, grebes, and cormorants, while common fish prey included flounders, herring, Pacific whiting, plainfin midshipman, dogfish shark, and sculpins (Retfalvi 1970; Knight et al. 1990; and Watson and Pierce 1998). Salmonids were also present in the diet of bald eagles, but do not contribute as greatly to the marine diet as they do to the diet of bald eagles foraging along inland rivers and reservoirs (especially during fall and winter salmon runs).

Bald eagles do not interact with the Washington salmon gillnet fisheries, and coastal breeding birds are probably not impacted by harvest because they rarely feed on salmon at this time of the year (Watson and Pierce 1998). However, fall and winter spawning salmon are a critical food source for winter bald eagles, especially along the major spawning rivers of western Washington.

3.8.5.4 Steller Sea Lion

The Steller sea lion was listed as threatened under the Endangered Species Act in 1990, after a decade of 12 percent annual population declines in the Aleutian Islands and Gulf of Alaska (NMFS 2001a). However, the eastern population segment that ranges from southeastern Alaska to California, has remained stable or increased slightly (NMFS 2001a,b). There is no indication that Steller sea lions breed in Washington, but each year a few hundred overwinter in the inland waters (Everitt et al. 1979), likely originating from rookeries in Oregon and British Columbia (NMFS 2001b). A known haulout is located on Sucia Island immediately north of Orcas Island within the San Juan Islands (Marine Catch Area 7; Figure 3.3-1) (Angell and Balcomb 1982).

Steller sea lions use both nearshore and deeper (greater than 60 feet) waters. Diet studies in Oregon showed a preference for Pacific whiting and lampreys, although Pacific herring, eulachon, anchovy, sculpin, and salmon, were also important (Beach et al. 1985; Reimer and Brown 1996). Steller sea lions are caught incidentally in fisheries. Perez and Loughlin (1991~~0~~) estimated that 20,000 of these animals were incidentally caught in the Alaska trawl fisheries between 1966 and 1988. Matkin and Fay (1980) calculated that more than 300 were shot while interfering with the 1978 Copper River gillnet fishery. Stellar sea lions have been occasionally taken in gillnets and trawls off Oregon and Washington (NMFS 1992), but there are no reports of incidental captures in Washington inland waters.

3.8.5.5 Humpback Whale/Fin Whale

Humpback whales occur seasonally off the Washington coast, inhabiting continental shelf and shelf-edge waters (Green et al. 1992; and Calambokidis et al. 2000, 2001). They rarely enter Washington inland marine waters, although they were once so common that a whaling station was established at Victoria, British Columbia (Schmitt et al. 1980). Today, just a very few humpback whales annually frequent the Canadian side of the Strait of Juan de Fuca, and about every other year, humpbacks stray into Puget Sound (personal communication with John Calambokidis, Cascadia Research, Senior Research Biologist, December 16, 2002). Humpback whales use of greater Puget Sound is likely too infrequent to interact with the salmon gillnet fisheries.

There are no recently confirmed sightings of fin whales in the inland marine waters of Washington, although they have been reported in the Strait of Georgia. However, in the past few years, three large ships have docked in Puget Sound (Cherry Point, Everett, and Port of Seattle) with struck fin whales still adhering to their bows (personal communication with John Calambokidis, Cascadia Research, Senior Research Biologist, December 16, 2002). It is suspected that one of the whales was part of the Strait of Georgia group, and another was struck in the western Strait of Juan de Fuca. However, there are no reports of encounters with fin whales in Puget Sound salmon fisheries.

3.8.5.6 Pacific Leatherback Turtle

Pacific leatherback turtles were listed as endangered throughout their range under the jurisdiction of the Endangered Species Act after experiencing precipitous declines in their nesting populations (NMFS and USFWS 1998). Although they do not nest in U.S. Pacific waters, Pacific leatherback turtles do inhabit the shelf and offshore Pacific Ocean waters of the United States, including Washington (Bowlby et al. 1994), during the summer months. Their entanglement with fishing gear has been well-documented in other areas (NMFS and USFWS 1998). However, leatherback turtle use of the inland waters of Washington is accidental at best; therefore, this species is unlikely to interact with Puget Sound salmon fisheries.

3.9 Ownership and Land Use – Parks and Recreation

The Puget Sound Action Area includes marine and freshwater systems, and associated riparian and nearshore areas. The majority of the surrounding land ownership is private (53%), followed by federal (36%), state/local (10%), and tribal (1%) (see Figure 3.2-4).

Recreational land use within the action area includes state and federal parks, and privately-owned and developed recreational facilities, including facilities with boat landings. The Interagency Committee for Outdoor Recreation provides a website displaying information about Washington's motorboat launches by county (Interagency Committee for Outdoor Recreation 2003). Information presented was collected during a 1998 field survey of all publicly-accessible motorboat launches in Washington State. Boat launches within the Puget Sound Action Area, by county, are presented in Table 3.9-1.

Table 3.9-1. Freshwater and saltwater boat launches in the 12 counties within the Puget Sound action area.

Region	Washington County	Freshwater Boat Launches [1]	Saltwater Boat Launches [1]	Total Boat Launches [1]
Strait of Juan de Fuca	Clallam	2	19	21
Hood Canal	Jefferson	5	16	21
	Kitsap	13	19	32
	Mason	18	13	31
South Puget Sound	King	34	6	40
	Pierce	18	20	38
	Thurston	14	6	20
North Puget Sound	Snohomish	23	6	29
	Skagit	30	8	38
	Whatcom	20	9	29
	Island	1	18	19
	San Juan	4	13	17
Total	12	182	153	335

[1] Boat launches within the Puget Sound Action Area. Clallam, Jefferson, Thurston, and Mason Counties have additional boat landings outside the action area.

Many of these publicly-accessible boat launches are owned and managed by either Washington Department of Fish and Wildlife or Washington State Parks. The diverse Washington State Parks system includes 125 parks and 250,000 acres of land managed. It ranks sixth among all 50 states in number of areas managed, fourth in day-use attendance, and eighth in number of overnight visitors served. Many of these parks are located on river banks, beaches and estuaries within the Puget Sound

Action Area. Most offer opportunities for either saltwater or freshwater fishing (Washington Parks and Recreation Commission 2002).

In a survey conducted by the Interagency Committee for Outdoor Recreation, it was estimated that 13 percent of the Washington state population annually participates in fishing (Interagency Committee for Outdoor Recreation 2002). Using the results of the Interagency Committee for Outdoor Recreation survey, the state's 12-county population within the Puget Sound Action Area on April 1, 2000, estimated at 3,978,513 citizens (Table 3.2-2), would translate into approximately 517,000 recreational fishermen. This estimate includes persons fishing for salmon (within the scope of this Environmental Impact Statement), and persons fishing for non-salmon species (not addressed by this Environmental Impact Statement).

3.10 Water Quality

Marine water quality is a function of natural and anthropogenic (human-caused) processes. Natural factors include climate (winds, tides, rainfall, upwelling processes), and biological processes such as phytoplankton blooms. Primary anthropogenic factors include:

- Urban stormwater runoff
- Treated wastewater effluent
- Industrial discharges
- Agricultural practices (e.g., tilling that results in wind and water erosion of soil; applications of fertilizer, pesticides and herbicides; runoff from dairy farms)
- Releases from failing septic systems
- Land management practices that affect runoff quantity and quality
- Other point and non-point source releases of contaminants.

Within the area encompassed by the Puget Sound Chinook ESU, over 1,300 streams and river segments and lakes do not meet Federally approved, state and Tribal water quality standards and are now listed as water quality limited under Section 303(d) of the Clean Water Act (DOE 2004). Tributary water quality problems contribute to poor water quality where sediment and contaminants from the tributaries settle in mainstem reaches and the estuary. The Washington Department of Ecology rated Puget Sound water quality as generally good in most areas (Newton et al. 2002). The report identified a number of specific locations where water quality has declined, due to low dissolved oxygen, fecal coliform bacteria contamination, or an indication of sensitivity to eutrophication based on persistent layering of waters of different densities (stratification) or nutrient conditions. Eutrophication is an increase in nutrients, typically nitrogen or phosphorus, that can result in very large algal blooms. As the nutrients are depleted, the algae die and sink to lower depths. The decomposition of the dead algae depletes the dissolved oxygen in the water, reducing the ability of the water to support life. In Puget Sound, eutrophication occurs due to a combination of weather patterns and nutrient inputs, typically from runoff or wastewater sources, like wastewater treatment plant discharges or failing septic systems. Areas of highest concern include southern Hood Canal, Budd Inlet, Penn Cove, Commencement Bay, Elliott Bay, Possession Sound, Saratoga Passage, and Sinclair Inlet. The Puget Sound Water Quality Action Team (PSWQAT 2002) provides a similar overview of water quality in Puget Sound with a somewhat different focus that includes toxic contaminants and biological resources. In particular, this report identifies areas with sediment contamination due to polycyclic aromatic hydrocarbons (PAHs) – the most likely contaminants from vessel operations.

The potential for water quality impacts associated with implementing the Proposed Action or alternatives is discussed in this Environmental Impact Statement in the context of vessel operations for commercial, tribal, and recreational fishing. Potential impacts could occur in the form of turbidity and sedimentation, and/or non-point source pollution from hydrocarbon spills or releases. Estimates of the amount of vessel traffic on Puget Sound associated with fishing are not readily available, so it is not possible to quantify the impacts of fishing versus other boating activities. However, there were 191,426 licensed vessels in 2002*, with a corresponding 293 licensed non-treaty commercial fishers. Using these figures, non-treaty commercial fishing vessels represent only one-tenth of one percent of the total vessels registered by Washington Department of Licensing in Puget Sound. ~~However,~~Because salmon fishing is just one of many boating activities that take place on Puget Sound, ~~so~~ it is not expected that fishing operations, either sport or commercial, will be a major factor in vessel activity.

3.10.1 Turbidity and Sedimentation

Vessel operations in and around moorage facilities and in other shallow areas have the potential to stir up bottom sediments and cause short-term increases in turbidity in marine and freshwater areas. Boat wakes may contribute to bank erosion in some areas.

3.10.2 Non-Point Source Pollution

The most likely pollutants attributable to the operation of fishing vessels are in the class of compounds known as polycyclic aromatic hydrocarbons (PAHs). These include diesel fuel, gasoline and lubricants that might be spilled directly into the water; unburned fuels and oils associated with the operation of two-cycle engines such as outboard motors; and deposition of the products of combustion from larger vessel engines. PAHs have limited solubility in water (Varanasi 1989), and are typically not found free in the water column. Lighter fractions tend to come to the surface where they evaporate. Heavier versions tend to sink to the bottom and adsorb to sediments. These contaminants can reenter the water column if sediments are disturbed, and are known to cause problems for benthic organisms and fishes that are in direct contact with the sediments (Puget Sound Water Quality Action Team 2002).

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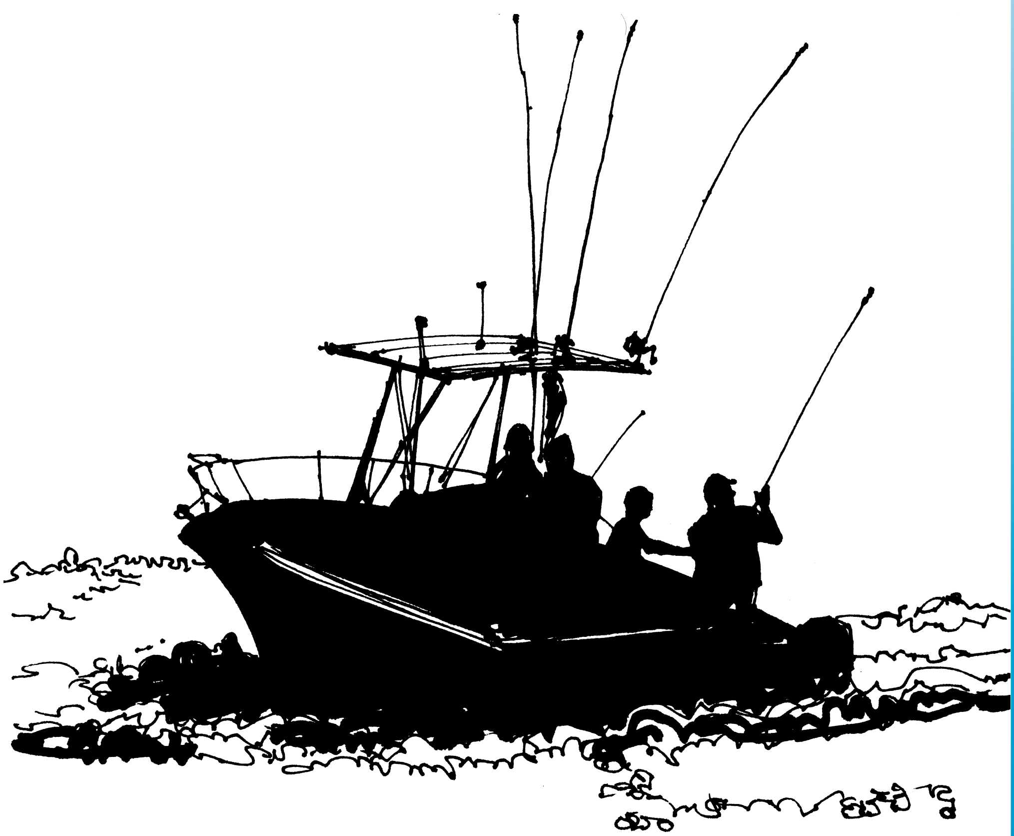
* Treaty-Indian vessel owners are not required to register with Washington Dept. of Licensing. The count of fishers includes licenses issued to non-treaty-Indian purse seine and gill net gears, and does not include fixed reef net gear.

Central and South Puget Sound have been identified as areas where PAH contamination is significant (Puget Sound Water Quality Action Team 2002). This contamination primarily resulted from historic use of creosote (a wood preservative) at specific locations, stormwater runoff from urban areas (petroleum product residues in runoff from parking lots and roadways), and the byproducts of combustion (wood burning, coal burning, and vehicle exhaust). Existing water quality problems attributable to polycyclic aromatic hydrocarbons are the result of a multitude of small, chronic contaminations, to which the operation of fishing vessels likely contributes.

Environmental Consequences of Alternatives



4

4.0 ENVIRONMENTAL CONSEQUENCES

4.1 Introduction

This section describes the predicted impacts to those components of the natural, built, and human environment described in Section 3 (Affected Environment) for each alternative defined in Section 2 (Alternatives Including the Proposed Action). NEPA requires that the analysis of alternatives consider seven types of impacts: direct, indirect, cumulative, short-term, long-term, irreversible and irretrievable (CEQ Regulations at 40 CFR 1508.25; NEPA section 102[2][C][iv][v]). The alternatives analyses in this section focus on the assessment of direct, indirect and cumulative effects.

Direct effects are caused by the action and occur at the same time and place (CEQ Regulations at 40 CFR 1508.8).

Indirect effects are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable (CEQ Regulations at 40 CFR 1508.8).

Cumulative impacts result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions (CEQ Regulations at 40 CFR 1508.7).

Predicted environmental effects of this nature are described in this section by environmental resource. Given the six-year duration of the Proposed Action, the effects are predicted to be primarily short-term in nature. No irreversible impacts associated with the Proposed Action and alternatives are predicted to occur. Long-term and irretrievable impacts are discussed with direct effects.

In order to evaluate the potential severity of environmental effects, metrics are used to characterize the magnitude and intensity of the effect. The metrics used in this analysis include:

No effect: Not measurable or expected, or of such a rare occurrence that it would be impossible to measure or detect.

Low effect: Measurable but of small amount or infrequent occurrence.

Moderate effect: Measurable at some level between low and substantial.

Substantial effect: A high impact that is measurable and/or expected, or likely to occur more frequently than anticipated.

Predicted environmental effects are quantified where possible, but for several resources where quantifiable information is not available, the analysis relies on qualitative assessments and best professional judgment.

Section 4.2 (following) describes the basis for the comparison of alternatives, and describes the analysis approach. The analyses in this section follow the order of resource issues described in

Section 3, Affected Environment. For example, the fish resource was described in Subsection 3.3, and the alternatives analysis for fish is found in Subsection 4.3. Discussions of the natural, built and human environment are organized as follows:

Section 4 Subsections	Natural Environment	Built Environment	Human Environment
4.3.1 and 4.3.2: Status of salmonid species	X		
4.3.3: Other fishes	X		
4.3.4: Fish habitat	X		
4.3.5 through 4.3.7: Potential ecological effects of alternative harvest activities	X		
4.4: Tribal treaty rights and trust responsibilities			X
4.5: Non-commercial use of salmonids by Puget Sound tribes			X
4.6: Regional economics of commercial and sport fisheries			X
4.7: Environmental justice			X
4.8.1 through 4.8.3 and 4.8.5: Seabirds, marine mammals, and other wildlife species	X		
4.8.4: Lower trophic-level species	X		
4.9: Land ownership and land use		X	
4.10: Water quality	X		

4.2 Basis for Comparison of Alternatives and Approach to Alternatives Analysis

The basis for comparing the alternatives described in Section 2, and the approach to the alternatives analysis is briefly described in this section to introduce the methods for predicting the effects of the Proposed Action and alternatives. Technical modeling tools used to analyze the Proposed Action and alternatives are also described.

4.2.1 No Action Alternative

NEPA essentially asks how current environmental conditions would change with the Proposed Action or alternatives. Therefore, the environmental consequences analysis of the alternatives requires defining a baseline against which the Proposed Action and alternatives can be evaluated and contrasted. In practice, this baseline is usually either existing conditions (i.e., the affected environment), or the no action alternative (CEQ Regulations at 40 CFR 1502.15). However, although NEPA requires that the alternatives considered for detailed analysis include a no action alternative, neither NEPA nor the CEQ implementing regulations require that the no action alternative be used as the baseline.

For this analysis, the Proposed Action (Alternative 1) most closely approximates current baseline conditions, because the same type of chinook salmon harvest management plan has been implemented since 2000. In situations where the proposed activity is fundamentally the continuation of a current management activity, the proposed action may be defined as the no action alternative because the proposed action represents no change from the baseline environmental condition (CEQ 40 Questions, question 3).[i] This may raise some confusion in relation to the settlement agreement with Washington Trout v. Lohn, in which no authorized take of listed chinook in Puget Sound (Alternative 4) is identified as the no action alternative to describe the case where literally no harvest of listed Puget Sound chinook salmon would occur. For the purposes of this analysis, Alternative 1 (the Proposed Action) is the baseline for comparison of alternatives under NEPA, and Alternative 4 represents the case in which the Proposed Action would not occur. The alternatives analyzed in detail in this

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[i] CEQ interpreted the 'no action' alternative in two ways (CEQ 40 Questions, question 3):

1) For a continuing action, such as a long-term plan or program of action, 'no action' is defined as 'no change' from current management direction or level of management intensity.
2) For a project, 'no action' is defined as 'the proposed activity would not take place, and the resulting environmental effects from taking no action would be compared with the effects of permitting the proposed activity or an alternative activity to go forward."

Fundamentally, these two interpretations are the same since each is intended to define the environmental baseline conditions that exist prior to the implementation of the proposed activity or its alternatives.

Environmental Impact Statement are compared to one another, as required by NEPA, to obtain a clear understanding of the comparative merits of each alternative.

4.2.2 Technical Approach to Impact Assessment

The Affected Environment section of this Environmental Impact Statement (Section 3) describes the effects of fishing that have occurred in the past; however, it does not accurately describe the baseline conditions from which the effects of the Puget Sound chinook salmon harvest alternatives can be determined, due to changing environmental conditions, population abundance and market conditions. Every year, the Washington Department of Fish and Wildlife and the Puget Sound treaty tribes (the co-managers) use a technical model[ii] to evaluate the effects of harvest management regimes against the predicted salmon abundances for the coming year. Therefore, this model could be used to examine the effects of various alternatives on the salmon resource by comparing them under the same set of baseline environmental conditions.

The 2003 fishing year is representative of salmon abundance and fishing patterns in recent years;[iii] therefore, 2003 pre-season expectations and modeling information are used to describe the general pattern of fisheries that would reasonably be expected to occur under Alternative 1, the Proposed Action, over the time period it would be in effect (the ~~2004~~ 2005–2009 fishing seasons). The model was then adjusted from these baseline conditions to predict impacts to salmon for the three harvest management alternatives described in Section 2. This information formed the basis for the alternatives analysis in this Environmental Impact Statement. A detailed description of the modeling assumptions is provided in Appendix C.

The environmental consequences of the Proposed Action and alternatives are affected by the distribution and magnitude of catch or mortality (catch and exploitation rate), available opportunities (sport angler trips), and numbers of fish that remain to reproduce (escapement). For example, the amount of money that comes into a community from fishing depends largely on the amount of fish commercial fishermen catch to sell, the opportunities available to sport fishermen to catch fish, and where those opportunities are available. Predicted effects to Puget Sound tribal treaty rights or subsistence uses are also dependent on access to fish and the available amount of fish. Predicted effects

[ii] The model is called the Fisheries Regulation and Assessment Model (FRAM).

[iii] Pink salmon return to Puget Sound only during odd-numbered years, so 2003 is the most recent year that would include impacts resulting from pink salmon fisheries. Using a year that includes pink salmon fisheries and returning pink salmon adults ensures that impacts to all salmon species are accurately represented.

on fish and wildlife resources are influenced by the encounters of these species with fishing activities and the number of fish that survive to reproduce. The technical model and other sources of available data were used to predict this core set of parameters: catch, exploitation rates, angler trips and escapement.

4.2.3 Scenarios for Alternatives

The outcome of implementing any of the alternatives evaluated in the Environmental Impact Statement as measured by the core set of parameters described above will depend on the Puget Sound chinook salmon abundance available to the fisheries in any individual year, and the amount of Puget Sound chinook harvest taken in Canadian and Alaskan fisheries prior to chinook salmon reaching Puget Sound fisheries. For example, chinook salmon populations are more likely to achieve management objectives at higher abundance and/or lower levels of Canadian/Alaskan fisheries, and therefore, fishing opportunity would be expected to be more widely distributed throughout Puget Sound. At lower abundance and/or high levels of Canadian/Alaskan fisheries, the geographic scope of fisheries and the amount of catch would be expected to be substantially reduced. Therefore, the Environmental Consequences analyses incorporate assumptions about the range of chinook salmon abundances and levels of chinook harvest in Canadian/Alaskan fisheries that could reasonably be expected to occur for the duration of the Proposed Action (the ~~2004~~ 2005–2009 fishing seasons).

These different scenarios are used only to explore the range of possible impacts to chinook salmon. The assumptions regarding the range of abundance and Canadian/Alaskan fisheries for coho, sockeye, pink, chum and steelhead are the same among scenarios for two reasons: 1) the purpose of the Proposed Action is to manage Puget Sound chinook salmon. It does not include management objectives for other species or describe how fisheries will respond to changes in abundance of those other salmon species; and, 2) the 1999 Pacific Salmon Treaty Chinook Annex provides the necessary information to model chinook impacts under higher levels of fishing than those observed in recent years, but which might occur in the next few years. However, there is insufficient information to allow modeling how catch of salmon species other than chinook would vary in response to changes in Canadian/Alaskan fisheries. Therefore, the analysis assumes abundance and Canadian/Alaskan fishery impacts for non-chinook salmon species will remain similar to those experienced in recent years.

4.2.3.1 Abundance

Abundance fluctuates due to changes in survival in the marine and freshwater environments through which salmon pass during their life cycle. Evidence suggests that marine survival of salmon species fluctuates in response to 20 to 30-year cycles of climatic conditions and ocean productivity (Mantua

1997; Cramer 1999). Declines in marine survival began to be detected in the early 1990s so marine survival would be expected to continue to be low for the next 10 to 20 years, although there has been some indication that marine survival has increased in the last several years, resulting in increased abundance of West Coast chinook salmon populations. To look at the level of abundance that might be reasonable to expect over the duration of the Proposed Action (the ~~2004~~ 2005–2009 fishing seasons), the pattern of Puget Sound chinook salmon abundance over the last thirteen years (1991 through 2003) was examined since it included periods of low marine survival (1990s),[iv] and what is believed to be higher marine survival (2000 through 2003). Freshwater conditions have not been found to fluctuate in cycles, but the changes in these environments have contributed to the variation in chinook salmon abundance observed in this same period. Total Puget Sound chinook salmon abundance in the 1990s averaged approximately 30 percent less than abundance observed in recent years,[v] so a 30 percent reduction in Puget Sound chinook abundance from the 2003 predicted Puget Sound chinook abundance was chosen for the low abundance condition. It is possible that marine survival could continue to increase, but there are some indications, based on ocean interceptions of immature Columbia River chinook, that abundance of West Coast salmon may decrease in the next few years (personal communication with D. Simmons, NMFS, February 2, 2004). Therefore, the 2003 abundance was chosen to represent the high abundance condition.

4.2.3.2 Canadian and Alaskan Fisheries

In their ocean migration, Puget Sound chinook salmon travel north along the west coast into Canadian waters, and at times as far north as Alaskan waters (Figure 1.4-1). Depending on the population, Canadian fisheries on average can account for as much as 75 percent of the fishing-related mortality on Puget Sound chinook salmon (see Subsection 4.3.1). Alaskan fisheries harvest a low proportion (1 to 2%) of Puget Sound chinook salmon. Although the management of Canadian fisheries is outside the jurisdiction of the co-managers, the level of Canadian/Alaskan fisheries is an important consideration in assessing the total impact of fishing on Puget Sound chinook salmon populations, and the contribution of Puget Sound fisheries to that total impact.

[iv] Marine survival in the 1990s was the lowest observed since the early 1970s.

[v] Although Puget Sound chinook salmon showed the same general trend in abundance, not all populations showed an increasing trend over the same period, and the variability in abundance varied from population to population.

The major Canadian fisheries that currently or in the past have harvested large numbers of Puget Sound chinook salmon include the West Coast Vancouver Island troll and sport fisheries, the Georgia Strait troll fishery and the Georgia Strait and Canadian Strait of Juan de Fuca sport fisheries. In recent years, Canadian fisheries have not harvested chinook salmon at levels allowed under the Pacific Salmon Treaty due to internal Canadian conservation issues (NMFS 2003). The Georgia Strait troll fishery has been virtually eliminated since 1995 (CTC 2003), and that situation is expected to continue because of changes in Canadian management priorities. Also, many of the fishermen previously in the Georgia Strait troll fishery have sold their fishing gear or moved to other fisheries. However, effort and catches in the other Canadian fisheries have been increasing from the record low levels in the most recent few years (CTC 2003). Fishery restrictions implemented in the mid-1990s to address Canadian chinook and coho salmon conservation concerns are likely to be relaxed to some degree in these fisheries in the next several years and may result in increased fisherman participation and catch. Therefore, the Canadian/Alaskan fisheries regime projected to occur in 2003 was chosen as the low northern fisheries condition because for Canadian fisheries other than the Georgia Strait troll fishery, it is unlikely that Canadian catch levels will decrease from those projected to occur in 2003, and more likely that total effort and catch will continue to increase from 2003 levels.

Maximum harvest levels expected to occur under the Pacific Salmon Treaty during implementation of the 2004–2009 RMP were modeled to represent the upper range of impacts associated with Canadian fisheries (i.e., worst case scenario). These maximum expected levels are not the maximum allowed under the Pacific Salmon Treaty, but the maximum reasonably expected to occur during the ~~2004~~ 2005–2009 fishing seasons, based on recent fishing patterns, shifts in fishing sector allocation over the past 10 years, and discussions with Canadian fishing managers (personal communication with D. Simmons, NMFS, Pat Pattillo, WDFW, and Larrie Lavoy, WDFW, July 2003). The maximum Canadian/Alaskan fisheries expected to occur during the 2004–2009 fishing seasons assumed: 1) the West Coast Vancouver Island troll and sport fishery would occur under the maximum level allowed under the Pacific Salmon Treaty; 2) the Georgia Strait troll fishery would remain at very low levels; and, 3) the Georgia Strait and Canadian Strait of Juan de Fuca sport fisheries would occur at the highest estimated catch level observed for the period 1994–2002. ~~A more detailed discussion of Canadian harvest patterns and the basis of the maximum northern fisheries scenario is included in Appendix B.~~

Taking into account the information on both abundance and expected northern fishing patterns described above, four scenarios were developed by the Interdisciplinary Team that encompass the range of abundance and northern fishing conditions that might reasonably be expected to occur during the implementation of the Proposed Action (Table 4.2-1).

Table 4.2-1. Scenarios associated with estimated harvest levels within the Puget Sound Action Area.

Scenario	Abundance	Alaskan/Canadian Fisheries
Scenario A	2003 Puget Sound abundance	2003 Canadian/Alaskan fisheries harvest
Scenario B	**2003 Puget Sound abundance**	**high Canadian/Alaskan fisheries harvest**
Scenario C	30% reduction from 2003 abundance	2003 Canadian/Alaskan fisheries harvest
Scenario D	30% reduction from 2003 abundance	high Alaskan/Canadian fisheries harvest.

The indications of a plateau or potential reduction in marine survival and expectations that Canadian fisheries will continue to increase as they have in recent years led the Interdisciplinary Team to conclude that Scenario B is the *most likely* to occur during the implementation of the Proposed Action. Consequently, the assessment of environmental consequences in the following subsections focus on comparisons to this alternative. The results under Scenarios A, C, or D are also reported, but in less detail.

4.3 Fish

4.3.1 Threatened and Endangered Fish Species

This section discusses the predicted, direct, environmental consequences of the Proposed Action or alternatives with respect to listed salmonid species found within the action area: Puget Sound chinook salmon, Hood Canal summer chum salmon, bull trout, Columbia River chinook salmon, and Columbia River chum salmon. The following discussion will address these species in this order. Indirect and cumulative impacts are discussed in Section 4.3.8.

Puget Sound Chinook and Hood Canal Summer Chum

Standards of Comparison for Puget Sound Chinook

The Puget Sound Chinook Salmon Evolutionarily Significant Unit (ESU) was listed as threatened in 1999 because the potential for these populations to become endangered in the foreseeable future was believed to be high if current conditions continued (Meyer et al. 1998). Harvest is identified as one factor of decline in the listing decision. The co-managers anticipate the vast majority of the harvest-related mortality to listed Puget Sound chinook salmon over the duration of the Resource Management Plan (RMP) will be incidental to fisheries directed at other stocks or species (~~NMFS 2004~~WDFW and PSIT 2004 ~~[4(d) determination]~~). Nevertheless, over the past decade, the co-managers have constrained harvest mortality, severely for some populations in the ESU, to avoid escapement falling to the point of instability. These harvest reductions have been in response to significant reductions in productivity and capacity of chinook salmon-bearing watersheds throughout Puget Sound, largely as a result of habitat degradation. The National Marine Fisheries Service (NMFS) has found these harvest actions are consistent with the requirements of the Endangered Species Act (ESA) (NMFS 1999; NMFS 2001; NMFS 2003; Puget Sound Treaty Tribes and Washington Department of Fish and Wildlife 2003).

The potential impacts of the Proposed Action or alternatives on listed Puget Sound chinook salmon are quantified in terms of the projected total fisheries exploitation rate and resulting spawning escapement for each population. In general terms, *exploitation rate* is the number of fish harvested from each population divided by the number of fish in the population[vi] (see Appendix C). *Spawning escapement* is the estimated number of fish that return to the spawning grounds each year. For some populations,

[vi] The total exploitation rate is technically defined as the proportion of adult chinook, from all year-classes, prior to the onset of fishing in a given year, harvested or killed incidentally as a result of fishing.

spawning escapement is measured in terms of those fish whose parents spawned naturally rather than in hatcheries or by other artificial propagation means.

Survival and recovery of the Puget Sound Chinook ESU will depend, over the long term, on necessary actions in other sectors, especially habitat actions, and not on harvest actions alone. There is an ongoing recovery planning effort for the Puget Sound Chinook ESU. Completion of the recovery plan and decisions regarding the form and timing of recovery efforts described in the recovery plan will determine the kinds of harvest actions that may be necessary and appropriate in the future. Absent that guidance at the time of this writing, NMFS must evaluate the proposed harvest actions by examining the impacts of harvest within the current context. Therefore, NMFS has evaluated the future performance of populations in the ESU under recent productivity conditions; i.e., assuming that the impact of hatchery and habitat management actions remain as they are now. The actual performance of the populations will vary due natural variability in freshwater and marine survival, and may also vary due to actions in the habitat and hatchery sectors. For example, if habitat and hatchery actions improve conditions over currently existing conditions, the current NMFS conservation standards would be conservative, likely overestimating the impact that harvest actions would have on the ESU.

Where available, exploitation rates and spawning escapement are compared to population-specific conservation standards established by the NMFS to ascertain whether fisheries will appreciably reduce survival and recovery of the ESU, as required by the ESA 4(d) Rule. Conservation standards are represented by rebuilding exploitation rates, critical escapement thresholds, and viable escapement thresholds.

The rebuilding exploitation rates (RERs) represent the highest rate of harvest that will achieve the following ESA conservation criteria. Over the long term (25 years), harvest at the RER level will achieve: 1a) a high (80%) probability of rebuilding, or 1b) no more than a 10 percent reduction in the probability of rebuilding, and 2) a very low (5%) probability of the population falling to the critical threshold (see Appendix A) compared with a zero-harvest baseline. Fishing regimes that exert harvest rates below the RER level, by definition, do not pose jeopardy to the ESU. Fishing regimes above the RERs may also not pose jeopardy to the ESU depending on the status and distribution of the chinook salmon populations throughout the ESU.

The *critical escapement threshold* (CET) represents a point of biological instability, below which the risk of extinction increases significantly, due to declining spawning success, depensatory mortality, or risk of loss of genetic integrity. This threshold is not precisely known for any population, but may be estimated by risk assessment if the current productivity of a population can be estimated. Based on theoretical assessment of ecological and genetic risk (McElhaney et al. 2000; and NMFS 2001), a generic critical threshold of 200 adults has been used for other populations for which population-specific data are unavailable or insufficient to estimate productivity. *Viable escapement thresholds* (VETs) in the context of this EIS analysis are a level of spawning escapement associated with rebuilding to recovery, consistent with current environmental conditions. For most populations, these thresholds are well below the escapement levels associated with recovery, but achieving these goals under current conditions is a necessary step to eventual recovery when habitat and other conditions are more favorable. Where data are available, viable escapement thresholds have been defined consistent with the current productivity and capacity of spawning habitat. Where such information is not available, the generic viable threshold (1,250 adults) defined by NMFS for Viable Salmonid Populations (McElhany et al. 2000; NMFS 2001) is used as a reference point. By definition, these thresholds offer only general guidance as to what generally represents points of stability or instability. Some populations may be fairly robust at very low abundances, while chinook salmon populations in large river systems may become unstable at higher abundances depending on resource location and spawner density. However, without population-specific information, NMFS believes these generic guidelines offer the best available information.

NMFS has developed specific conservation standards for 12 of the 22 populations and one management unit (Nooksack early) within the Puget Sound Chinook ESU (Table 4.3-1). Nine of these 12 populations and one management unit have estimates of rebuilding exploitation rate (RER), critical escapement threshold (CET), and viable escapement threshold (VET). Although RERs have not been established for the Upper Cascade spring or Snoqualmie chinook populations, ancillary information indicated that the RERs developed for other populations within their management units should be protective of these populations (Susan Bishop, NMFS, April 20, 2003; and Skagit Rebuilding Exploitation Rate Workgroup 2003). The remaining populations have a mixture of specific and generic standards – also developed by NMFS (McElhany et al. 2000). Standards for all populations are summarized in Table4.3-1. NMFS uses all of this information to assess the status and distribution of the chinook salmon populations throughout the ESU, and then to determine whether the harvest action would pose jeopardy to the ESU as a whole.

The model used for this EIS analysis estimated fishery impacts to chinook salmon and other species in Alaska, British Columbia, and *Southern U.S. Fisheries* – those occurring in Puget Sound and off the Pacific coast of Washington, Oregon, and California (see Technical Appendix B). Within the Southern

U.S. area, more than 95 percent of the catch of species discussed here occurs within Puget Sound (Pacific Salmon Commission 2002).

Subsection 4.3.1 compares the impacts of the Proposed Action or alternatives on Puget Sound chinook under each of four scenarios as described in Subsection 4.2, Basis for Comparison of Alternatives and Approach to Alternatives Analysis. Each scenario defines a different baseline condition in terms of forecast abundance of Puget Sound Chinook and harvests occurring in fisheries in Canada and Alaska.

These different scenarios are used only to explore the range of possible impacts to chinook salmon. The assumptions regarding the range of abundance and Canadian/Alaskan fisheries for coho, sockeye, pink, chum, and steelhead are the same among scenarios for two reasons: 1) the purpose of the Proposed Action is to manage Puget Sound chinook salmon. It does not include management objectives for other species or describe how fisheries will respond to changes in abundance of those other salmon species; and 2) the 1999 Pacific Salmon Treaty Chinook Annex provides the necessary information to model chinook salmon impacts under higher levels of fishing than those observed in recent years, but which might occur in the next few years. However, there is insufficient information to allow NMFS to model how catch of salmon species other than chinook would vary in response to changes in Canadian/Alaskan fisheries. Therefore, the analysis assumes abundance and Canadian/Alaskan fishery impacts for non-chinook salmon species will remain similar to those experienced in recent years.

Table 4.3-1. Rebuilding Exploitation Rates, and critical and viable escapement standards for listed Puget Sound chinook and Hood Canal summer chum, against which impacts of Alternatives were assessed.

Population	Rebuilding Exploitation Rate	Critical escapement	MSY, viable, or capacity escapement level
Nooksack Spring	12%		500
North Fork		200	
South Fork		200	
Skagit Summer-Fall			
Lower Skagit	49%	251	2182
Lower Sauk	51%	200	681
Upper Skagit	60%	967	7454
Skagit Spring			
Upper Cascade		170	
Upper Sauk	38%	130	330
Suiattle	41%	170	400
Stillaguamish Summer-Fall			
North Fork	32%	300	552
South Fork	24%	200	300
Snohomish Summer-Fall	18%		
Skykomish	18%	1650	3500
Snoqualmie		400	
Green	53%	835	5523
Lake Washington			
Sammamish		200	1200
Cedar		200	1200
Puyallup		200	1200
White River Spring		200	1000
Nisqually		200	1100
Mid- Hood Canal / Dosewallips		200	1250
Skokomish		200	1250
Dungeness		200	925
Elwha		200	2900
Hood Canal – Juan de Fuca Summer Chum Populations			
Hood Canal	11%	4070	
Strait of Juan de Fuca	9%	920	

Scenario	Pre-Action Resource Status [vii]	
	Abundance	Harvest in Canadian/Alaskan Fisheries
Scenario A	2003	2003
Scenario B	2003	Maximum expected under the 1999-2008 Pacific Salmon Treaty Annex
Scenario C	70% of 2003	2003
Scenario D	70% of 2003	Maximum expected under the 1999-2008 Pacific Salmon Treaty Annex

Scenario B is considered the most likely scenario during the RMP implementation period; therefore, the analysis emphasizes this scenario. However, the performance of each alternative is compared both across the four scenarios, and with each of the other alternatives for a given scenario. For example, Alternative 2 is evaluated for Scenarios A through D. Then Alternative 2, Scenario A is compared with Alternative 1, Scenario A, and so forth.

Table 4.3-3 in Subsection 4.3.1.5, Summary Discussion of Alternatives, summarizes the performance of each alternative (under Scenario B) in relation to the conservation standards for those populations. Table 4.3-4 in Subsection 4.3.1.5 summarizes the impacts of Alternatives 2 through 4 relative to Alternative 1, the Proposed Action, under Scenario B. Table 4.3-5 in Subsection 4.3.1.5 summarizes performance of each alternative under all scenarios relative to conservation standards, and Table 4.3.6 summarizes impacts of Alternatives 2 though 4 for all scenarios. Additional tables in this Subsection 4.3.1.5 (and in Appendix B) provide more detailed information on exploitation rates, total fishery-related mortality for hatchery and natural chinook salmon (landed and non-landed), and escapement of hatchery and naturally-spawning chinook salmon.

Standards of Comparison for Hood Canal Summer Chum

There are seven summer chum salmon populations in the listed Hood Canal-Strait of Juan de Fuca summer chum ESU. NMFS has determined that over the long term, fisheries exploitation rates should be constrained to an average of 10.9 percent or less for Hood Canal component salmon and 9 percent or less for Strait of Juan de Fuca component of the Hood Canal/Strait of Juan de Fuca ESU. This standard

[vii] Represents preseason projections of 2003 fisheries and abundance.

allows that, in any one year, exploitation rates may vary from 3 to 15 percent for the Hood Canal component, and from 3 to 12 percent for the Strait of Juan de Fuca component. Fisheries should result in appropriate distribution of escapement among the various populations in each region, and should not otherwise impede the survival and recovery of the ESU (NMFS 2000). For summer chum, exploitation rates are expressed as total catch (in all fisheries) as a proportion of the sum of catch and escapement. However~~, returns to the Quilcene River~~ Quilcene summer-chum stock (Quilcene/Dabob Bay Management Unit) (for which the run is dominated by a large summer chum hatchery program) are excluded from the exploitation rate calculation. Critical escapement goals have also been designated: 4,070 for the Hood Canal summer chum region, and 920 for the Strait of Juan de Fuca region.

Bull Trout, and Columbia River Chinook and Chum Salmon

A small number of anadromous char, presumed to be bull trout, are caught in freshwater sport fisheries and may be caught in near-shore salmon net fisheries primarily in northern Puget Sound. Listed Columbia River-origin chinook and chum salmon are infrequently caught in Puget Sound (personal communication via e-mail from Dell Simmons, NMFS, to Susan Bishop, NMFS Sustainable Fisheries Division, December 2002).

Fishery closures under Alternative 2, 3 or 4 would slightly reduce the rare catch of these species that might occur under Alternative 1, but neither the Proposed Action nor the Alternatives would exert a measurable impact on these species under any of the harvest management scenarios. Therefore, bull trout and the Columbia River ESUs will not be discussed further in this document.

Metrics for Comparison of Impacts

The Proposed Action (Alternative 1) serves as the baseline against which the other alternatives are measured. The magnitude of the impacts of Alternatives 2, 3, or 4 relative to the baseline are classified as follows:

Term	When the impact varies by:
None	Not measurable, rare, infrequent
Low	Less than 10 percent
Moderate	10 percent to 30 percent
Substantial	More than 30 percent

Although it is useful and necessary to provide some system of metrics against which to assess the effects of the Proposed Action or alternatives, the complexity of salmon life history means that the magnitude of changes in effect may not translate into realized benefits or risks to the populations of the same magnitude. Therefore, it is important to note that there are several limitations to the application of these metrics to fish that should be taken into account in interpreting the results of applying these metrics. First, substantial increases in spawning escapements may not result in commensurate increases in the progeny of those spawners. The objective for salmon fisheries management is to constrain fishing mortality to the extent necessary to optimize the production of subsequent generations. The *productivity* of salmon populations, often defined in terms of the number of recruits produced per female spawner, increases over a range of escapement, then reaches a plateau or declines at higher levels of escapement due to density-dependent survival; i.e., too many spawners for the available habitat, or too many juvenile salmon for the available food in the river. The escapement level corresponding to the point of optimum productivity varies widely among individual populations due to the accessible area of suitable spawning and rearing habitat within a river system, and the very complex array of physical and biological factors that influence the annual survival of salmon eggs and juveniles through their freshwater life history. However, the influence of these physical and biological factors varies greatly from year to year, so that were fisheries management to achieve optimum escapement consistently from year to year, the actual production from those spawners would still vary widely. The marine environment exerts even greater influence on the number of juvenile salmon that reach adulthood. Consequently, this Environmental Impact Statement can compare the predicted escapement for populations against specific or general escapement standards, but cannot accurately project the resulting abundance of subsequent generations of adult salmon. Also, changes in risk relative to achievement of the Rebuilding Exploitation Rates may not be the same as changes in risk measured by changes in escapement. That is, the changes in achieving the Rebuilding Exploitation Rates are likely to be more beneficial or adverse relative to recovery than changes in escapement.

It should also be noted that changes in exploitation rates are expressed in the discussion below as the difference – in percentage points – between two rates, whereas changes in escapement are expressed as the percent difference between two values. For example, if the exploitation rate for Nooksack early chinook is 20 percent under Alternative 1 and 15 percent under Alternative 2, the change is 5 percentage points (20% minus 15% = 5%). If the escapement of Nooksack early chinook changes from 200 under Alternative 1 to 250 under Alternative 2, the change is 25 percent ([250 minus 200] divided by 200).

4.3.1.1 Alternative 1 – Proposed Action/Status Quo

Alternative 1 (the Proposed Action) is the alternative that most closely resembles recent historical harvest management plans. Its implementation is predicted to result in exploitation rates below rebuilding exploitation rate (RER) ceilings for five of the nine populations and one management unit that have RER standards. With the exception of the Nooksack early management unit, escapements under this alternative are predicted to exceed critical thresholds for all populations under all scenarios, in most cases by substantial margins. Viable escapement thresholds (VETs) are predicted to be met or exceeded for nine of the 18 populations and one management unit that have VET standards.

Summary of Scenario Differences

Under Alternative 1, Scenarios A, C, or D, representing conditions similar to 2003 (A); decreased forecast abundance (C); or decreased forecast abundance with maximized Canadian/Alaskan fisheries (D), the predicted Southern U.S. catch from listed Puget Sound populations is 106 percent, 74 percent, and 71 percent respectively of that under Scenario B (see Table 4.3-2 in Subsection 4.3.1.5, Summary Discussion of Alternatives). Catch of other species is discussed in Subsection 4.3.2, Basis for Comparison of Alternatives and Approach to Alternatives Analysis.

Exploitation rates under Alternative 1, Scenarios A, C, and D are predicted to vary from those under Alternative 1, Scenario B, by 1 to 5 percent. Exploitation rates for the Nooksack population, which exceeded RER ceilings under Alternative 1, Scenario B, also are predicted to exceed RER ceilings under Scenarios A, C, or D by margins of 8 to 14 percent. Exploitation rates for the Skykomish River chinook salmon population are also predicted to exceed the RER ceiling under all scenarios by margins of 1 percent to 5 percent. Exploitation rates for the Lower Skagit River fall and Lower Sauk River summer chinook populations, which were not predicted to meet RER ceilings under Alternative 1, Scenario B, were below the ceiling under Alternative 1, Scenarios A or C, by 1 to 3 percent, and above the RER ceiling under Scenario D by 5 to 7 percent. The exploitation rate for the Green River fall chinook population is predicted to exceed the RER ceiling under Alternative 1, Scenario A, by 9 percent, but is predicted to be 4 to 5 percent below the ceiling under Scenarios C or D (see Table 4.3-5 and Table 4.3-7a through Table 4.3-7d in Subsection 4.3.1.5).

Except for the Nooksack early populations, all populations that met CETs under Alternative 1, Scenario B, are predicted to meet them under Scenarios B, C, or D, as well. The North Fork Nooksack River early chinook salmon population is not predicted to meet CETs in any scenario under Alternative 1. The South Fork Nooksack population is not predicted to meet its CET under Scenarios C or D. The Upper Skagit River summer chinook population, which was predicted to meet its VET goal under Alternative 1, Scenario B, was also predicted to meet it under Alternative 1, Scenario A, but to fall slightly below goal under Alternative 1, Scenarios C or D. This was also true for the South Fork Stillaguamish fall population. Other populations that would meet or exceed VET goals under Scenario

B would meet or exceed them under the other scenarios, and those that were predicted to fall below goal under Scenario B also did so under the other scenarios (see Table 4.3-5 in Subsection 4.3.1.5).

Impacts to Puget Sound Chinook Populations

Under Alternative 1, Scenario B (high abundance and Canadian/Alaskan fisheries at the maximum allowed by treaty), the fishery model projected Southern U.S. catches of 52,720 chinook from naturally-spawning Puget Sound populations, and 1,663 chum from listed Hood Canal/Strait of Juan de Fuca summer populations. An additional 81,570 chinook from hatcheries and streams outside the action area are predicted to be caught (see Table 4.3-2 in Subsection 4.3.1.5).

Under Alternative 1, Scenario B, exploitation rates are predicted to be below their RERs for five of the nine populations and one management unit for which RERs have been derived (see Table 4.3-3 in Subsection 4.3.1.5). Exploitation rates are predicted by the fisheries model to exceed RER standards for the Nooksack early management unit by 13 percentage points, despite the fact that the Southern U.S. exploitation rate is predicted to be only 7 percentage points. The Lower Skagit River population is predicted to exceed its RER ceiling by 6 percentage points, the Lower Sauk River population by 4 percentage points, the Skykomish River population by 4 percentage points, and the Green River chinook salmon population by 10 percentage points. However, owing to peculiarities associated with the 2003 base year data for the Skagit summer/fall chinook salmon populations, it is likely that the model predicts higher exploitation rates than may actually occur [viii] during implementation of the Proposed Action (NMFS 2004 [4(d) determination]). It is also important to note that for the Skagit River summer-fall chinook populations, the predicted Southern U.S. exploitation rate (16%) accounted for less than one-fourth of the total predicted exploitation rate (55%) (see Table 4.3-3 and detail Table 4.3-7b in Subsection 4.3.1.5). The model predicted that exploitation rates for six populations would fall below RER ceilings under Alternative 1, Scenario B, by margins of 5 to 13 percentage points. These include exploitation rates for the upper Skagit, Upper Sauk and Suiattle chinook populations (11% and 14%, respectively, below the RER ceiling), the North Fork Stillaguamish and the South Fork Stillaguamish chinook populations (13% and 5%, respectively, below the RER ceiling) (see Table 4.3-7b in Subsection 4.3.1.5). The model predicted that, under Alternative 1, Scenario A, exploitation rates

[viii] Anomalous age structure and the presence of pink salmon fisheries in 2003 make the estimates of exploitation rates liberal, The Southern United States exploitation rates are more likely to be similar to recent years; i.e., 6 to 18 percent

for two additional populations – the lower Skagit fall and Lower Sauk summer populations – would fall below their RER ceilings (1% and 3%, respectively) (see Table 4.3-7a in Subsection 4.3.1.5).

The majority of harvest for the Nooksack early and Skagit summer/fall occurs in Canadian fisheries. The RER for the Nooksack early chinook management unit is predicted to be exceeded even without Southern U.S. fishing. For the Nooksack early chinook management unit, harvest mortality in Southern U.S. fisheries is predicted to increase the probability of falling below its CET by 21 percentage points and decrease the probability of rebuilding by 6 percentage points, measured over 25 years. For the Skagit summer/fall chinook salmon populations, harvest mortality in Southern U.S. fisheries is predicted to keep the probability of falling below its CET below 5 percentage points and decrease the probability of rebuilding by 26 percentage points, measured over 25 years. It should be noted that these are probably maximum estimates since the calculations are based on low marine survival assumptions, and recent information indicates that marine survival may be improving. Both the Skagit River summer/fall populations are currently above their VETs and have shown increasing trends in escapement.

Under Alternative 1, Scenario B, only the North Fork Nooksack chinook salmon population is predicted to not meet its CET. For most other populations, escapements are predicted to exceed critical thresholds by more than 100 percent. Escapement is predicted to exceed the viable escapement threshold for nine populations, including: Upper Skagit River, Upper Sauk River, Suiattle River, North Fork Stillaguamish and South Fork Stillaguamish, Green River, White River, Puyallup River, and Nisqually River. Escapement under Alternative 1, Scenario B, is predicted to be below the VET for 10 chinook populations and one management unit, including: Nooksack River early, Lower Skagit River, Lower Sauk River, Skykomish River, Sammamish River, Cedar River, Mid-Hood Canal, Skokomish, Dungeness, and Elwha chinook salmon populations (see Table 4.3-3 in Subsection 4.3.1.5).

In summary, implementation of Alternative 1 (the Proposed Action), Scenario B, is predicted to result in exploitation rates below RER ceilings for five of the nine populations and one management unit with RER standards. Critical escapement thresholds are predicted to be exceeded for all populations except the Nooksack early management unit, in most cases by substantial margins. Viable escapement thresholds are predicted to be met or exceeded for nine of the 18 populations and one management unit with thresholds, including Upper Skagit; Upper Sauk and Suiattle, North Fork and South Fork Stillaguamish, Green River, Puyallup, White, and Nisqually River chinook salmon populations (see Table 4.3-5 and Tables 4.3-7a through 4.3-7d in Subsection 4.3.1.5).

The Puget Sound Technical Recovery Team (TRT) has identified five distinct geographic/life history regions in the Puget Sound Chinook Salmon ESU: the Strait of Georgia, North Puget Sound, South Puget Sound, Hood Canal, and Strait of Juan de Fuca. Current TRT guidance recommends that a recovered ESU would have two to four low-risk populations within each region, representative of the range of life histories within each of the regions. Under Alternative 1, the Nooksack early management unit that makes up the Strait of Georgia region is predicted to exceed its RER; five of the eight [ix] North Puget Sound populations are predicted to meet their RER and/or exceed the VETs; four of the six South Puget Sound populations are predicted to exceed their VETs; and none of the populations in the Strait of Georgia, Hood Canal, or Strait of Juan de Fuca regions are predicted to exceed their VETs. Except for the North Fork Nooksack chinook population, all populations in all regions are predicted to exceed their CETs.

NMFS is currently evaluating Alternative 1, as proposed by the co-managers in the Puget Sound Chinook Management Plan, under the ESA 4(d) Rule. Taking into account the distribution of population status throughout the ESU and other relevant factors, NMFS has preliminarily concluded that Alternative 1 would not appreciably reduce the likelihood of survival and recovery of the ESU (NMFS 2004~~*in press*~~).

Impacts to Hood Canal and Strait of Juan de Fuca Summer Chum

The fisheries modeled under Alternative 1 (the Proposed Action) are predicted to result in a Southern U.S. catch of ~~141~~ 1,651 Hood Canal and 12 Strait of Juan de Fuca summer chum salmon (excluding those from the Quilcene/Dabob Bay management unit.~~,~~ However, the majority of the Hood Canal summer chum catch is comprised of fish from the Quilcene/Dabob Bay Management Unit, which are managed for an escapement goal and treated separately under the Summer Chum Salmon Conservation Initiative). Escapement in this management unit is dominated by production from the Big Quilcene hatchery. Excluding the Quilcene/Dabob Bay Management Unit harvest, the Southern U.S. catch of Hood Canal summer chum is expected to be 214 and ~~T~~the exploitation rates (including Canadian catch) are predicted to be 3~~2~~ percent for the Hood Canal region and 0.4 percent for the Strait of Juan de Fuca region, well below the long-term goals of the Summer Chum Salmon Conservation Initiative of 10.9 percent for Hood Canal summer and 9 percent for Strait of Juan de Fuca summer chum (Washington Department of Fish and Wildlife and Point-No-Point Treaty Tribes, Summer Chum Salmon

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[ix] There are ten populations in the North Puget Sound Region, but only eight currently have identified management standards.

Conservation Initiative, April 2000). The predicted escapement of ~~11,454~~ 7,437 Hood Canal summer chum (11,454 including the Quilcene/Dabob Bay Management Unit) and 6,955 Strait of Juan de Fuca summer chum exceeds the critical escapement goals for these regions by ~~181~~ 83 percent and 656 percent, respectively (see Table 4.3-7a in Subsection 4.3.1.5).

4.3.1.2 Alternative 2 – Escapement Goal Management at the Management Unit Level

Alternative 2 represents a more restrictive fishing regime than Alternative 1, especially for populations in North Puget Sound. With three notable exceptions (discussed below), escapements are predicted to be higher for most populations compared to Alternative 1.

Summary of Scenario Differences

Under Alternative 2, Scenarios A, C, or D, representing conditions similar to 2003 (A); decreased forecast abundance (C); or decreased forecast abundance with maximized Alaskan and Canadian fisheries (D), Southern U.S. catch of naturally-spawning chinook salmon is predicted to be 123 percent, 71 percent, and 69 percent respectively of that under Scenario B. Catch of other species is discussed in Subsection 4.3.2, Basis for Comparison of Alternatives and Approach to Alternatives Analysis.

Exploitation rates for the Nooksack early chinook management unit, the North Fork Stillaguamish population, and the South Fork Stillaguamish population, which are predicted to exceed RER ceilings under Alternative 2, Scenario B, are also predicted to exceed RER ceilings under Scenarios A, C, or D. Exploitation rates for the Skykomish River and Green River populations are predicted to exceed the RER ceilings under Scenarios A or B, but are predicted to be below the RER ceilings for Scenarios C or D. Escapements for Alternative 2, Scenario A, are predicted to be generally lower than escapements under Alternative 2, Scenario B and escapements under Alternative 2, Scenarios C or D are predicted to be generally higher (see Table 4.3-5 and Tables 4.3-8a through 4.3-8d in Subsection 4.3.1.5). Nevertheless, populations (other than the Nooksack River population) predicted to meet CETs under Scenario B are also predicted to meet CETs under Scenarios A, C, or D, as well. The South Fork Stillaguamish population is not predicted to meet its CET in any scenario under Alternative 2. Populations predicted to meet or exceed VET goals under Alternative 2, Scenario B, are also predicted to meet or exceed them under Alternative 2, Scenario A. With one exception, (Lower Sauk River), populations predicted to meet or exceed VETs under Alternative 2, Scenario B, would meet or exceed VETs under Alternative 2, Scenarios C or D (see Table 4.3-5 and Tables 4.3-8a through 4.3-8d in Subsection 4.3.1.5).

Comparison of Alternative 2 (Escapement Goal Management at the Management Unit Level) to the Proposed Action

Impacts to Puget Sound Chinook Populations

Under Alternative 2, Scenario B (high abundance and Canadian/Alaskan fisheries at the maximum allowed by treaty), the fishery model projected Southern U.S. catches of 42,793 chinook from naturally-spawning chinook Puget Sound chinook populations, or 11,743 fewer than with Alternative 1, Scenario B. It is predicted that an additional 36,074 chinook salmon from hatcheries and from streams outside the action area would be caught, which is 75,857 fewer than under Alternative 1, Scenario B (see Table 4.3-2 in Subsection 4.3.1.5).

Under Alternative 2, Scenario B, the total exploitation rate for the Nooksack early management unit is predicted to exceed its RER ceiling by 7 percentage points, despite the fact that the Southern U.S. exploitation rate is predicted to be only 1 percent. The exploitation rate for the North Fork Stillaguamish population is predicted to exceed the RER ceiling by 35 percentage points, the South Fork Stillaguamish population by 43 percentage points, the Skykomish River population by 5 percentage points, and the Green River population by 3 percentage points. Modeled exploitation rates for the five other populations with RERs range from 8 to 25 percentage points less than their RER ceilings. Escapements under Alternative 2, Scenario B, are predicted to exceed the CET for all populations except the North Fork Nooksack and South Fork Stillaguamish populations. In all but five cases (South Fork Nooksack, Skykomish, Sammamish, Cedar and Dungeness populations), escapements are predicted to exceed critical thresholds by more than 100 percent. Escapement under Alternative 2, Scenario B is predicted to meet or exceed VET for 9 of the 18 populations and one management unit for which VETs have been established, including: the Lower Sauk River, Upper Skagit River, Upper Sauk River, Suiattle River, White River, North Fork Stillaguamish, Green-Duwamish, Puyallup River and Nisqually River populations. Modeling results indicate that viable escapement thresholds would not be met for the 10 other populations and one management unit with Alternative 2, Scenario B (see Table 4.3-3 and Table 4.3-8b in Subsection 4.3.1.5).

For the Nooksack early management unit, model results indicate that the RER would be exceeded even without salmon fishing in Southern U.S. waters. For the Nooksack early chinook management unit, the probability of falling below its CET due to Southern U.S. fishing-related mortality is predicted to increase by 1 percentage point, and the probability of rebuilding is predicted to decrease by 1 percentage point, measured over 25 years.

Relative to Alternative 1, Scenario B, implementing Alternative 2, Scenario B, is predicted to result in low to moderate reductions in exploitation rates for nine Puget Sound chinook populations and one management unit, with resulting increases in spawning escapement. Impacts to these populations would be classed as beneficial and of low to moderate magnitude. Under Alternative 2, Scenario B, chinook salmon spawning escapements are predicted to decrease in the North and South Forks of the Stillaguamish, the Skykomish and Snoqualmie Rivers, and in the Puyallup, White and Nisqually Rivers. Impacts are predicted to be substantially negative for the North Fork Stillaguamish, the South Fork Stillaguamish, the Puyallup and the White River populations. Impacts to populations in the Skykomish, Snoqualmie and Nisqually Rivers are predicted to be negative but low. For the South Fork Stillaguamish population, the decreased escapements are predicted to be approximately 32 percent below the VET. Despite the predicted decrease in spawning escapement in the Puyallup, White, and Nisqually Rivers, these populations are all expected to meet or exceed VETs under Alternative 2, Scenario B. Escapements for the Green, Sammamish, Cedar, and Skokomish River populations are predicted to change by less than 1 percent relative to Alternative 1, Scenario B. These impacts are considered immeasurable. The pattern of impacts from applying Alternative 2 under Scenarios A, C, or D is predicted to be similar to its application under Alternative 2, Scenario B. In most cases, the type of impact (beneficial or negative) under Alternative 2, Scenario B, would be the same under Scenarios A, C, or D. However, as can be seen from Table 4.3-6 in Subsection 4.3.1.5, there is a tendency for the magnitude of beneficial impacts to increase and negative impacts to decrease going from Scenario B to Scenarios C or D. See Tables 4.3-8a-1 and 4.3-8d-2 in Subsection 4.3.1.5 for additional detail.

In summary, because Alternative 2 represents a more restrictive fishing regime than Alternative 1 (especially for populations in North Puget Sound), escapements are predicted to be higher for most populations compared to Alternative 1, Scenario B (see Tables 4.3-4 through 4.3-6 in Subsection 4.3.1.5). The notable exceptions are predicted to be escapements to the North and South Fork Stillaguamish, the Skykomish, and Snoqualmie populations where exploitation rates are predicted to be higher and escapements lower than under Alternative 1, Scenario B. The increased exploitation would result from the additional harvest opportunity available in Tulalip Bay (Marine Catch Area 8D) and the Stillaguamish River under Alternative 2 that is not anticipated to occur under Alternative 1.

The TRT has identified five distinct geographic/life history regions in the Puget Sound Chinook Salmon Evolutionarily Significant Unit: the Strait of Georgia, North Puget Sound, South Puget Sound, Hood Canal, and the Strait of Juan de Fuca. Current TRT guidance recommends that a recovered ESU would have two to four low-risk populations within each region, representative of the range of life histories within each of the regions. Under Alternative 2, the Nooksack early management unit that makes up the Strait of Georgia region is predicted to exceed its RER; six of the eight[x] North Puget Sound populations are predicted to meet their RER and/or exceed the VETs; four of the six South Puget Sound populations are predicted to exceed their VETs; and none of the populations in the Strait of Georgia, Hood Canal, or the Strait of Juan de Fuca regions are predicted to exceed their VETs. Except for the North Fork Nooksack (Strait of Georgia) and South Fork Stillaguamish (North Puget Sound) chinook populations, all populations in all regions are predicted to exceed their CETs.

Impacts to Hood Canal and Strait of Juan de Fuca Summer Chum Salmon

Because virtually all marine salmon fisheries would be closed under Alternative 2, incidental impacts to summer chum predicted to occur under Alternative 1 would be eliminated, and the Southern U.S. catch of Hood Canal and Strait of Juan de Fuca summer chum salmon is predicted to be zero. Consequently, the exploitation rate is predicted to decrease to less than 1 percent (including Canadian fishery impacts), and escapement increase by approximately ~~76~~ 3 percent. The exploitation rate standards – 10.9 percent for populations in the Hood Canal region, and 9 percent for populations in the Strait of Juan de Fuca region – are predicted to be achieved. The changes in exploitation rate and escapement would be classified as ~~a substantial~~ low, beneficial effect for Hood Canal summer chum. The impact on Strait of Juan de Fuca summer chum is expected to be immeasurable. Impacts under Alternative 2, Scenarios A, C, and D were the same as under Alternative 2, Scenario B (see Tables 4.3-8a and 4.3.8b in Subsection 4.3.1.5).

4.3.1.3 Alternative 3 – Escapement Goal Management at the Population Level

Alternative 3 represents a more restrictive fishing regime than Alternative 1 or Alternative 2, especially for populations in North Puget Sound. Escapements in North Puget Sound watersheds are predicted to be higher under Alternative 3 compared to Alternative 1. For all but two South Puget Sound chinook salmon populations (Puyallup River and White River), changes relative to Alterative 1 are predicted to be minimal.

Summary of Scenario Differences

Under Alternative 3, Scenarios A, C, or D, representing conditions similar to 2003 (A); decreased forecast abundance (C); or decreased forecast abundance with maximized Canadian/Alaskan fisheries

[x] There are ten populations in the North Puget Sound Region, but only eight currently have identified management standards.

(D), Southern U.S. catch of naturally-spawning Puget Sound chinook salmon is predicted to be 107 percent, 53 percent, and 49 percent, respectively, of that under Alternative 3, Scenario B. Catch of other species is discussed in Subsection 4.3.2, Basis for Comparison of Alternatives and Approach to Alternatives Analysis.

It is predicted that critical escapement thresholds would be met for all populations except the North Fork Nooksack chinook population under Alternative 3, Scenario A. Under Alternative 3, Scenarios C or D, it is predicted that CETs would be met for all populations except the Nooksack early chinook population. With the exception of the Lower Sauk population (20 to 25% below VET under Scenarios C or D), it is predicted that VETs would be met for the same populations under Alternative 3, Scenarios A, C, or D as they were under Alternative 3, Scenario B (see Table 4.3-5 and Tables 4.3-9a through 4.3-9d in Subsection 4.3.1.5).

Comparison of Alternative 3 to Alternative 1 (Proposed Action)

Impacts to Puget Sound Chinook Populations

Under Alternative 3, Scenario B (high abundance and Canadian/Alaskan fisheries at the maximum allowed by treaty), the Southern U.S. catch of chinook salmon from naturally-spawning Puget Sound populations is predicted to be 39,231, or 6,018 fewer than with Alternative 1, Scenario B. An additional 30,201 chinook salmon from hatcheries and from streams outside the action area are predicted to be landed, which is 81,730 fewer than with Alternative 1, Scenario B. The catch of listed Hood Canal/Strait of Juan de Fuca summer chum (excluding those from the Quilcene/Dabob Bay Management Unit) is predicted to be zero, or ~~1,663~~ 214 fewer than with Alternative 1, Scenario B. Catch of other species is discussed in Subsection 4.3.2, Basis for Comparison of Alternatives and Approach to Alternatives Analysis. See Table 4.3-9a through 4.3-9d in Subsection 4.3.1.5 for a detailed listing of fishery-related impacts to individual populations of Puget Sound chinook~~ and Hood Canal summer chum salmon~~.

Under Alternative 3, Scenario B, RERs are predicted to be met except for the Nooksack early chinook management unit and the Green River chinook population, and in these cases, exploitation rates are predicted to exceed the RER ceilings by 7 percentage points and 3 percentage points, respectively. As with Alternative 2, it should be noted that the Southern U.S. exploitation rate for the Nooksack early management unit is predicted to be only 1 percent while the total exploitation rate is predicted to be 19 percent. For the other populations in this group, predicted exploitation rates range from 8 to 25 percentage points below the RER ceilings. Critical escapement thresholds are predicted to be exceeded for all populations except the North Fork Nooksack population, in most cases by margins well over 100 percent. Escapements are predicted to exceed VETs for ten populations. Notably, the VET for the South Fork Stillaguamish population is predicted to be met with Alternative 3, Scenario B, whereas it is not under Alternative 2, Scenario B. Those populations that are not predicted to exceed VETs under Alternative 3, Scenario B, include Nooksack early, Lower Skagit, Skykomish, Dungeness, Elwha, Sammamish, Cedar, Mid-Hood Canal, and Skokomish chinook salmon populations (see Table 4.3-5 and Tables 4.3-9a-1 through 4.3-9d-2 in Subsection 4.3.1.5).

For the Nooksack early management unit, model results predict that the RER would be exceeded even without salmon fishing in Southern U.S. waters. For the Nooksack early chinook management unit, the probability of falling below its CET due to Southern U.S. fishing-related mortality is predicted to increase by 1 percentage point, and the probability of rebuilding is predicted to decrease by 1 percentage point, measured over 25 years.

Because Alternative 3 is very similar to Alternative 2, the impacts of its implementation relative to Alternative 1 would be nearly identical to those described for Alternative 2 (see Tables 4.3-3 and 4.3-4 in Subsection 4.3.1.5). The notable exception would be in the Stillaguamish watershed, where application of Alternative 3 is predicted to result in a small reduction in exploitation rate and low beneficial impacts to spawning escapement for populations within the Stillaguamish and Snohomish management units. Under Alternative 3, the South Fork Stillaguamish population is predicted to meet its CET under all scenarios, whereas it is not predicted to meet its CET under Alternative 2 for any scenario. Relative to Alternative 1, Scenario B, impacts associated with the application of Alternative 3, Scenario B, would be beneficial and of low to moderate impact for 14 populations, substantially negative for two populations (Puyallup and White River), and of a low negative magnitude for one population (Nisqually River). Model results of the effects of Alternative 3 on the Green, Sammamish, and Cedar River chinook salmon populations were less than 1 percent and therefore classed as immeasurable. For Scenarios A, C, or D, predicted impacts (relative to Alternative 1 Scenarios A, C, or D) would be nearly identical to those under Scenario B. Although small changes in escapement (Cedar, Sammamish and Skokomish populations) shifted impacts from low negative, to low beneficial, or no to low impact in some cases, the actual percentage changes were very small (see Table 4.3-4, Table 4.3-6, and Tables 4.3-9a-2 through 4.3-9d-2 in Subsection 4.3.1.5).

In summary, Alternative 3 represents a more restrictive fishing regime than Alternative 1 or Alternative 2, especially for populations in North Puget Sound; therefore, it is predicted that escapements in North Puget Sound watersheds would be higher compared to Alternative 1. For all but two South Puget

Sound populations (Puyallup River and White River), changes relative to Alterative 1 are predicted to be minimal (see Tables 4.3-4 and 4.3-5 in Subsection 4.3.1.5).

The TRT has identified five distinct geographic/life history regions in the Puget Sound Chinook Salmon ESU: the Strait of Georgia, North Puget Sound, South Puget Sound, Hood Canal, and the Strait of Juan de Fuca. Current TRT guidance recommends that a recovered ESU would have two to four low-risk populations within each region, representative of the range of life histories within each of the regions. Under Alternative 3, the Nooksack early management unit that makes up the Strait of Georgia region is predicted to exceed its RER; all eight [xi] North Puget Sound populations are predicted to meet their RER and/or exceed the VETs; four of the six South Puget Sound populations are predicted to exceed their VETs; and none of the populations in the Strait of Georgia Strait, Hood Canal, or the Strait of Juan de Fuca regions are predicted to exceed their VETs. Except for the North Fork Nooksack chinook population, all populations in all regions are predicted to exceed their CETs.

Impacts to Hood Canal and Strait of Juan de Fuca Summer Chum

The catch of listed Hood Canal/Strait of Juan de Fuca summer chum (excluding those from the Quilcene/Dabob Bay Management Unit) is predicted to be zero, or 214 fewer than with Alternative 1, Scenario B. Under Alternative 3, there would be no summer chum harvested in Puget Sound fisheries. Therefore, the consequences would be the same as those described for Alternative 2. See Table 4.3-9a through 4.3-9d in Subsection 4.3.1.5 for a detailed listing of fishery-related impacts to individual populations of Puget Sound chinook and Hood Canal summer chum salmon.

4.3.1.4 Alternative 4 – No Action/No Authorized Take

Alternative 4, the most restrictive of the harvest management alternatives, is predicted to reduce catch and increase escapement of all populations of naturally-spawning Puget Sound chinook salmon relative to Alternative 1.

Summary or Scenario Differences

Under Alternative 4, Scenarios A, C, or D, representing conditions similar to 2003 (A); decreased forecast abundance (C); or decreased forecast abundance with maximized Canadian/Alaskan fisheries (D), Southern U.S. catch of naturally-spawning chinook is predicted to be 99 percent, 73 percent, and

[xi] There are ten populations in the North Puget Sound Region, but only eight currently have identified management standards.

73 percent, respectively, of that with Alternative 3, Scenario B. Catch of other species is discussed in Subsection 4.3.2, Basis of Comparison of Alternatives and Approach to Alternatives Analysis.

Modeled escapement patterns under Alternative 4, Scenarios A, C, or D were similar to those under Alternative 4, Scenario B. Decreased abundance under Scenarios C or D would result in predicted escapement for the Nooksack early populations falling below their CETs under Scenarios C or D, whereas escapement was above CET for Scenarios A or B for the North Fork Nooksack population. Decreased abundance under Scenarios C or D would result in predicted escapement for the Lower Skagit population falling below its VET in Scenarios C or D, whereas it exceeded VET in Scenarios A and B (see Table 4.3-5 and Tables 4.3-10a-1 through 4.3-10d-1in Subsection 4.3.1.5).

<u>Comparison of Alternative 4 to Alternative 1 (Proposed Action)</u>

<u>Impacts to Puget Sound Chinook Populations</u>

Under Alternative 4, Scenario B (high abundance and Canadian/Alaskan fisheries at the maximum allowed by treaty), the catch of Puget Sound chinook from naturally-spawning chinook populations is predicted to be 6,289 fish, or 46,648 fewer than with Alternative 1, Scenario B. The total chinook catch predicted under Alternative 4, Scenario B, is 150,891 fewer than with Alternative 1, Scenario B (see Table 4.3-2 in Subsection 4.3.1.5).

Catch of other species is discussed in Subsection 4.3.2, Basis for Comparison of Alternatives and Approach to Alternatives Analysis. See Tables 4.3-10a through 4.3-10d~~b~~ in Subsection 4.3.1.5 for a detailed listing of fishery-related impacts to individual populations of Puget Sound chinook and Hood Canal summer chum salmon.

Population-specific impacts of Alternative 4 under Scenario B, are predicted to be nearly identical to those of Alternative 2 or 3, Scenario B. Under Alternative 4, Scenario B, exploitation rates are predicted to be less than RER standards for all populations except in the Nooksack early management unit. Critical escapement thresholds are predicted to be exceeded for all populations except the North Fork Nooksack population.Viable escapement thresholds are predicted to be met or exceeded for the Lower Sauk, Upper Skagit, North Fork Stillaguamish, Upper Sauk, Suiattle, White River, the South Fork Stillaguamish, Green-Duwamish, Puyallup, Nisqually, and Skokomish chinook salmon populations (see Table 4.3-3 and Table 4.3-10b in Subsection 4.3.1.5).

For the Nooksack early management unit, the RER would be exceeded even without salmon fishing in Southern U.S. waters. For the Nooksack early chinook management unit, the probability of falling below its CET due to Southern U.S. fishing-related mortality is predicted to increase by 1 percentage point and the probability of rebuilding is predicted to decrease by 1 percentage point, measured over 25 years.

Alternative 4, the most restrictive of the alternatives, is predicted to reduce catch and increase escapement of all populations of naturally-spawning Puget Sound chinook salmon relative to Alternative 1. Increases in escapement are predicted to result in beneficial impacts of low to moderate magnitude for 16 of the 22 populations, and substantial beneficial impacts for four other populations. The four populations predicted to have substantial increases in spawning escapement under Alternative 4 relative to Alternative 1 are the Green, Puyallup, Nisqually, and Skokomish chinook salmon populations. Modeled spawning escapements for these populations predict exceedance of the VET by 84 percent, 163 percent, 196 percent, and 90 percent, respectively (see Table 4.3-4 and Table 4.3-10a-2 in Subsection 4.3.1.5). However, to some extent, the beneficial impact of increased escapement might be moderated by capacity of the extant habitats to support additional spawners and their progeny.

As would be expected, impacts associated with the application of Alternative 4 under Scenarios A, C, or D relative to Alternative 1, Scenarios A, C, or D, were similar in type and, in most cases, magnitude, to the impacts modeled under Scenario B. Two notable exceptions were the Green River and Puyallup River populations where substantial beneficial impacts were indicated under Scenarios A or B, but only moderately beneficial impacts under Scenarios C or D (lower abundance conditions). For the Cedar and Sammamish River populations, impacts are predicted to range from low and beneficial (Alternative 4, Scenario A or B) to low and adverse (Alternative 4, Scenarios C or D), compared to the same scenarios under Alternative 1. However, the actual change in numbers of fish in escapement is predicted to be no more than 1 percent (see Table 4.3-4 and Tables 4.3-10a-2 through 4.3-10d-2 in Subsection 4.3.1.5).

In summary, Alternative 4 represents the most restrictive fishing regime and would result in low to substantial increases in spawning escapement relative to Alternative 1. These increases would not necessarily result in beneficial impacts to all populations. (See discussion below.)

The TRT has identified five distinct geographic/life history regions in the Puget Sound Chinook Salmon ESU: the Strait of Georgia, North Puget Sound, South Puget Sound, Hood Canal, and the Strait of Juan de Fuca. Current TRT guidance recommends that a recovered ESU would have two to four low-risk populations within each region, representative of the range of life histories within each of the regions. Under Alternative 4, the Nooksack early populations that make up the Strait of Georgia region are predicted to exceed its RER; all eight[xii] North Puget Sound populations are predicted to meet their RER and/or exceed the VETs; four of the six South Puget Sound populations are predicted to exceed their VETs; one of the two populations in the Hood Canal region is predicted to exceed its VET; and none of the populations in the Strait of Georgia or the Strait of Juan de Fuca regions are predicted to exceed their VETs. Except for the North Fork Nooksack chinook population, all populations in all regions are predicted to exceed their CETs.

Impacts to Hood Canal and Strait of Juan de Fuca Summer Chum

Under Alternative 4, the catch from listed Hood Canal and Strait of Juan de Fuca summer chum salmon populations is predicted to be zero, compared to 214 and 12, respectively,~~141~~ under Alternative 1. Therefore, the consequences would be the same as those described for Alternative 2 or 3.

4.3.1.5 Summary Discussion of Alternatives

Under Alternative 1, the Proposed Action, RERs are predicted to be met under nearly all scenarios and within nearly all populations except the Nooksack early chinook management unit, and the Skykomish summer population. While the Skykomish summer population is predicted to meet the RER standard under most other alternatives and scenarios, the Nooksack early management unit is not predicted to meet its RER goal under any alternative or scenario. Failure of the Nooksack early populations to meet RERs and, in most instances, CETs, can be attributed to the fact that a high proportion of impacts to this population occur in fisheries outside of Puget Sound, not within the jurisdiction of the Resource Management Plan. Another notable exception is predicted for the Green River population. However, unlike the Nooksack population, the Green River population, despite exceeding RER ceilings under several alternative/scenario combinations, is predicted to meet or exceed its VET in all cases.

Critical escapement goals are predicted to be met for all populations under Alternative 1 except the North Fork Nooksack chinook salmon population, the South Fork Nooksack population under the lower abundance scenarios, and the South Fork Stillaguamish fall population under any scenario. The North Fork Nooksack population is not predicted to meet its CET under any alternative or scenario. Seventy percent or more of the fishing-related mortality on the Nooksack early chinook population occurs as a result of Canadian/Alaskan fisheries. Catch in fisheries covered by the Resource

[xii] There are ten populations in the North Puget Sound Region, but only eight currently have identified management standards.

Management Plan is predicted to be at most 36 fish; thus, there is likely to be little difference in the impact of any alternative.

Under Alternative 1, performance relative to VETs is predicted to vary considerably for the different populations. What would be consistent, however, is that certain populations are predicted to not meet VETs under most, if not all alternatives and scenarios. These include the Nooksack early, Lower Skagit, Skykomish, Sammamish, Cedar, Mid-Hood Canal, Skokomish, Dungeness, and Elwha River populations.

As noted previously, increasingly restrictive alternatives generally result in increased spawning escapement. Thus, application of Alternatives 2 through 4 appear to have a beneficial impact on most populations relative to Alternative 1. However, while spawning escapement provides a useful basis for comparing alternatives, the intricacy of salmon life histories must be taken into account in interpreting the model results.

First, substantial increases in spawning escapements may not result in commensurate increases in the progeny of those chinook salmon spawners. The objective for salmon fisheries management is to constrain fishing mortality to the extent necessary to optimize the production of subsequent generations. The productivity of salmon populations, often defined in terms of the number of recruits produced per female spawner, increases over a range of escapement, then reaches a plateau or declines at higher levels of escapement due to density-dependent survival; i.e., too many spawners for the available habitat, or too many juvenile salmon for the available food in the river. The escapement level corresponding to the point of optimum productivity varies widely among individual populations due to the accessible area of suitable spawning and rearing habitat within a river system, and the very complex array of physical and biological factors that influence the annual survival of salmon eggs and juveniles through their freshwater life history. However, the influence of these physical and biological factors varies greatly from year to year, so that were fisheries management to achieve optimum escapement consistently from year to year, the actual production from those spawners would still vary widely. The marine environment exerts even greater influence on the number of juvenile salmon that reach adulthood. Consequently, this Environmental Impact Statement can compare the predicted escapement for populations against specific or general escapement standards, but cannot accurately project the resulting abundance of subsequent generations of adult salmon. In addition, changes in risk relative to achievement of the RERs may not be the same as changes in risk measured by changes in escapement. That is, the changes in achieving the RERs are likely to be more beneficial or adverse relative to recovery than changes in escapement.

The harvest standards for the Hood Canal and Strait of Juan de Fuca Summer Chum Evolutionarily Significant Unit are predicted to be met under any alternative.

Table 4.3-2. Predicted Southern U.S. catch of Puget Sound chinook populations under Alternatives 1-4 and Scenarios A-D.

		Scenario A	Scenario B	Scenario C	Scenario D
Natural		55,512	45,249	32,256	31,238
Other	Alternative 1	110,994	111,931	83,808	81,058
Total		166,506	157,180	116,064	112,296
Natural		45,249	42,793	21,614	19,667
Other	Alternative 2	81,570	36,074	21,753	19,354
Total		126,819	78,867	43,367	39,021
Natural		41,931	39,231	20,785	18,885
Other	Alternative 3	65,565	30,201	21,753	19,354
Total		107,496	69,432	42,538	38,239
Natural		6,233	6,289	4,597	4,619
Other	Alternative 4				
Total		6,233	6,289	4,597	4,619

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-3. Performance of Alternatives 1 through 4 under Scenario B relative to rebuilding exploitation rate, critical escapement threshold, and viable escapement threshold standards.

	Performance Relative to Rebuilding Exploitation Rate				Performance Relative to Critical Escapement Threshold				Performance Relative to Viable Escapement Threshold			
	A-1	A-2	A-3	A-4	A-1	A-2	A-3	A-4	A-1	A-2	A-3	A-4
Nooksack Early*	N	N	N	N					N	N	N	N
North Fork					N	N	N	N	NA	NA	NA	NA
South Fork					Y	Y	Y	Y	NA	NA	NA	NA
Skagit Summer-Fall*												
Lower Skagit Fall	N	Y	Y	Y	Y	Y	Y	Y	N	N	N	N
Lower Sauk Summer	N	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
Upper Skagit Summer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Skagit Spring*												
Upper Cascade	NA	NA	NA	NA	Y	Y	Y	Y				
Upper Sauk	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Suiattle	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Stillaguamish Summer-Fall*												
North Fork Summer	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
South Fork Fall	Y	N	Y	Y	Y	N	Y	Y	Y	N	Y	Y
Snohomish Summer-Fall*												
Skykomish Summer	N	N	Y	Y	Y	Y	Y	Y	N	N	N	N
Snoqualmie Fall	NA	NA	NA	NA	Y	Y	Y	Y	NA	NA	NA	NA
Green-Duwamish Fall*	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
Lake Washington Fall												
Sammamish	NA	NA	NA	NA	Y	Y	Y	Y	N	N	N	N
Cedar	NA	NA	NA	NA	Y	Y	Y	Y	N	N	N	N
Puyallup Fall	NA	NA	NA	NA	Y	Y	Y	Y	Y	Y	Y	Y
White River Spring	NA	NA	NA	NA	Y	Y	Y	Y	Y	Y	Y	Y
Nisqually Fall	NA	NA	NA	NA	Y	Y	Y	Y	Y	Y	Y	Y
Mid- Hood Canal Fall	NA	NA	NA	NA	Y	Y	Y	Y	N	N	N	N
Skokomish Fall	NA	NA	NA	NA	Y	Y	Y	Y	N	N	N	Y
Dungeness Summer	NA	NA	NA	NA	Y	Y	Y	Y	N	N	N	N
Elwha Summer	NA	NA	NA	NA	Y	Y	Y	Y	N	N	N	N

Y	Meets or exceeds goal.
N	Does not meet goal.
NA	Standard not applicable.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-4 Summary of impacts of Alternatives 2-4 relative to the proposed action under Scenario B

	Alternative 2 Compared to Alternative 1		**Alternative 3 Compared to Alternative 1**		**Alternative 4 Compared to Alternative 1**	
	Type	Extent	Type	Extent	Type	Extent
Nooksack Early	B	M	B	M	B	M
Lower Skagit Fall	B	M	B	M	B	M
Lower Sauk Summer	B	M	B	M	B	M
Upper Skagit Summer	B	M	B	M	B	M
Upper Cascade Spring	B	L	B	L	B	L
Upper Sauk Spring	B	L	B	L	B	L
Suiattle Spring	B	L	B	L	B	L
NF Stillaguamish Summer	N	S	B	L	B	L
SF Stillaguamish Fall	N	S	B	L	B	L
Skykomish Summer	N	L	B	M	B	M
Snoqualmie Fall	N	L	B	M	B	M
Green-Duwamish Fall	0	0	0	0	B	S
Sammamish Fall	0	0	0	0	0	0
Cedar Fall	0	0	0	0	0	0
Puyallup Fall	N	S	N	S	B	S
White River Spring	N	S	N	S	B	M
Nisqually Fall	N	L	N	L	B	S
Mid-Hood Canal Fall	B	L	B	L	B	L
Skokomish Fall	0	0	0	0	B	S
Dungeness Summer	B	L	B	L	B	L
Elwha Summer	B	L	B	L	B	L

Impact Type		Impact Magnitude	
Beneficial	B	Low (<10%)	L
Negative	N	Moderate (10%-30%)	M
None (not measurable)	0	Substantial (>30%)	S
		Not Measurable (<1%)	0

Table 4.3-5. Performance of Alternatives 1 through 4 under Scenarios A-D relative to rebuilding exploitation rate, critical escapement threshold, and viable escapement threshold standards.

Rebuilding Exploitation Rate

	Alternative 1				Alternative 2				Alternative 3				Alternative 4			
	S-A	S-B	S-C	S-D	S-A	S-B	S-C	S-D	S-A	S-B	S-C	S-D	S-A	S-B	S-C	S-D
Nooksack Early*	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
North Fork																
South Fork																
Skagit Summer-Fall*																
Lower Skagit Fall	Y	N	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Lower Sauk Summer	Y	N	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Upper Skagit Summer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Skagit Spring*																
Upper Cascade	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Upper Sauk	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Suiattle	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Stillaguamish Summer-Fall*																
North Fork Summer	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y
South Fork Fall	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y
Snohomish Summer-Fall*																
Skykomish Summer	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Snoqualmie Fall	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Green-Duwamish Fall*	Y	Y	Y	Y	N	N	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Lake Washington Fall																
Sammamish	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cedar	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Puyallup Fall	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
White River Spring	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nisqually Fall	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mid- Hood Canal Fall	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Skokomish Fall	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dungeness Summer	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Elwha Summer	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Critical Escapement Threhold

	Alternative 1				Alternative 2				Alternative 3				Alternative 4			
	S-A	S-B	S-C	S-D	S-A	S-B	S-C	S-D	S-A	S-B	S-C	S-D	S-A	S-B	S-C	S-D
Nooksack Early*																
North Fork	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
South Fork	Y	Y	N	N	Y	Y	N	N	Y	Y	N	N	Y	Y	N	N
Skagit Summer-Fall*																
Lower Skagit Fall	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Lower Sauk Summer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Upper Skagit Summer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Skagit Spring*																
Upper Cascade	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Upper Sauk	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Suiattle	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Stillaguamish Summer-Fall*																
North Fork Summer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
South Fork Fall	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y
Snohomish Summer-Fall*																
Skykomish Summer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Snoqualmie Fall	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Green-Duwamish Fall*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Lake Washington Fall																
Sammamish	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Cedar	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Puyallup Fall	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
White River Spring	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Nisqually Fall	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Mid- Hood Canal Fall	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Skokomish Fall	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Dungeness Summer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Elwha Summer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Viable Escapement Threhold

	Alternative 1				Alternative 2				Alternative 3				Alternative 4			
	S-A	S-B	S-C	S-D	S-A	S-B	S-C	S-D	S-A	S-B	S-C	S-D	S-A	S-B	S-C	S-D
Nooksack Early*	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
North Fork	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
South Fork	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Skagit Summer-Fall*																
Lower Skagit Fall	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Lower Sauk Summer	N	N	N	N	Y	Y	N	N	Y	Y	N	N	Y	Y	N	N
Upper Skagit Summer	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Skagit Spring*																
Upper Cascade																
Upper Sauk	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Suiattle	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Stillaguamish Summer-Fall*																
North Fork Summer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
South Fork Fall	Y	Y	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y
Snohomish Summer-Fall*																
Skykomish Summer	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Snoqualmie Fall	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Green-Duwamish Fall*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Lake Washington Fall																
Sammamish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Cedar	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Puyallup Fall	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
White River Spring	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Nisqually Fall	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Mid- Hood Canal Fall	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Skokomish Fall	N	N	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y
Dungeness Summer	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Elwha Summer	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

Y Meets or exceeds goal.
N Does not meet goal.
NA Standard not applicable.

Y Meets or exceeds goal.
N Does not meet goal.
NA Standard not applicable.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-6 Summary of impacts of alternatives 2-4 relative to the proposed action under scenarios 1-4.

	Alternative 2 Compared to Alternative 1								**Alternative 3 Compared to Alternative 1**								**Alternative 4 Compared to Alternative 1**							
	Scenario A		Scenario B		Scenario C		Scenario D		Scenario A		Scenario B		Scenario C		Scenario D		Scenario A		Scenario B		Scenario C		Scenario D	
	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent
Nooksack Early	B	L	B	M	B	L	B	M	B	L	B	M	B	L	B	M	B	L	B	M	B	L	B	M
Lower Skagit Fall	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M
Lower Sauk Summer	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M
Upper Skagit Summer	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M
Upper Cascade Spring	B	L	B	L	B	M	B	M	B	L	B	L	B	M	B	M	B	L	B	L	B	M	B	M
Upper Sauk Spring	B	L	B	L	B	M	B	M	B	L	B	L	B	M	B	M	B	L	B	L	B	M	B	M
Suiattle Spring	B	L	B	L	B	M	B	M	B	L	B	L	B	M	B	M	B	L	B	L	B	M	B	M
NF Stillaguamish Summer	N	S	N	S	N	S	N	S	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L
SF Stillaguamish Fall	N	S	N	S	N	S	N	S	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L
Skykomish Summer	N	L	N	L	B	L	B	L	B	L	B	M	B	L	B	L	B	L	B	M	B	L	B	L
Snoqualmie Fall	N	L	N	L	B	L	B	L	B	L	B	M	B	L	B	L	B	L	B	M	B	L	B	L
Green-Duwamish Fall	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	B	S	B	S	B	M	B	M
Sammamish Fall	B	L	0	0	N	L	N	L	B	L	0	0	N	L	N	L	B	L	0	0	N	L	N	L
Cedar Fall	B	L	0	0	N	L	N	L	B	L	0	0	N	L	N	L	B	L	0	0	N	L	N	L
Puyallup Fall	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	B	S	B	S	B	M	B	M
White River Spring	N	S	N	S	N	L	N	L	N	S	N	S	N	L	N	L	B	M	B	M	B	M	B	M
Nisqually Fall	N	L	N	L	N	L	N	L	N	L	N	L	N	L	N	L	B	S	B	S	B	S	B	S
Mid-Hood Canal Fall	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L
Skokomish Fall	B	L	0	0	N	L	N	L	B	L	0	0	N	L	N	L	B	S	B	S	B	S	B	S
Dungeness Summer	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L
Elwha Summer	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L

Impact Type

Beneficial	B
Negative	N
Not Measurable	0

Impact Extent

Low (<10%)	L
Moderate (10%-30%)	M
Substantial (>30%)	S
Not Measurable (<1%)	0

Table 4.3-7a Performance of Alternative 1 (Proposed Action) under Scenario A relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	**Alternative 1 Scenario A**				**Performance vs. Recovery Standards**		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	20%	7%	37	388	8%		-22%
North Fork				171		-15%	
South Fork				217		9%	
Skagit Summer-Fall*	48%	18%	3,894	11,633			
Lower Skagit Fall				1,247	-1%	397%	-43%
Lower Sauk Summer				620	-3%	210%	-9%
Upper Skagit Summer				9,765	-12%	910%	31%
Skagit Spring*	23%	23%	570	1,921			
Upper Cascade				563		231%	
Upper Sauk				647	-15%	398%	96%
Suiattle				712	-18%	319%	78%
Stillaguamish Summer-F	17%	11%	313	2,322			
North Fork Summer				1,892	-15%	531%	243%
South Fork Fall				430	-7%	115%	43%
Snohomish Summer-Fal	19%	18%	2,325	5,073			
Skykomish Summer				2,604	-18%	58%	-26%
Snoqualmie Fall				2,469		517%	
Green-Duwamish Fall*	62%	51%	15,901	5,819	9%	597%	5%
Lake Washington Fall		20%					
Sammamish	31%		86	305		53%	-76%
Cedar	31%		87	305		53%	-75%
Puyallup Fall	49%	39%	5,024	2,392		1096%	99%
White River Spring	20%	19%	356	1,468		634%	47%
Nisqually Fall	76%	68%	17,425	1,106		453%	1%
Mid- Hood Canal Fall	26%	13%	95	531		166%	-58%
Skokomish Fall	63%	50%	9,372	1,211		506%	-3%
Dungeness Summer	22%	5%	15	352		76%	-62%
Elwha Summer	22%	5%	98	2,125		963%	-27%
All Chinook from Listed Populations			**55,599**	**36,951**			

Hood Canal and Strait of Juan de Fuca Summer Chum				**Performance vs Recovery Standards**	
	Wild Exploitation Rate[4]	Southern U.S. Catch[4]	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	3%	214	7,437	-8%	83%
Juan de Fuca	0.4%	12	6,955	-9%	656%
All Summer Chum		**226**	**14,392**		

* Populations with specific NMFS-developed standards

[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])

[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

[4] Excludes Quilcene River population.

[shaded box] Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-7b Performance of Alternative 1 (Proposed Action) under Scenario B relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	Alternative 1 Scenario B				Performance vs. Recovery Standards		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	25%	8%	38	365	13%		-27%
North Fork				161		-20%	
South Fork				204		2%	
Skagit Summer-Fall*	55%	16%	3,737	11,029			
Lower Skagit Fall				1,183	6%	371%	-46%
Lower Sauk Summer				588	4%	194%	-14%
Upper Skagit Summer				9,258	-5%	857%	24%
Skagit Spring*	27%	23%	567	1,845			
Upper Cascade				541		218%	
Upper Sauk				622	-11%	378%	88%
Suiattle				684	-14%	302%	71%
Stillaguamish Summer-F	19%	11%	314	2,281			
North Fork Summer				1,859	-13%	520%	237%
South Fork Fall				422	-5%	111%	41%
Snohomish Summer-Fal	22%	18%	2,286	4,901			
Skykomish Summer				2,516	-18%	52%	-28%
Snoqualmie Fall				2,385		496%	
Green-Duwamish Fall*	63%	47%	15,103	5,816	10%	597%	5%
Lake Washington Fall		20%					
Sammamish	35%		86	294		47%	-76%
Cedar	35%		85	294		47%	-76%
Puyallup Fall	50%	35%	4,623	2,419		1110%	102%
White River Spring	20%	18%	323	1,459		630%	46%
Nisqually Fall	76%	65%	16,929	1,126		463%	2%
Mid- Hood Canal Fall	32%	13%	94	504		152%	-60%
Skokomish Fall	63%	44%	8,509	1,237		519%	-1%
Dungeness Summer	27%	5%	15	336		68%	-64%
Elwha Summer	28%	5%	97	2,031		916%	-30%
All Chinook from Listed Populations			**52,806**	**35,937**			

Hood Canal and Strait of Juan de Fuca Summer Chum				Performance vs Recovery Standards	
	Wild Exploitation Rate [4]	Southern U.S. Catch [4]	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	3%	214	7,437	-8%	83%
Juan de Fuca	0.4%	12	6,955	-9%	656%
All Summer Chum		**226**	**14,392**		

* Populations with specific NMFS-developed standards
[1] Calculated as difference of rates ([predicted wild exploiion rate - recovery exploitation rate])
[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])
[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}
[4] Excludes Quilcene River population.

Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-7c Performance of Alternative 1 (Proposed Action) under Scenario C relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	**Alternative 1 Scenario C**				**Performance vs. Recovery Standards**		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	20%	7%	26	278	8%		-44%
North Fork				122		-39%	
South Fork				156		-22%	
Skagit Summer-Fall*	49%	18%	2,778	8,033			
Lower Skagit Fall				861	0%	243%	-61%
Lower Sauk Summer				428	-2%	114%	-37%
Upper Skagit Summer				6,743	-11%	597%	-10%
Skagit Spring*	23%	23%	393	1,331			
Upper Cascade				390		129%	
Upper Sauk				449	-15%	245%	36%
Suiattle				493	-18%	190%	23%
Stillaguamish Summer-F	17%	12%	225	1,620			
North Fork Summer				1,320	-15%	340%	139%
South Fork Fall				300	-7%	50%	0%
Snohomish Summer-Fal	20%	18%	1,633	3,543			
Skykomish Summer				1,819	-18%	10%	-48%
Snoqualmie Fall				1,724		331%	
Green-Duwamish Fall*	49%	39%	9,185	5,801	-4%	595%	5%
Lake Washington Fall		23%					
Sammamish	33%		72	223		12%	-82%
Cedar	33%		72	223		12%	-81%
Puyallup Fall	50%	39%	3,772	1,798		799%	50%
White River Spring	20%	19%	243	1,011		406%	1%
Nisqually Fall	64%	56%	9,544	1,119		460%	2%
Mid- Hood Canal Fall	26%	12%	65	367		84%	-71%
Skokomish Fall	45%	31%	4,166	1,239		520%	-1%
Dungeness Summer	22%	5%	12	245		23%	-74%
Elwha Summer	23%	5%	70	1,480		640%	-49%
All Chinook from Listed Populations			**32,256**	**28,311**			

Hood Canal and Strait of Juan de Fuca Summer Chum				**Performance vs Recovery Standards**	
	Wild Exploitation Rate [4]	Southern U.S. Catch [4]	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	3%	214	7,437	-8%	83%
Juan de Fuca	0.4%	12	6,955	-9%	656%
All Summer Chum		**226**	**14,392**		

* Populations with specific NMFS-developed standards

[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])

[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

[4] Excludes Quilcene River population.

Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-7d Performance of Alternative 1 (Proposed Action) under Scenario D relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	**Alternative 1 Scenario D**				**Performance vs. Recovery Standards**		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	26%	7%	27	252	14%		-50%
North Fork				111		-45%	
South Fork				141		-29%	
Skagit Summer-Fall*	56%	16%	2,698	7,551			
Lower Skagit Fall				810	7%	223%	-63%
Lower Sauk Summer				403	5%	101%	-41%
Upper Skagit Summer				6,339	-4%	556%	-15%
Skagit Spring*	28%	24%	415	1,270			
Upper Cascade				372		119%	
Upper Sauk				428	-10%	229%	30%
Suiattle				471	-13%	177%	18%
Stillaguamish Summer-F	20%	12%	239	1,584			
North Fork Summer				1,291	-12%	330%	134%
South Fork Fall				293	-4%	47%	-2%
Snohomish Summer-Fal	23%	18%	1,685	3,399			
Skykomish Summer				1,745	-18%	6%	-50%
Snoqualmie Fall				1,654		314%	
Green-Duwamish Fall*	51%	36%	8,768	5,802	-2%	595%	5%
Lake Washington Fall		22%					
Sammamish	38%		73	214		7%	-83%
Cedar	38%		74	214		7%	-82%
Puyallup Fall	50%	35%	3,464	1,834		817%	53%
White River Spring	20%	17%	219	1,011		406%	1%
Nisqually Fall	66%	53%	9,714	1,109		455%	1%
Mid- Hood Canal Fall	34%	12%	67	344		72%	-72%
Skokomish Fall	48%	26%	3,712	1,225		513%	-2%
Dungeness Summer	29%	5%	12	231		16%	-75%
Elwha Summer	30%	5%	71	1,395		598%	-52%
All Chinook from Listed Populations			**31,238**	**27,435**			

Hood Canal and Strait of Juan de Fuca Summer Chum				**Performance vs Recovery Standards**	
	Wild Exploitation Rate [4]	Southern U.S. Catch [4]	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	3%	214	7,437	-8%	83%
Juan de Fuca	0.4%	12	6,955	-9%	656%
All Summer Chum		**226**	**14,392**		

* Populations with specific NMFS-developed standards

1 Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])

2 Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

3 Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

4 Excludes Quilcene River population.

Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-8a-1 Performance of Alternative 2 (Escapement Goal Management at Management Unit Level) under Scenario A relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	**Alternative 2 Scenario A**				**Performance vs. Recovery Standards**		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	14%	1%	8	422	2%	6%	-16%
North Fork				186		-7%	
South Fork				236		18%	
Skagit Summer-Fall*	32%	1%	147	14,656			
Lower Skagit Fall				1,571	-17%	526%	-28%
Lower Sauk Summer				782	-19%	291%	15%
Upper Skagit Summer				12,303	-28%	1172%	65%
Skagit Spring*	12%	3%	73	2,073			
Upper Cascade				607		257%	
Upper Sauk				699	-26%	437%	112%
Suiattle				768	-29%	352%	92%
Stillaguamish Summer-F	66%	60%	1,614	903			
North Fork Summer				736	34%	145%	33%
South Fork Fall				167	42%	-16%	-44%
Snohomish Summer-Fal	22%	21%	2,606	4,634			
Skykomish Summer				2,379	-18%	44%	-32%
Snoqualmie Fall				2,255		464%	
Green-Duwamish Fall*	55%	42%	11,312	5,800	2%	595%	5%
Lake Washington Fall		5%					
Sammamish	18%		18	307		54%	-75%
Cedar	18%		18	307		54%	-74%
Puyallup Fall	70%	57%	6,271	1,200		500%	0%
White River Spring	46%	46%	434	1,000		400%	0%
Nisqually Fall	72%	63%	14,375	1,100		450%	0%
Mid- Hood Canal Fall	19%	5%	39	552		176%	-56%
Skokomish Fall	60%	46%	8,334	1,218		509%	-3%
Dungeness Summer	19%	1%	3	360		80%	-61%
Elwha Summer	19%	1%	16	2,172		986%	-25%
All Chinook from Listed Populations			**45,268**	**36,704**			

Hood Canal and Strait of Juan de Fuca Summer Chum				**Performance vs Recovery Standards**	
	Wild Exploitation Rate[4]	Southern U.S. Catch[4]	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	0%	0	7,651	-11%	88%
Juan de Fuca	0.2%	0	6,985	-9%	659%
All Summer Chum		**0**	**14,636**		

* Populations with specific NMFS-developed standards
[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])
[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])
[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}
[4] Excludes Quilcene River population.

(Shaded) Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-8a-2 Performance of Alternative 2 (Escapement Goal Management at Management Unit Level) under Scenario A relative to Alternative 1 Scenario A (Proposed Action).

Puget Sound Chinook	**Impacts Relative to Alternative 1 Scenario A**					
	Change in Wild Exploitation Rate[1]	Change in Southern U.S. Catch[1]	Change in Natural Escapement[1]	% Change in Natural Escapement[2]	Type of Impact	Magnitude of Impact
Nooksack Early*	-6%	-29	34	9%		
North Fork			15	9%	Beneficial	Low
South Fork			19	9%	Beneficial	Low
Skagit Summer-Fall*	-16%	-3,747	3,023	26%		
Lower Skagit Fall			324	26%	Beneficial	Moderate
Lower Sauk Summer			161	26%	Beneficial	Moderate
Upper Skagit Summer			2,538	26%	Beneficial	Moderate
Skagit Spring*	-11%	-497	152	8%	Beneficial	Low
Upper Cascade			45	8%	Beneficial	Low
Upper Sauk			51	8%	Beneficial	Low
Suiattle			56	8%	Beneficial	Low
Stillaguamish Summer-F	49%	1,301	-1,419	-61%		
North Fork Summer			-1,156	-61%	Negative	Substantial
South Fork Fall			-263	-61%	Negative	Substantial
Snohomish Summer-Fal	3%	281	-439	-9%		
Skykomish Summer			-225	-9%	Negative	Low
Snoqualmie Fall			-214	-9%	Negative	Low
Green-Duwamish Fall*	-7%	-4,589	-19	-0.3%	None	None
Lake Washington Fall						
Sammamish	-13%	-68	2	1%	Beneficial	Low
Cedar	-13%	-69	2	1%	Beneficial	Low
Puyallup Fall	21%	1,247	-1,192	-50%	Negative	Substantial
White River Spring	26%	78	-468	-32%	Negative	Substantial
Nisqually Fall	-4%	-3,050	-6	-1%	Negative	Low
Mid- Hood Canal Fall	-7%	-56	21	4%	Beneficial	Low
Skokomish Fall	-3%	-1,038	7	1%	Beneficial	Low
Dungeness Summer	-3%	-12	8	2%	Beneficial	Low
Elwha Summer	-3%	-82	47	2%	Beneficial	Low

	Impacts Relative to Alternative A Scenario A					
Summer Chum	Wild Exploitation Rate[4]	Southern U.S. Catch[4]	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Hood Canal	-3%	-214	214	3%	Beneficial	Low
Juan de Fuca	0%	-12	30	0%	None	None

* Populations with specific NMFS-developed standards
[1] Alternative 1 - Alternative 2
[2] (Alternative 1 - Alternative 2) ÷ Alternative 1
[3] See explanation of impact metrics.
[4] Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-8b-1 Performance of Alternative 2 (Escapement Goal Management at Management Unit Level) under Scenario B relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	**Alternative 2 Scenario B**				**Performance vs. Recovery Standards**		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	19%	1%	9	412	7%		-18%
North Fork				181		-9%	
South Fork				231		15%	
Skagit Summer-Fall*	41%	1%	147	13,935			
Lower Skagit Fall				1,494	-8%	495%	-32%
Lower Sauk Summer				743	-10%	272%	9%
Upper Skagit Summer				11,698	-19%	1110%	57%
Skagit Spring*	16%	3%	74	2,009			
Upper Cascade				589		246%	
Upper Sauk				677	-22%	421%	105%
Suiattle				745	-25%	338%	86%
Stillaguamish Summer-F	67%	59%	1,591	904			
North Fork Summer				737	35%	146%	33%
South Fork Fall				167	43%	-16%	-44%
Snohomish Summer-Fal	23%	19%	2,347	4,603			
Skykomish Summer				2,363	-18%	43%	-32%
Snoqualmie Fall				2,240		460%	
Green-Duwamish Fall*	56%	38%	10,526	5,800	3%	595%	5%
Lake Washington Fall		5%					
Sammamish	23%		37	295		48%	-76%
Cedar	23%		18	295		48%	-75%
Puyallup Fall	71%	53%	5,990	1,200		500%	0%
White River Spring	46%	44%	414	1,000		400%	0%
Nisqually Fall	73%	60%	14,010	1,100		450%	0%
Mid- Hood Canal Fall	25%	5%	39	527		164%	-58%
Skokomish Fall	61%	40%	7,612	1,231		516%	-2%
Dungeness Summer	24%	1%	3	344		72%	-63%
Elwha Summer	24%	1%	16	2,079		940%	-28%
All Chinook from Listed Populations			**42,833**	**35,734**			

Hood Canal and Strait of Juan de Fuca Summer Chum				**Performance vs Recovery Standards**	
	Wild Exploitation Rate[4]	Southern U.S. Catch[4]	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	0%	0	7,651	-11%	88%
Juan de Fuca	0.2%	0	6,985	-9%	659%
All Summer Chum		**0**	**14,636**		

* Populations with specific NMFS-developed standards

[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])

[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

[4] Excludes Quilcene River population.

(shaded) Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-8b-2 Performance of Alternative 2 (Escapement Goal Management at Management Unit Level) under Scenario B relative to Alternative 1 Scenario B (Proposed Action).

Puget Sound Chinook	**Impacts Relative to Alternative 1 Scenario B**					
	Change in Wild Exploitation Rate[1]	Change in Southern U.S. Catch[1]	Change in Natural Escapement[1]	% Change in Natural Escapement[2]	Type of Impact	Magnitude of Impact
Nooksack Early*	-6%	-29	47	13%		
North Fork			21	13%	Beneficial	Moderate
South Fork			26	13%	Beneficial	Moderate
Skagit Summer-Fall*	-14%	-3,590	2,906	26%		
Lower Skagit Fall			312	26%	Beneficial	Moderate
Lower Sauk Summer			155	26%	Beneficial	Moderate
Upper Skagit Summer			2,439	26%	Beneficial	Moderate
Skagit Spring*	-11%	-493	164	9%	Beneficial	Low
Upper Cascade			48	9%	Beneficial	Low
Upper Sauk			55	9%	Beneficial	Low
Suiattle			61	9%	Beneficial	Low
Stillaguamish Summer-F	48%	1,277	-1,377	-60%		
North Fork Summer			-1,122	-60%	Negative	Substantial
South Fork Fall			-255	-60%	Negative	Substantial
Snohomish Summer-Fal	1%	61	-298	-6%		
Skykomish Summer			-153	-6%	Negative	Low
Snoqualmie Fall			-145	-6%	Negative	Low
Green-Duwamish Fall*	-7%	-4,577	-16	-0.3%	None	None
Lake Washington Fall						
Sammamish	-12%	-49	1	0%	None	None
Cedar	-12%	-67	1	0%	None	None
Puyallup Fall	21%	1,367	-1,219	-50%	Negative	Substantial
White River Spring	26%	91	-459	-31%	Negative	Substantial
Nisqually Fall	-3%	-2,919	-26	-2%	Negative	Low
Mid- Hood Canal Fall	-7%	-55	23	5%	Beneficial	Low
Skokomish Fall	-2%	-897	-6	0%	None	None
Dungeness Summer	-3%	-12	8	2%	Beneficial	Low
Elwha Summer	-4%	-81	48	2%	Beneficial	Low

	Impacts Relative to Alternative 1 Scenario B					
Summer Chum	Wild Exploitation Rate[4]	Southern U.S. Catch[4]	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Hood Canal	-3%	-214	214	3%	Beneficial	Low
Juan de Fuca	0%	-12	30	0%	None	None

* Populations with specific NMFS-developed standards

[1] Alternative 1 - Alternative 2

[2] (Alternative 1 - Alternative 2) ÷ Alternative 1

[3] See explanation of impact metrics.

[4] Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-8c-1 Performance of Alternative 2 (Escapement Goal Management at Management Unit Level) under Scenario C relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	**Alternative 2 Scenario C**				**Performance vs. Recovery Standards**		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	14%	1%	6	304	2%		-39%
North Fork				134		-33%	
South Fork				170		-15%	
Skagit Summer-Fall*	33%	1%	105	10,215			
Lower Skagit Fall				1,095	-16%	336%	-50%
Lower Sauk Summer				545	-18%	172%	-20%
Upper Skagit Summer				8,575	-27%	787%	15%
Skagit Spring*	12%	3%	53	1,460			
Upper Cascade				428		152%	
Upper Sauk				492	-26%	278%	49%
Suiattle				541	-29%	218%	35%
Stillaguamish Summer-F	52%	46%	864	909			
North Fork Summer				741	20%	147%	34%
South Fork Fall				168	28%	-16%	-44%
Snohomish Summer-Fal	10%	3%	244	3,875			
Skykomish Summer				1,989	-18%	21%	-43%
Snoqualmie Fall				1,886		372%	
Green-Duwamish Fall*	36%	23%	4,403	5,800	-17%	595%	5%
Lake Washington Fall		5%					
Sammamish	19%		28	214		7%	-83%
Cedar	19%		13	214		7%	-82%
Puyallup Fall	57%	44%	3,703	1,200		500%	0%
White River Spring	23%	23%	156	1,000		400%	0%
Nisqually Fall	61%	51%	8,324	1,100		450%	0%
Mid- Hood Canal Fall	20%	5%	29	385		93%	-69%
Skokomish Fall	43%	29%	3,701	1,221		511%	-2%
Dungeness Summer	19%	1%	2	251		26%	-73%
Elwha Summer	19%	1%	11	1,516		658%	-48%
All Chinook from Listed Populations			**21,642**	**29,664**			

Hood Canal and Strait of Juan de Fuca Summer Chum				**Performance vs Recovery Standards**	
	Wild Exploitation Rate[4]	Southern U.S. Catch[4]	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	0%	0	7,651	-11%	88%
Juan de Fuca	0.2%	0	6,985	-9%	659%
All Summer Chum		**0**	**14,636**		

* Populations with specific NMFS-developed standards
[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])
[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])
[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}
[4] Excludes Quilcene River population.

Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-8c-2 Performance of Alternative 2 (Escapement Goal Management at Management Unit Level) under Scenario C relative to Alternative 1 Scenario C (Proposed Action).

Puget Sound Chinook	**Impacts Relative to Alternative 1 Scenario A**					
	Change in Wild Exploitation Rate[1]	Change in Southern U.S. Catch[1]	Change in Natural Escapement[1]	% Change in Natural Escapement[2]	Type of Impact	Magnitude of Impact
Nooksack Early*	-6%	-20	26	9%		
North Fork			11	9%	Beneficial	Low
South Fork			15	9%	Beneficial	Low
Skagit Summer-Fall*	-16%	-2,673	2,182	27%		
Lower Skagit Fall			234	27%	Beneficial	Moderate
Lower Sauk Summer			116	27%	Beneficial	Moderate
Upper Skagit Summer			1,832	27%	Beneficial	Moderate
Skagit Spring*	-11%	-340	129	10%	Beneficial	Moderate
Upper Cascade			38	10%	Beneficial	Moderate
Upper Sauk			43	10%	Beneficial	Moderate
Suiattle			48	10%	Beneficial	Moderate
Stillaguamish Summer-F	35%	639	-711	-44%		
North Fork Summer			-579	-44%	Negative	Substantial
South Fork Fall			-132	-44%	Negative	Substantial
Snohomish Summer-Fal	-10%	-1,389	332	9%		
Skykomish Summer			170	9%	Beneficial	Low
Snoqualmie Fall			162	9%	Beneficial	Low
Green-Duwamish Fall*	-13%	-4,782	-1	0.0%	None	None
Lake Washington Fall						
Sammamish	-14%	-45	-9	-4%	Negative	Low
Cedar	-14%	-59	-9	-4%	Negative	Low
Puyallup Fall	7%	-69	-598	-33%	Negative	Substantial
White River Spring	3%	-87	-11	-1%	Negative	Low
Nisqually Fall	-3%	-1,220	-19	-2%	Negative	Low
Mid- Hood Canal Fall	-6%	-36	18	5%	Beneficial	Low
Skokomish Fall	-2%	-465	-18	-1%	Negative	Low
Dungeness Summer	-3%	-10	6	2%	Beneficial	Low
Elwha Summer	-4%	-59	36	2%	Beneficial	Low

Summer Chum	**Impacts Relative to Alternative A Scenario A**					
	Wild Exploitation Rate[4]	Southern U.S. Catch[4]	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Hood Canal	-3%	-214	214	3%	Beneficial	Low
Juan de Fuca	0%	-12	30	0%	None	None

* Populations with specific NMFS-developed standards
[1] Alternative 1 - Alternative 2
[2] (Alternative 1 - Alternative 2) ÷ Alternative 1
[3] See explanation of impact metrics.
[4] Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-8d-1 Performance of Alternative 2 (Escapement Goal Management at Management Unit Level) under Scenario D relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	**Alternative 2 Scenario D**				**Performance vs. Recovery Standards**		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	20%	1%	6	285	8%		-43%
North Fork				125		-37%	
South Fork				160		-20%	
Skagit Summer-Fall*	43%	1%	105	9,625			
Lower Skagit Fall				1,032	-6%	311%	-53%
Lower Sauk Summer				513	-8%	157%	-25%
Upper Skagit Summer				8,080	-17%	736%	8%
Skagit Spring*	17%	3%	54	1,395			
Upper Cascade				409		140%	
Upper Sauk				470	-21%	262%	42%
Suiattle				517	-24%	204%	29%
Stillaguamish Summer-F	52%	43%	817	919			
North Fork Summer				749	20%	150%	36%
South Fork Fall				170	28%	-15%	-43%
Snohomish Summer-Fal	13%	3%	248	3,720			
Skykomish Summer				1,909	-18%	16%	-45%
Snoqualmie Fall				1,811		353%	
Green-Duwamish Fall*	38%	18%	3,685	5,800	-15%	595%	5%
Lake Washington Fall		5%					
Sammamish	25%		13	204		2%	-84%
Cedar	25%		13	204		2%	-83%
Puyallup Fall	59%	39%	3,449	1,200		500%	0%
White River Spring	22%	20%	137	1,000		400%	0%
Nisqually Fall	62%	47%	7,998	1,100		450%	0%
Mid- Hood Canal Fall	28%	5%	29	361		81%	-71%
Skokomish Fall	46%	23%	3,113	1,215		508%	-3%
Dungeness Summer	26%	1%	2	237		19%	-74%
Elwha Summer	26%	1%	11	1,431		616%	-51%
All Chinook from Listed Populations			**19,680**	**28,696**			

Hood Canal and Strait of Juan de Fuca Summer Chum				**Performance vs Recovery Standards**	
	Wild Exploitation Rate [4]	Southern U.S. Catch [4]	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	0%	0	7,651	-11%	88%
Juan de Fuca	0.2%	0	6,985	-9%	659%
All Summer Chum		**0**	**14,636**		

* Populations with specific NMFS-developed standards
[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])
[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])
[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}
[4] Excludes Quilcene River population.

Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-8d-2 Performance of Alternative 2 (Escapement Goal Management at Management Unit Level) under Scenario D relative to Alternative 1 Scenario D (Proposed Action).

Puget Sound Chinook	**Impacts Relative to Alternative 1 Scenario A**					
	Change in Wild Exploitation Rate[1]	Change in Southern U.S. Catch[1]	Change in Natural Escapement[1]	% Change in Natural Escapement[2]	Type of Impact	Magnitude of Impact
Nooksack Early*	-6%	-21	33	13%		
North Fork			15	13%	Beneficial	Moderate
South Fork			18	13%	Beneficial	Moderate
Skagit Summer-Fall*	-13%	-2,593	2,074	27%		
Lower Skagit Fall			222	27%	Beneficial	Moderate
Lower Sauk Summer			111	27%	Beneficial	Moderate
Upper Skagit Summer			1,741	27%	Beneficial	Moderate
Skagit Spring*	-11%	-361	125	10%	Beneficial	Moderate
Upper Cascade			37	10%	Beneficial	Moderate
Upper Sauk			42	10%	Beneficial	Moderate
Suiattle			46	10%	Beneficial	Moderate
Stillaguamish Summer-F	32%	578	-665	-42%		
North Fork Summer			-542	-42%	Negative	Substantial
South Fork Fall			-123	-42%	Negative	Substantial
Snohomish Summer-Fal	-10%	-1,437	321	9%		
Skykomish Summer			165	9%	Beneficial	Low
Snoqualmie Fall			156	9%	Beneficial	Low
Green-Duwamish Fall*	-13%	-5,083	-2	0.0%	None	None
Lake Washington Fall						
Sammamish	-13%	-60	-10	-5%	Negative	Low
Cedar	-13%	-61	-10	-5%	Negative	Low
Puyallup Fall	9%	-15	-634	-35%	Negative	Substantial
White River Spring	2%	-82	-11	-1%	Negative	Low
Nisqually Fall	-4%	-1,716	-9	-1%	Negative	Low
Mid- Hood Canal Fall	-6%	-38	17	5%	Beneficial	Low
Skokomish Fall	-2%	-599	-10	-1%	Negative	Low
Dungeness Summer	-3%	-10	6	3%	Beneficial	Low
Elwha Summer	-4%	-60	36	3%	Beneficial	Low

Summer Chum	**Impacts Relative to Alternative A Scenario A**					
	Wild Exploitation Rate[4]	Southern U.S. Catch [4]	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Hood Canal	-3%	-214	214	3%	Beneficial	Low
Juan de Fuca	0%	-12	30	0%	None	None

* Populations with specific NMFS-developed standards
[1] Alternative 1 - Alternative 2
[2] (Alternative 1 - Alternative 2) ÷ Alternative 1
[3] See explanation of impact metrics.
[4] Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-9a-1 Performance of Alternative 3 (Escapement Goal Management at Population Level) under Scenario A relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	**Alternative 3 Scenario A**				**Performance vs. Recovery Standards**		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	14%	1%	8	422	2%		-16%
North Fork				186		-7%	
South Fork				236		18%	
Skagit Summer-Fall*	32%	1%	147	14,656			
Lower Skagit Fall				1,571	-17%	526%	-28%
Lower Sauk Summer				782	-19%	291%	15%
Upper Skagit Summer				12,303	-28%	1172%	65%
Skagit Spring*	12%	3%	71	2,074			
Upper Cascade				608		257%	
Upper Sauk				699	-26%	438%	112%
Suiattle				769	-29%	352%	92%
Stillaguamish Summer-Fal	8%	2%	47	2,468			
North Fork Summer				2,011	-24%	570%	264%
South Fork Fall				457	-16%	128%	52%
Snohomish Summer-Fall*	10%	4%	857	5,475			
Skykomish Summer				2,810	-18%	70%	-20%
Snoqualmie Fall				2,665		566%	
Green-Duwamish Fall*	55%	42%	11,312	5,800	2%	595%	5%
Lake Washington Fall		5%					
Sammamish	18%		18	307		54%	-75%
Cedar	18%		18	307		54%	-74%
Puyallup Fall	70%	57%	6,271	1,200		500%	0%
White River Spring	46%	46%	434	1,000		400%	0%
Nisqually Fall	72%	63%	14,375	1,100		450%	0%
Mid- Hood Canal Fall	19%	5%	39	552		176%	-56%
Skokomish Fall	60%	46%	8,333	1,218		509%	-3%
Dungeness Summer	19%	1%	3	360		80%	-61%
Elwha Summer	19%	1%	16	2,172		986%	-25%
All Chinook from Listed Populations			**41,949**	**39,111**			

Hood Canal and Strait of Juan de Fuca Summer Chum				**Performance vs Recovery Standards**	
	Wild Exploitation Rate[4]	Southern U.S. Catch[4]	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	0.3%	0	7,651	-11%	88%
Juan de Fuca	0.2%	0	6,985	-9%	659%
All Summer Chum		**0**	**14,636**		

* Populations with specific NMFS-developed standards

[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])

[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

[4] Excludes Quilcene River population.

Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-9a-2 Performance of Alternative 3 (Escapement Goal Management at Population Level) under Scenario A relative to Alternative 1 Scenario A (Proposed Action).

Puget Sound Chinook	**Impacts Relative to Alternative 1 Scenario A**					
	Change in Wild Exploitation Rate[1]	Change in Southern U.S. Catch[1]	Change in Natural Escapement[1]	% Change in Natural Escapement[2]	Type of Impact	Magnitude of Impact
Nooksack Early*	-6%	-29	34	9%		
North Fork			15	9%	Beneficial	Low
South Fork			19	9%	Beneficial	Low
Skagit Summer-Fall*	-16%	-3,747	3,023	26%		
Lower Skagit Fall			324	26%	Beneficial	Moderate
Lower Sauk Summer			161	26%	Beneficial	Moderate
Upper Skagit Summer			2,538	26%	Beneficial	Moderate
Skagit Spring*	-11%	-499	153	8%	Beneficial	Low
Upper Cascade			45	8%	Beneficial	Low
Upper Sauk			52	8%	Beneficial	Low
Suiattle			57	8%	Beneficial	Low
Stillaguamish Summer-Fal	-9%	-266	146	6%		
North Fork Summer			119	6%	Beneficial	Low
South Fork Fall			27	6%	Beneficial	Low
Snohomish Summer-Fall*	-9%	-1,468	402	8%		
Skykomish Summer			206	8%	Beneficial	Low
Snoqualmie Fall			196	8%	Beneficial	Low
Green-Duwamish Fall*	-7%	-4,589	-19	-0.3%	None	None
Lake Washington Fall						
Sammamish	-13%	-68	2	1%	Beneficial	Low
Cedar	-13%	-69	2	1%	Beneficial	Low
Puyallup Fall	21%	1,247	-1,192	-50%	Negative	Substantial
White River Spring	26%	78	-468	-32%	Negative	Substantial
Nisqually Fall	-4%	-3,050	-6	-1%	Negative	Low
Mid- Hood Canal Fall	-7%	-56	21	4%	Beneficial	Low
Skokomish Fall	-3%	-1,039	7	1%	Beneficial	Low
Dungeness Summer	-3%	-12	8	2%	Beneficial	Low
Elwha Summer	-3%	-82	47	2%	Beneficial	Low

Summer Chum	**Impacts Relative to Alternative A Scenario A**					
	Wild Exploitation Rate[4]	Southern U.S. Catch[4]	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Hood Canal	-3%	-214	214	3%	Beneficial	Low
Juan de Fuca	0%	-12	30	0%	None	None

* Populations with specific NMFS-developed standards

[1] Alternative 1 - Alternative 2

[2] (Alternative 1 - Alternative 2) ÷ Alternative 1

[3] See explanation of impact metrics.

[4] Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-9b-1 Performance of Alternative 3 (Escapement Goal Management at Population Level) under Scenario B relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	**Alternative 3 Scenario B**				**Performance vs. Recovery Standards**		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	19%	1%	9	412	7%		-18%
North Fork				181		-9%	
South Fork				231		15%	
Skagit Summer-Fall*	41%	1%	147	13,935			
Lower Skagit Fall				1,494	-8%	495%	-32%
Lower Sauk Summer				743	-10%	272%	9%
Upper Skagit Summer				11,698	-19%	1110%	57%
Skagit Spring*	16%	3%	72	2,010			
Upper Cascade				589		246%	
Upper Sauk				677	-22%	421%	105%
Suiattle				745	-25%	338%	86%
Stillaguamish Summer-Fa	10%	2%	48	2,446			
North Fork Summer				1,993	-22%	564%	261%
South Fork Fall				453	-14%	126%	51%
Snohomish Summer-Fall*	12%	3%	328	5,368			
Skykomish Summer				2,755	-18%	67%	-21%
Snoqualmie Fall				2,613		553%	
Green-Duwamish Fall*	56%	38%	10,526	5,800	3%	595%	5%
Lake Washington Fall		5%					
Sammamish	23%		37	295		48%	-76%
Cedar	23%		18	295		48%	-75%
Puyallup Fall	71%	53%	5,990	1,200		500%	0%
White River Spring	46%	44%	414	1,000		400%	0%
Nisqually Fall	73%	60%	14,010	1,100		450%	0%
Mid- Hood Canal Fall	25%	5%	39	527		164%	-58%
Skokomish Fall	61%	40%	7,611	1,231		516%	-2%
Dungeness Summer	24%	1%	3	344		72%	-63%
Elwha Summer	24%	1%	16	2,079		940%	-28%
All Chinook from Listed Populations			**39,268**	**38,042**			

Hood Canal and Strait of Juan de Fuca Summer Chum				**Performance vs Recovery Standards**	
	Wild Exploitation Rate[4]	Southern U.S. Catch[4]	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	0.3%	0	7,651	-11%	88%
Juan de Fuca	0.2%	0	6,985	-9%	659%
All Summer Chum		**0**	**14,636**		

* Populations with specific NMFS-developed standards

[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])

[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

[4] Excludes Quilcene River population.

Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-9b-2 Performance of Alternative 3 (Escapement Goal Management at Population Level) under Scenario B relative to Alternative 1 Scenario B (Proposed Action).

Puget Sound Chinook	**Impacts Relative to Alternative 1 Scenario B**					
	Change in Wild Exploitation Rate[1]	Change in Southern U.S. Catch[1]	Change in Natural Escapement[1]	% Change in Natural Escapement[2]	Type of Impact	Magnitude of Impact
Nooksack Early*	-6%	-29	47	13%		
North Fork			21	13%	Beneficial	Moderate
South Fork			26	13%	Beneficial	Moderate
Skagit Summer-Fall*	-14%	-3,590	2,906	26%		
Lower Skagit Fall			312	26%	Beneficial	Moderate
Lower Sauk Summer			155	26%	Beneficial	Moderate
Upper Skagit Summer			2,439	26%	Beneficial	Moderate
Skagit Spring*	-11%	-495	165	9%	Beneficial	Low
Upper Cascade			48	9%	Beneficial	Low
Upper Sauk			56	9%	Beneficial	Low
Suiattle			61	9%	Beneficial	Low
Stillaguamish Summer-Fa	-9%	-266	165	7%		
North Fork Summer			134	7%	Beneficial	Low
South Fork Fall			31	7%	Beneficial	Low
Snohomish Summer-Fall*	-10%	-1,958	467	10%		
Skykomish Summer			240	10%	Beneficial	Moderate
Snoqualmie Fall			227	10%	Beneficial	Moderate
Green-Duwamish Fall*	-7%	-4,577	-16	-0.3%	None	None
Lake Washington Fall						
Sammamish	-12%	-49	1	0%	None	None
Cedar	-12%	-67	1	0%	None	None
Puyallup Fall	21%	1,367	-1,219	-50%	Negative	Substantial
White River Spring	26%	91	-459	-31%	Negative	Substantial
Nisqually Fall	-3%	-2,919	-26	-2%	Negative	Low
Mid- Hood Canal Fall	-7%	-55	23	5%	Beneficial	Low
Skokomish Fall	-2%	-898	-6	0%	None	None
Dungeness Summer	-3%	-12	8	2%	Beneficial	Low
Elwha Summer	-4%	-81	48	2%	Beneficial	Low

	Impacts Relative to Alternative A Scenario B					
Summer Chum	Wild Exploitation Rate[4]	Southern U.S. Catch[4]	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Hood Canal	-3%	-214	214	3%	Beneficial	Low
Juan de Fuca	0%	-12	30	0%	None	None

* Populations with specific NMFS-developed standards

[1] Alternative 1 - Alternative 2

[2] (Alternative 1 - Alternative 2) ÷ Alternative 1

[3] See explanation of impact metrics.

[4] Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-9c-1 Performance of Alternative 3 (Escapement Goal Management at Population Level) under Scenario C relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	**Alternative C Scenario C**				**Performance vs. Recovery Standards**		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	14%	1%	6	304	2%		-39%
North Fork				134		-33%	
South Fork				170		-15%	
Skagit Summer-Fall*	33%	1%	105	10,215			
Lower Skagit Fall				1,095	-16%	336%	-50%
Lower Sauk Summer				545	-18%	172%	-20%
Upper Skagit Summer				8,575	-27%	787%	15%
Skagit Spring*	12%	3%	53	1,460			
Upper Cascade				428		152%	
Upper Sauk				492	-26%	278%	49%
Suiattle				541	-29%	218%	35%
Stillaguamish Summer-Fal	8%	2%	35	1,738			
North Fork Summer				1,416	-24%	372%	157%
South Fork Fall				322	-16%	61%	7%
Snohomish Summer-Fall*	10%	3%	244	3,875			
Skykomish Summer				1,989	-18%	21%	-43%
Snoqualmie Fall				1,886		372%	
Green-Duwamish Fall*	36%	23%	4,403	5,800	-17%	595%	5%
Lake Washington Fall		5%					
Sammamish	19%		28	214		7%	-83%
Cedar	19%		13	214		7%	-82%
Puyallup Fall	57%	44%	3,703	1,200		500%	0%
White River Spring	23%	23%	156	1,000		400%	0%
Nisqually Fall	61%	51%	8,324	1,100		450%	0%
Mid- Hood Canal Fall	20%	5%	29	385		93%	-69%
Skokomish Fall	43%	29%	3,701	1,221		511%	-2%
Dungeness Summer	19%	1%	2	251		26%	-73%
Elwha Summer	19%	1%	11	1,516		658%	-48%
All Chinook from Listed Populations			**20,813**	**30,493**			

Hood Canal and Strait of Juan de Fuca Summer Chum				**Performance vs Recovery Standards**	
	Wild Exploitation Rate[4]	Southern U.S. Catch[4]	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	0%	0	7,651	-11%	88%
Juan de Fuca	0.2%	0	6,985	-9%	659%
All Summer Chum		**0**	**14,636**		

* Populations with specific NMFS-developed standards

[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])

[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

[4] Excludes Quilcene River population.

Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-9c-2 Performance of Alternative 3 (Escapement Goal Management at Population Level) under Scenario C relative to Alternative 1 Scenario C (Proposed Action).

Puget Sound Chinook	**Impacts Relative to Alternative 1 Scenario A**					
	Change in Wild Exploitation Rate[1]	Change in Southern U.S. Catch[1]	Change in Natural Escapement[1]	% Change in Natural Escapement[2]	Type of Impact	Magnitude of Impact
Nooksack Early*	-6%	-20	26	9%		
North Fork			11	9%	Beneficial	Low
South Fork			15	9%	Beneficial	Low
Skagit Summer-Fall*	-16%	-2,673	2,182	27%		
Lower Skagit Fall			234	27%	Beneficial	Moderate
Lower Sauk Summer			116	27%	Beneficial	Moderate
Upper Skagit Summer			1,832	27%	Beneficial	Moderate
Skagit Spring*	-11%	-340	129	10%	Beneficial	Moderate
Upper Cascade			38	10%	Beneficial	Moderate
Upper Sauk			43	10%	Beneficial	Moderate
Suiattle			48	10%	Beneficial	Moderate
Stillaguamish Summer-Fal	-9%	-190	118	7%		
North Fork Summer			96	7%	Beneficial	Low
South Fork Fall			22	7%	Beneficial	Low
Snohomish Summer-Fall*	-10%	-1,389	332	9%		
Skykomish Summer			170	9%	Beneficial	Low
Snoqualmie Fall			162	9%	Beneficial	Low
Green-Duwamish Fall*	-13%	-4,782	-1	0.0%	None	None
Lake Washington Fall						
Sammamish	-14%	-45	-9	-4%	Negative	Low
Cedar	-14%	-59	-9	-4%	Negative	Low
Puyallup Fall	7%	-69	-598	-33%	Negative	Substantial
White River Spring	3%	-87	-11	-1%	Negative	Low
Nisqually Fall	-3%	-1,220	-19	-2%	Negative	Low
Mid- Hood Canal Fall	-6%	-36	18	5%	Beneficial	Low
Skokomish Fall	-2%	-465	-18	-1%	Negative	Low
Dungeness Summer	-3%	-10	6	2%	Beneficial	Low
Elwha Summer	-4%	-59	36	2%	Beneficial	Low

Summer Chum	**Impacts Relative to Alternative A Scenario A**					
	Wild Exploitation Rate[4]	Southern U.S. Catch[4]	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Hood Canal	-3%	-214	214	3%	Beneficial	Low
Juan de Fuca	0%	-12	30	0%	None	None

* Populations with specific NMFS-developed standards

[1] Alternative 1 - Alternative 2

[2] (Alternative 1 - Alternative 2) ÷ Alternative 1

[3] See explanation of impact metrics.

[4] Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-9d-1 Performance of Alternative 3 (Escapement Goal Management at Population Level) under Scenario D relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	**Alternative 3 Scenario D**				**Performance vs. Recovery Standards**		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	20%	1%	6	285	8%		-43%
North Fork				125		-37%	
South Fork				160		-20%	
Skagit Summer-Fall*	43%	1%	105	9,625			
Lower Skagit Fall				1,032	-6%	311%	-53%
Lower Sauk Summer				513	-8%	157%	-25%
Upper Skagit Summer				8,080	-17%	736%	8%
Skagit Spring*	17%	3%	54	1,395			
Upper Cascade				409		140%	
Upper Sauk				470	-21%	262%	42%
Suiattle				517	-24%	204%	29%
Stillaguamish Summer-Fal	11%	2%	35	1,702			
North Fork Summer				1,387	-21%	362%	151%
South Fork Fall				315	-13%	57%	5%
Snohomish Summer-Fall*	13%	3%	248	3,720			
Skykomish Summer				1,909	-18%	16%	-45%
Snoqualmie Fall				1,811		353%	
Green-Duwamish Fall*	38%	18%	3,685	5,800	-15%	595%	5%
Lake Washington Fall		5%					
Sammamish	25%		28	204		2%	-84%
Cedar	25%		13	204		2%	-83%
Puyallup Fall	59%	39%	3,449	1,200		500%	0%
White River Spring	22%	20%	137	1,000		400%	0%
Nisqually Fall	62%	47%	7,998	1,100		450%	0%
Mid- Hood Canal Fall	28%	5%	29	361		81%	-71%
Skokomish Fall	46%	23%	3,113	1,215		508%	-3%
Dungeness Summer	26%	1%	2	237		19%	-74%
Elwha Summer	26%	1%	11	1,431		616%	-51%
All Chinook from Listed Populations			**18,913**	**29,479**			

Hood Canal and Strait of Juan de Fuca Summer Chum				**Performance vs Recovery Standards**	
	Wild Exploitation Rate [4]	Southern U.S. Catch [4]	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	0.3%	0	7,651	-11%	88%
Juan de Fuca	0.2%	0	6,985	-9%	659%
All Summer Chum		**0**	**14,636**		

* Populations with specific NMFS-developed standards
[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])
[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])
[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}
[4] Excludes Quilcene River population.
(shaded) Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-9d-2 Performance of Alternative 3 (Escapement Goal Management at Population Level) under Scenario D relative to Alternative 1 Scenario D (Proposed Action).

Puget Sound Chinook	**Impacts Relative to Alternative 1 Scenario A**					
	Change in Wild Exploitation Rate[1]	Change in Southern U.S. Catch[1]	Change in Natural Escapement[1]	% Change in Natural Escapement[2]	Type of Impact	Magnitude of Impact
Nooksack Early*	-6%	-21	33	13%		
North Fork			15	13%	Beneficial	Moderate
South Fork			18	13%	Beneficial	Moderate
Skagit Summer-Fall*	-13%	-2,593	2,074	27%		
Lower Skagit Fall			222	27%	Beneficial	Moderate
Lower Sauk Summer			111	27%	Beneficial	Moderate
Upper Skagit Summer			1,741	27%	Beneficial	Moderate
Skagit Spring*	-11%	-361	125	10%	Beneficial	Moderate
Upper Cascade			37	10%	Beneficial	Moderate
Upper Sauk			42	10%	Beneficial	Moderate
Suiattle			46	10%	Beneficial	Moderate
Stillaguamish Summer-Fal	-9%	-204	118	7%		
North Fork Summer			96	7%	Beneficial	Low
South Fork Fall			22	7%	Beneficial	Low
Snohomish Summer-Fall*	-10%	-1,437	321	9%		
Skykomish Summer			165	9%	Beneficial	Low
Snoqualmie Fall			156	9%	Beneficial	Low
Green-Duwamish Fall*	-13%	-5,083	-2	0.0%	None	None
Lake Washington Fall						
Sammamish	-13%	-45	-10	-5%	Negative	Low
Cedar	-13%	-61	-10	-5%	Negative	Low
Puyallup Fall	9%	-15	-634	-35%	Negative	Substantial
White River Spring	2%	-82	-11	-1%	Negative	Low
Nisqually Fall	-4%	-1,716	-9	-1%	Negative	Low
Mid- Hood Canal Fall	-6%	-38	17	5%	Beneficial	Low
Skokomish Fall	-2%	-599	-10	-1%	Negative	Low
Dungeness Summer	-3%	-10	6	3%	Beneficial	Low
Elwha Summer	-4%	-60	36	3%	Beneficial	Low

Summer Chum	**Impacts Relative to Alternative A Scenario A**					
	Wild Exploitation Rate[4]	Southern U.S.Catch	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Hood Canal	-3%	-214	214	3%	Beneficial	Low
Juan de Fuca	0%	-12	30	0%	None	None

* Populations with specific NMFS-developed standards
[1] Alternative 1 - Alternative 2
[2] (Alternative 1 - Alternative 2) ÷ Alternative 1
[3] See explanation of impact metrics.
[4] Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-10a-1 Performance of Alternative 4 (No Fishing) under Scenario A relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	Alternative 4 Scenario A				Performance vs. Recovery Standards		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	14%	1%	8	422	2%		-16%
North Fork				186		-7%	
South Fork				236		18%	
Skagit Summer-Fall*	32%	1%	147	14,656			
Lower Skagit Fall				1,571	-17%	526%	-28%
Lower Sauk Summer				782	-19%	291%	15%
Upper Skagit Summer				12,303	-28%	1172%	65%
Skagit Spring*	12%	3%	71	2,074			
Upper Cascade				608		257%	
Upper Sauk				699	-26%	438%	112%
Suiattle				769	-29%	352%	92%
Stillaguamish Summer-Fal	8%	2%	47	2,468			
North Fork Summer				2,011	-24%	570%	264%
South Fork Fall				457	-16%	128%	52%
Snohomish Summer-Fall*	9%	3%	329	5,504			
Skykomish Summer				2,825	-18%	71%	-19%
Snoqualmie Fall				2,679		570%	
Green-Duwamish Fall*	18%	5%	1,675	10,558	-35%	1164%	91%
Lake Washington Fall		5%					
Sammamish	18%		37	307		54%	-75%
Cedar	18%		18	307		54%	-74%
Puyallup Fall	18%	5%	629	3,286		1543%	174%
White River Spring	2%	1%	18	1,831		816%	83%
Nisqually Fall	16%	7%	2,142	3,338		1569%	203%
Mid- Hood Canal Fall	19%	5%	39	552		176%	-56%
Skokomish Fall	19%	5%	1,054	2,482		1141%	99%
Dungeness Summer	19%	1%	3	360		80%	-61%
Elwha Summer	19%	1%	16	2,172		986%	-25%
All Chinook from Listed Populations			**6,233**	**50,317**			

Hood Canal and Strait of Juan de Fuca Summer Chum				Performance vs Recovery Standards	
	Wild Exploitation Rate[4]	Southern U.S. Catch	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	0.3%	0	7,651	-11%	88%
Juan de Fuca	0.2%	0	6,985	-9%	659%
All Summer Chum		**0**	**14,636**		

* Populations with specific NMFS-developed standards

[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])

[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

[4] Excludes Quilcene River population.

(shaded) Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-10a-2 Performance of Alternative 4 (No Fishing) under Scenario A relative to Alternative 1 Scenario A (Proposed Action).

Puget Sound Chinook	Impacts Relative to Alternative 1 Scenario A					
	Change in Wild Exploitation Rate[1]	Change in Southern U.S. Catch[1]	Change in Natural Escapement[1]	% Change in Natural Escapement[2]	Type of Impact	Magnitude of Impact
Nooksack Early*	-6%	-29	34	9%		
North Fork			15	9%	Beneficial	Low
South Fork			19	9%	Beneficial	Low
Skagit Summer-Fall*	-16%	-3,747	3,023	26%		
Lower Skagit Fall			324	26%	Beneficial	Moderate
Lower Sauk Summer			161	26%	Beneficial	Moderate
Upper Skagit Summer			2,538	26%	Beneficial	Moderate
Skagit Spring*	-11%	-499	153	8%	Beneficial	Low
Upper Cascade			45	8%	Beneficial	Low
Upper Sauk			52	8%	Beneficial	Low
Suiattle			57	8%	Beneficial	Low
Stillaguamish Summer-Fal	-9%	-266	146	6%		
North Fork Summer			119	6%	Beneficial	Low
South Fork Fall			27	6%	Beneficial	Low
Snohomish Summer-Fall*	-10%	-1,996	431	8%		
Skykomish Summer			221	8%	Beneficial	Low
Snoqualmie Fall			210	8%	Beneficial	Low
Green-Duwamish Fall*	-44%	-14,226	4,739	81.4%	Beneficial	Substantial
Lake Washington Fall						
Sammamish	-13%	-49	2	1%	Beneficial	Low
Cedar	-13%	-69	2	1%	Beneficial	Low
Puyallup Fall	-31%	-4,395	894	37%	Beneficial	Substantial
White River Spring	-18%	-338	363	25%	Beneficial	Moderate
Nisqually Fall	-60%	-15,283	2,232	202%	Beneficial	Substantial
Mid- Hood Canal Fall	-7%	-56	21	4%	Beneficial	Low
Skokomish Fall	-44%	-8,318	1,271	105%	Beneficial	Substantial
Dungeness Summer	-3%	-12	8	2%	Beneficial	Low
Elwha Summer	-3%	-82	47	2%	Beneficial	Low

Summer Chum	Impacts Relative to Alternative A Scenario A					
	Wild Exploitation Rate[4]	Southern U.S.Catch	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Hood Canal	-3%	-214	214	3%	Beneficial	Low
Juan de Fuca	0%	-12	30	0%	None	None

* Populations with specific NMFS-developed standards

[1] Alternative 1 - Alternative 2

[2] (Alternative 1 - Alternative 2) ÷ Alternative 1

[3] See explanation of impact metrics.

[4] Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-10b-1 Performance of Alternative 4 (No Fishing) under Scenario B relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	**Alternative 4 Scenario B**				**Performance vs. Recovery Standards**		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	19%	1%	9	412	7%		-18%
North Fork				181		-9%	
South Fork				231		15%	
Skagit Summer-Fall*	41%	1%	147	13,935			
Lower Skagit Fall				1,494	-8%	495%	-32%
Lower Sauk Summer				743	-10%	272%	9%
Upper Skagit Summer				11,698	-19%	1110%	57%
Skagit Spring*	16%	3%	72	2,010			
Upper Cascade				589		246%	
Upper Sauk				677	-22%	421%	105%
Suiattle				745	-25%	338%	86%
Stillaguamish Summer-Fal	10%	2%	48	2,446			
North Fork Summer				1,993	-22%	564%	261%
South Fork Fall				453	-14%	126%	51%
Snohomish Summer-Fall*	12%	3%	328	5,368			
Skykomish Summer				2,755	-18%	67%	-21%
Snoqualmie Fall				2,613		553%	
Green-Duwamish Fall*	23%	5%	1,684	10,153	-30%	1116%	84%
Lake Washington Fall		5%					
Sammamish	23%		37	295		48%	-76%
Cedar	23%		18	295		48%	-75%
Puyallup Fall	23%	5%	633	3,160		1480%	163%
White River Spring	3%	1%	18	1,792		796%	79%
Nisqually Fall	21%	7%	2,183	3,261		1531%	196%
Mid- Hood Canal Fall	25%	5%	39	527		164%	-58%
Skokomish Fall	25%	5%	1,054	2,370		1085%	90%
Dungeness Summer	24%	1%	3	344		72%	-63%
Elwha Summer	24%	1%	16	2,079		940%	-28%
All Chinook from Listed Populations			**6,289**	**48,447**			

Hood Canal and Strait of Juan de Fuca Summer Chum				**Performance vs Recovery Standards**	
	Wild Exploitation Rate[4]	Southern U.S. Catch	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	0.3%	0	7,651	-11%	88%
Juan de Fuca	0.2%	0	6,985	-9%	659%
All Summer Chum		**0**	**14,636**		

* Populations with specific NMFS-developed standards

[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])

[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

[4] Excludes Quilcene River population.

[shaded box] Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-10b-2 Performance of Alternative 4 (No Fishing) under Scenario B relative to Alternative 1 Scenario B (Proposed Action).

Puget Sound Chinook	**Impacts Relative to Alternative 1 Scenario B**					
	Change in Wild Exploitation Rate[1]	Change in Southern U.S. Catch[1]	Change in Natural Escapement[1]	% Change in Natural Escapement[2]	Type of Impact	Magnitude of Impact
Nooksack Early*	-6%	-29	47	13%		
North Fork			21	13%	Beneficial	Moderate
South Fork			26	13%	Beneficial	Moderate
Skagit Summer-Fall*	-14%	-3,590	2,906	26%		
Lower Skagit Fall			312	26%	Beneficial	Moderate
Lower Sauk Summer			155	26%	Beneficial	Moderate
Upper Skagit Summer			2,439	26%	Beneficial	Moderate
Skagit Spring*	-11%	-495	165	9%	Beneficial	Low
Upper Cascade			48	9%	Beneficial	Low
Upper Sauk			56	9%	Beneficial	Low
Suiattle			61	9%	Beneficial	Low
Stillaguamish Summer-Fal	-9%	-266	165	7%		
North Fork Summer			134	7%	Beneficial	Low
South Fork Fall			31	7%	Beneficial	Low
Snohomish Summer-Fall*	-10%	-1,958	467	10%		
Skykomish Summer			240	10%	Beneficial	Moderate
Snoqualmie Fall			227	10%	Beneficial	Moderate
Green-Duwamish Fall*	-40%	-13,419	4,337	74.6%	Beneficial	Substantial
Lake Washington Fall						
Sammamish	-12%	-49	1	0%	None	None
Cedar	-12%	-67	1	0%	None	None
Puyallup Fall	-27%	-3,990	741	31%	Beneficial	Substantial
White River Spring	-17%	-305	333	23%	Beneficial	Moderate
Nisqually Fall	-55%	-14,746	2,135	190%	Beneficial	Substantial
Mid- Hood Canal Fall	-7%	-55	23	5%	Beneficial	Low
Skokomish Fall	-38%	-7,455	1,133	92%	Beneficial	Substantial
Dungeness Summer	-3%	-12	8	2%	Beneficial	Low
Elwha Summer	-4%	-81	48	2%	Beneficial	Low

	Impacts Relative to Alternative 1 Scenario B					
Summer Chum	Wild Exploitation Rate[4]	Southern U.S.Catch	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Hood Canal	-3%	-214	214	3%	Beneficial	Low
Juan de Fuca	0%	-12	30	0%	None	None

* Populations with specific NMFS-developed standards

[1] Alternative 1 - Alternative 2

[2] (Alternative 1 - Alternative 2) ÷ Alternative 1

[3] See explanation of impact metrics.

[4] Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-10c-1 Performance of Alternative 4 (No Fishing) under Scenario Crelative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	Alternative 4 Scenario C				Performance vs. Recovery Standards		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	14%	1%	6	304	2%		-39%
North Fork				134		-33%	
South Fork				170		-15%	
Skagit Summer-Fall*	33%	1%	105	10,215			
Lower Skagit Fall				1,095	-16%	336%	-50%
Lower Sauk Summer				545	-18%	172%	-20%
Upper Skagit Summer				8,575	-27%	787%	15%
Skagit Spring*	12%	3%	53	1,460			
Upper Cascade				428		152%	
Upper Sauk				492	-26%	278%	49%
Suiattle				541	-29%	218%	35%
Stillaguamish Summer-Fal	8%	2%	35	1,738			
North Fork Summer				1,416	-24%	372%	157%
South Fork Fall				322	-16%	61%	7%
Snohomish Summer-Fall*	10%	3%	244	3,875			
Skykomish Summer				1,989	-18%	21%	-43%
Snoqualmie Fall				1,886		372%	
Green-Duwamish Fall*	19%	5%	1,228	7,367	-34%	782%	33%
Lake Washington Fall		5%					
Sammamish	19%		27	214		7%	-83%
Cedar	19%		13	214		7%	-82%
Puyallup Fall	19%	5%	461	2,293		1047%	91%
White River Spring	2%	1%	14	1,283		542%	28%
Nisqually Fall	17%	8%	1,600	2,330		1065%	112%
Mid- Hood Canal Fall	20%	5%	29	385		93%	-69%
Skokomish Fall	20%	5%	769	1,730		765%	38%
Dungeness Summer	19%	1%	2	251		26%	-73%
Elwha Summer	19%	1%	11	1,516		658%	-48%
All Chinook from Listed Populations			**4,597**	**35,175**			

Hood Canal and Strait of Juan de Fuca Summer Chum				Performance vs Recovery Standards	
	Wild Exploitation Rate [4]	Southern U.S. Catch	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	0.3%	0	7,651	-11%	88%
Juan de Fuca	0.2%	0	6,985	-9%	659%
All Summer Chum		**0**	**14,636**		

* Populations with specific NMFS-developed standards
[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])
[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])
[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}
[4] Excludes Quilcene River population.

Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-10c-2 Performance of Alternative 4 (No Fishing) under Scenario C relative to Alternative 1 Scenario C (Proposed Action).

Puget Sound Chinook	Impacts Relative to Alternative 1 Scenario C					
	Change in Wild Exploitation Rate[1]	Change in Southern U.S. Catch[1]	Change in Natural Escapement[1]	% Change in Natural Escapement[2]	Type of Impact	Magnitude of Impact
Nooksack Early*	-6%	-20	26	9%		
North Fork			11	9%	Beneficial	Low
South Fork			15	9%	Beneficial	Low
Skagit Summer-Fall*	-16%	-2,673	2,182	27%		
Lower Skagit Fall			234	27%	Beneficial	Moderate
Lower Sauk Summer			116	27%	Beneficial	Moderate
Upper Skagit Summer			1,832	27%	Beneficial	Moderate
Skagit Spring*	-11%	-340	129	10%	Beneficial	Moderate
Upper Cascade			38	10%	Beneficial	Moderate
Upper Sauk			43	10%	Beneficial	Moderate
Suiattle			48	10%	Beneficial	Moderate
Stillaguamish Summer-Fal	-9%	-190	118	7%		
North Fork Summer			96	7%	Beneficial	Low
South Fork Fall			22	7%	Beneficial	Low
Snohomish Summer-Fall*	-10%	-1,389	332	9%		
Skykomish Summer			170	9%	Beneficial	Low
Snoqualmie Fall			162	9%	Beneficial	Low
Green-Duwamish Fall*	-30%	-7,957	1,566	27.0%	Beneficial	Moderate
Lake Washington Fall						
Sammamish	-14%	-45	-9	-4%	Negative	Low
Cedar	-14%	-59	-9	-4%	Negative	Low
Puyallup Fall	-31%	-3,311	495	28%	Beneficial	Moderate
White River Spring	-18%	-229	272	27%	Beneficial	Moderate
Nisqually Fall	-47%	-7,944	1,211	108%	Beneficial	Substantial
Mid- Hood Canal Fall	-6%	-36	18	5%	Beneficial	Low
Skokomish Fall	-25%	-3,397	491	40%	Beneficial	Substantial
Dungeness Summer	-3%	-10	6	2%	Beneficial	Low
Elwha Summer	-4%	-59	36	2%	Beneficial	Low

	Impacts Relative to Alternative 1 Scenario C					
Summer Chum	Wild Exploitation Rate[4]	Southern U.S.Catch	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Hood Canal	-3%	-214	214	3%	Beneficial	Low
Juan de Fuca	0%	-12	30	0%	None	None

* Populations with specific NMFS-developed standards
[1] Alternative 1 - Alternative 2
[2] (Alternative 1 - Alternative 2) ÷ Alternative 1
[3] See explanation of impact metrics.
[4] Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-10d-1 Performance of Alternative 4 (No Fishing) under Scenario D relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	Alternative 4 Scenario D				Performance vs. Recovery Standards		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	20%	1%	6	285	8%		-43%
North Fork				125		-37%	
South Fork				160		-20%	
Skagit Summer-Fall*	43%	1%	105	9,625			
Lower Skagit Fall				1,032	-6%	311%	-53%
Lower Sauk Summer				513	-8%	157%	-25%
Upper Skagit Summer				8,080	-17%	736%	8%
Skagit Spring*	17%	3%	54	1,395			
Upper Cascade				409		140%	
Upper Sauk				470	-21%	262%	42%
Suiattle				517	-24%	204%	29%
Stillaguamish Summer-Fa	11%	2%	35	1,702			
North Fork Summer				1,387	-21%	362%	151%
South Fork Fall				315	-13%	57%	5%
Snohomish Summer-Fall*	13%	3%	244	3,720			
Skykomish Summer				1,909	-18%	16%	-45%
Snoqualmie Fall				1,811		353%	
Green-Duwamish Fall*	25%	5%	1,232	7,006	-28%	739%	27%
Lake Washington Fall		5%					
Sammamish	25%		13	204		2%	-84%
Cedar	25%		13	204		2%	-83%
Puyallup Fall	25%	5%	463	2,180		990%	82%
White River Spring	3%	1%	14	1,246		523%	25%
Nisqually Fall	23%	8%	1,630	2,264		1032%	106%
Mid- Hood Canal Fall	28%	5%	29	361		81%	-71%
Skokomish Fall	28%	5%	767	1,622		711%	30%
Dungeness Summer	26%	1%	2	237		19%	-74%
Elwha Summer	26%	1%	11	1,431		616%	-51%
All Chinook from Listed Populations			**4,619**	**33,482**			

Hood Canal and Strait of Juan de Fuca Summer Chum				Performance vs Recovery Standards	
	Wild Exploitation Rate[4]	Southern U.S. Catch	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	0.3%	0	7,651	-11%	88%
Juan de Fuca	0.2%	0	6,985	-9%	659%
All Summer Chum		**0**	**14,636**		

* Populations with specific NMFS-developed standards

1 Calculated as difference of rates ([predicted wild exploiton rate - recovery exploitation rate])

2 Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

3 Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

4 Excludes Quilcene River population.

[shaded box] Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-10d-2 Performance of Alternative 4 (No Fishing) under Scenario D relative to Alternative 1 Scenario D (Proposed Action).

Puget Sound Chinook	Impacts Relative to Alternative 1 Scenario D					
	Change in Wild Exploitation Rate[1]	Change in Southern U.S. Catch[1]	Change in Natural Escapement[1]	% Change in Natural Escapement[2]	Type of Impact	Magnitude of Impact
Nooksack Early*	-6%	-21	33	13%		
North Fork			15	13%	Beneficial	Moderate
South Fork			18	13%	Beneficial	Moderate
Skagit Summer-Fall*	-13%	-2,593	2,074	27%		
Lower Skagit Fall			222	27%	Beneficial	Moderate
Lower Sauk Summer			111	27%	Beneficial	Moderate
Upper Skagit Summer			1,741	27%	Beneficial	Moderate
Skagit Spring*	-11%	-361	125	10%	Beneficial	Moderate
Upper Cascade			37	10%	Beneficial	Moderate
Upper Sauk			42	10%	Beneficial	Moderate
Suiattle			46	10%	Beneficial	Moderate
Stillaguamish Summer-Fa	-9%	-204	118	7%		
North Fork Summer			96	7%	Beneficial	Low
South Fork Fall			22	7%	Beneficial	Low
Snohomish Summer-Fall*	-10%	-1,441	321	9%		
Skykomish Summer			165	9%	Beneficial	Low
Snoqualmie Fall			156	9%	Beneficial	Low
Green-Duwamish Fall*	-26%	-7,536	1,204	20.8%	Beneficial	Moderate
Lake Washington Fall						
Sammamish	-13%	-60	-10	-5%	Negative	Low
Cedar	-13%	-61	-10	-5%	Negative	Low
Puyallup Fall	-25%	-3,001	346	19%	Beneficial	Moderate
White River Spring	-17%	-205	235	23%	Beneficial	Moderate
Nisqually Fall	-43%	-8,084	1,155	104%	Beneficial	Substantial
Mid- Hood Canal Fall	-6%	-38	17	5%	Beneficial	Low
Skokomish Fall	-20%	-2,945	397	32%	Beneficial	Substantial
Dungeness Summer	-3%	-10	6	3%	Beneficial	Low
Elwha Summer	-4%	-60	36	3%	Beneficial	Low

Summer Chum	Impacts Relative to Alternative 1 Scenario D					
	Wild Exploitation Rate[4]	Southern U.S.Catch	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Hood Canal	-3%	-214	214	3%	Beneficial	Low
Juan de Fuca	0%	-12	30	0%	None	None

* Populations with specific NMFS-developed standards

1 Alternative 1 - Alternative 2

2 (Alternative 1 - Alternative 2) ÷ Alternative 1

3 See explanation of impact metrics.

4 Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

4.3.2 Unlisted Salmonid Species

Puget Sound populations of coho, sockeye, pink, chum salmon, and steelhead would also be affected by the Proposed Action or alternatives considered in this Environmental Impact Statement. As noted in Section 3.3, Fish: Affected Environment, chinook and coho salmon from Washington and Oregon coastal populations are infrequently taken in Puget Sound fisheries, and therefore would not be measurably affected. The co-managers aggregate populations of sockeye, coho, pink, chum salmon, and steelhead into seven management units: the Nooksack-Samish, Skagit, Stillaguamish, and Snohomish River management units in North Puget Sound; the South Sound management unit, which includes streams south of the Snohomish; the Hood Canal management unit; and the Strait of Juan de Fuca management unit. The two sockeye salmon management units – the Skagit (Baker) River and South Puget Sound (Cedar River) – are managed to achieve escapement goals. Coho salmon harvest is managed to not exceed exploitation rate ceilings specific to each management unit. These exploitation rate ceilings would be set annually according to the forecast abundance of each management unit, and appropriate to the productivity level implied by the forecast. Pink and chum salmon fisheries are managed to achieve escapement goals for each management unit. Since these coho, chum, sockeye, pink salmon, and steelhead populations are unlisted populations, NMFS has not set Endangered Species Act standards for them. The standards of performance referred to in this Environmental Impact Statement are the exploitation rate ceilings, or escapement goals established by the co-managers beginning with the 2001 management year.

The alternatives considered all assume that river fisheries could remain open from December through March when adult chinook salmon are absent from Puget Sound streams. More than 95 percent of the net harvest of steelhead occurs during this period. The model employed in the analysis is able to account for the relatively small changes in tribal harvest that would occur in late summer and fall fisheries when chinook salmon and summer steelhead presence overlaps. Under Alternative 2 or 3, catch in these fisheries would be reduced relative to Alternative 1. Because such a large part of steelhead harvest occurs between December and March, the effect on catch and escapement of steelhead under Alternative 2 or 3 relative to Alternative 1 would be a low to moderately beneficial impact.

It is important to note that, in the modeling for this impact analysis, the abundance of species other than chinook salmon within the action area was held constant with the base period; that is, the "scenarios" used to simulate variability in abundance and fishing regimes outside the action area were not applied for these species.

4.3.2.1 Alternative 1 – Proposed Action/Status Quo

Impacts to Unlisted Puget Sound Salmon Populations

Under Alternative 1, the modeled total Southern U.S. catch of unlisted salmon species originating from Puget Sound is predicted to be 476,794 coho salmon, 92,850 sockeye salmon, 419,957 pink salmon, and 715,235 fall and winter chum salmon.

Under Alternative 1, escapement of naturally-spawning coho salmon is predicted to be 326,114 fish. As shown in Table 4.3-11, it is predicted that the co-managers' exploitation rate goals would be met under Alternative 1 for all Puget Sound coho salmon management units by margins ranging from 13 to 27 percent. An exploitation rate ceiling has not been established for South Puget Sound coho salmon, but the exploitation rate achieved under Alternative 1 would balance natural spawning capacity and hatchery program objectives.

Under Alternative 1, the escapement of Baker River sockeye salmon is predicted to exceed the goal by almost 300 percent. A recreational and tribal fishery for Cedar River sockeye salmon was modeled under Alternative 1 with a predicted total catch of 92,600 sockeye. Under this Alternative, escapement is predicted to be 17 percent below the goal for the Cedar River (Table 4.3-11).

The escapement of naturally-spawning pink salmon to streams in the seven management units is predicted to be 897,976 fish. Under Alternative 1, escapements of pink salmon are predicted to exceed the goal by a substantial margin for the Nooksack, Skagit, and Snohomish River pink salmon management units, and are predicted to be substantially below the goals for South Puget Sound and Hood Canal. A pink salmon escapement goal is not available for the Strait of Juan de Fuca management unit.

Table 4.3-11 Performance of Alternative 1 (Proposed Action) relative to exploitation rate objectives or escapement goals for coho, sockeye, pink, and fall-winter chum salmon.

						Performance vs Standards	
	Wild Exploitation Rate	Exploit. Rate Objective	Southern U.S. Catch	Natural Escapement	Escapement Goal	Exploitation Rate	Escapement
Coho							
Nooksack/Samish	50%	75%	41,215	8,182		-25%	
Skagit	37%	60%	42,493	73,624		-23%	
Stillaguamish	37%	50%	12,069	24,017		-13%	
Snohomish	33%	60%	76,720	136,873		-27%	
South Sound	55%		246,383	47,086			
Hood Canal	42%	65%	42,909	19,012		-23%	
Juan de Fuca	14%	40%	15,005	17,320		-26%	
All Coho			**476,794**	**326,114**			
Sockeye							
Skagit			250	11,823	3,000		294%
South Sound			92,600	291,916	350,000		-17%
All Sockeye			**92,850**	**303,739**			
Pink							
Nooksack/Samish	7%		7,184	91,988	50,000		84%
Skagit	30%		184,614	430,792	330,000		31%
Stillaguamish	36%		90,690	164,000	155,000		6%
Snohomish	37%		101,193	173,000	120,000		44%
South Sound	9%		1,319	13,283	25,000		-47%
Hood Canal	39%		33,467	20,065	125,000		-84%
Juan de Fuca	35%		1,490	4,848			
All Pink			**419,957**	**897,976**			
Fall Chum							
Nooksack/Samish	56%		54,738	35,610	20,800		71%
Skagit	9%		4,253	42,237	40,000		6%
Stillaguamish	59%		21,577	14,400	13,100		10%
Snohomish	51%		54,284	17,600	10,200		73%
South Sound	68%		361,258	150,923	64,350		135%
Hood Canal	49%		218,987	50,382	39,900		26%
Juan de Fuca	7%		137	2,585	3,600		-28%
All Fall Chum			**715,234**	**313,737**			

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Escapement of naturally-spawning fall and winter chum salmon to streams in the seven management units under Alternative 1 is predicted to be 313,737 fish. Under Alternative 1, escapement is predicted to meet the co-managers' escapement goals by substantial margins for the Nooksack, Snohomish, South Puget Sound, and Hood Canal chum salmon management units, and by low margins for the Skagit and Stillaguamish management units. Escapement of naturally-spawning fall and winter chum salmon is predicted to be substantially less than the goal for the Strait of Juan de Fuca Management Unit (see Table 4.3-11).

4.3.2.2 Alternative 2 – Escapement Goal Management at the Management Unit Level

Impacts to Unlisted Puget Sound Salmon Populations and Comparison to Alternative 1

Under Alternative 2, the modeled total Southern U.S. catch of unlisted salmon species originating from Puget Sound is predicted to be 197,691 coho salmon, zero sockeye salmon, 115,732 pink salmon, and 152,384 fall and winter chum salmon.

As shown in Table 4.3-12a, the co-managers' exploitation rate goals are predicted to be met under Alternative 2 for all Puget Sound coho salmon management units by margins ranging from 26 to 62 percent. Exploitation rates on naturally-spawning coho salmon are predicted to be substantially lower than with Alternative 1, by margins ranging from 24 to 56 percent, while coho escapement is predicted to increase substantially, by margins ranging from 9 to 74 percent (see Table 4.3-12b).

With Alternative 2, Cedar River sockeye salmon fisheries would be closed, with the result that escapement is predicted to increase by approximately 92,600 fish, bringing escapement to slightly over the goal of 300,000. Catch of Baker River sockeye is predicted to be zero. The predicted increase in Cedar River sockeye salmon escapement of approximately 24 percent would constitute a moderate beneficial impact. The increased escapement of Baker River sockeye salmon would constitute a small (low) beneficial impact relative to Alternative 1. Harvest of Puget Sound pink salmon is predicted to decline by more than 339,000 compared to Alternative 1. Spawning escapement to the Nooksack and South Puget Sound management units is predicted to increase by a small margin and by a substantial margin (ranging from 22 to 58 percent) to the Skagit, Stillaguamish, Snohomish, Hood Canal, and Strait of Juan de Fuca units (Table 4.3-12b). As with Alternative 1, escapements are not predicted to meet the escapement goals for the South Sound and Hood Canal management units.

Table 4.3-12a Performance of Alternative 2 relative to exploitation rate objectives or escapement goals for coho, sockeye, pink, and fall-winter chum salmon.

						Performance vs Standards:	
	Wild Exploitation Rate	Exploit. Rate Objective	Southern U.S. Catch	Natural Escapement	Escapement Goal	Exploitation Rate	Escapement
Coho							
Nooksack/Samish	13%	75%	7,386	14,272		-62%	
Skagit	6%	60%	5,019	109,887		-54%	
Stillaguamish	24%	50%	8,024	28,689		-26%	
Snohomish	19%	60%	47,594	165,820		-41%	
South Sound	33%		115,245	69,945			
Hood Canal	12%	65%	7,931	28,533		-53%	
Juan de Fuca	6%	40%	6,492	18,819		-34%	
All Coho			**197,691**	**435,965**			
Sockeye							
Skagit	0%		0	12,073	3,000		302%
South Sound	0%		0	362,292	350,000		4%
All Sockeye			**0**	**237,256**			
Pink							
Nooksack/Samish	0%		0	99,172	50,000		98%
Skagit	0%		0	615,406	330,000		86%
Stillaguamish	21%		54,331	200,360	155,000		29%
Snohomish	0%		34,800	274,192	120,000		128%
South Sound	4%		600	13,999	25,000		-44%
Hood Canal	16%		26,001	27,556	125,000		-78%
Juan de Fuca	15%		0	6,338			
All Pink			**115,732**	**1,237,023**			
Fall Chum							
Nooksack/Samish	1%		1,090	79,482	20,800		282%
Skagit	1%		252	46,071	40,000		15%
Stillaguamish	2%		852	34,194	13,100		161%
Snohomish	0%		239	35,583	10,200		249%
South Sound	16%		83,501	399,761	64,350		521%
Hood Canal	4%		66,448	95,473	39,900		139%
Juan de Fuca	2%		2	2,722	3,600		-24%
All Fall Chum			**152,384**	**693,286**			

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-12b Performance of Alternative 2 (Escapement goal management at the management unit level) relative to Alternative 1 for coho, sockeye, pink, and chum salmon.

	Changes Relative to Alternative 1						
	Wild Exploitation Rate	Southern U.S.Catch	Total Mortality	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Coho							
Nooksack/Samish	-37%	(33829)	(6,151)	6,090	74%	beneficial	substantial
Skagit	-31%	(37474)	(36,580)	36,263	49%	beneficial	substantial
Stillaguamish	-13%	(4045)	(4,782)	4,672	19%	beneficial	substantial
Snohomish	-14%	(29126)	(29,567)	28,947	21%	beneficial	substantial
South Sound	-22%	(131138)	(23,503)	22,859	49%	beneficial	substantial
Hood Canal	-30%	(34978)	(9,662)	9,521	50%	beneficial	substantial
Juan de Fuca	-8%	(8513)	(1,529)	1,499	9%	beneficial	low
All Coho		**(279103)**	**(111774)**	**109851**	34%		
Sockeye							
Skagit		(250)		250			
South Sound		(92600)		70,376			
All Sockeye		**(92850)**		**250**			
Pink							
Nooksack/Samish		(7184)	(7,184)	7,184	8%	beneficial	low
Skagit		(184614)	(184,611)	184,614	43%	beneficial	substantial
Stillaguamish		(36359)	(36,359)	36,360	22%	beneficial	substantial
Snohomish		(66393)	(101,192)	101,192	58%	beneficial	substantial
South Sound		(719)	(716)	716	5%	beneficial	low
Hood Canal		(7466)	(7,491)	7,491	37%	beneficial	substantial
Juan de Fuca		(1490)	(1,490)	1,490	31%	beneficial	substantial
All Pink		**(304225)**	**(339043)**	**339047**	38%		
Fall Chum							
Nooksack/Samish		(53648)	(43,872)	43,872	123%	beneficial	substantial
Skagit		(4001)	(3,834)	3,834	9%	beneficial	low
Stillaguamish		(20725)	(19,789)	19,794	137%	beneficial	substantial
Snohomish		(54045)	(17,983)	17,983	102%	beneficial	substantial
South Sound		(277757)	(248,838)	248,838	165%	beneficial	substantial
Hood Canal		(152539)	(45,091)	45,091	89%	beneficial	substantial
Juan de Fuca		(135)	(137)	137	5%	beneficial	low
All Fall Chum		**(562,850)**	**(379,544)**	**379,549**	121%		

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003

Escapement of most naturally-spawning fall and winter chum salmon management units is predicted to increase by more than 100 percent compared to Alternative 1. As with Alternative 1, chum salmon escapement is predicted to meet the co-managers' escapement goals by substantial margins in all but the Skagit and Strait of Juan de Fuca chum salmon management units. The increase in escapement for the Skagit management unit is predicted to be low compared to Alternative 1, and the Strait of Juan de Fuca management unit is not predicted to meet its escapement goal.

Based on the expected increases in escapement of naturally-spawning fish that are predicted to occur under Alternative 2 relative to Alternative 1, the impacts of Alternative 2 to populations in the two sockeye salmon management units would be beneficial, but low. Impacts to all other populations of coho, fall and winter chum, and pink salmon are predicted to be moderately to substantially beneficial. However, as explained previously, for populations where escapements exceed current goals by substantial margins, the potential for density-dependent decreases in productivity due to competition for mates, food, or territory would be heightened; therefore, natural production by these populations is unlikely to increase in direct proportion to the predicted increase in spawning escapement.

4.3.2.3 Alternative 3 – Escapement Goal Management at the Population Level With Terminal Fisheries Only

Impacts to Unlisted Puget Sound Salmon Populations

Under Alternative 3, the modeled total Southern U.S. catch of unlisted salmon species originating from Puget Sound is predicted to be 157,753 coho salmon, zero sockeye salmon, 26,601 pink salmon, and 151,578 fall and winter chum salmon.

As shown in Table 4.3-13a, the co-managers' exploitation rate goals are predicted to be met under Alternative 2 for all Puget Sound coho salmon management units by margins ranging from 34 to 62 percent. Exploitation rates on naturally-spawning coho salmon are predicted to be substantially lower than with Alternative 1, by margins ranging from 8 to 37 percent, while coho escapement is predicted to increase substantially, by margins ranging from 9 to 74 percent (see Table 4.3-13a).

Table 4.3-13a Performance of Alternative 3 relative to exploitation rate objectives or escapement goals for coho, sockeye, pink, and fall-winter chum salmon.

						Performance vs Standards	
	Wild Exploitation Rate	Exploit. Rate Objective	Southern U.S. Catch	Natural Escapement	Escapement Goal	Exploitation Rate	Escapement
Coho							
Nooksack/Samish	13%	75%	7,386	14,272		-62%	
Skagit	6%	60%	5,019	109,887		-54%	
Stillaguamish	8%	50%	1,908	34,840		-42%	
Snohomish	8%	60%	13,772	187,066		-52%	
South Sound	33%		115,245	69,945			
Hood Canal	12%	65%	7,931	28,533		-53%	
Juan de Fuca	6%	40%	6,492	18,819		-34%	
All Coho			**157,753**	**463,362**			
Sockeye							
Skagit	0%		0	12,073	3,000		302%
South Sound	0%		0	224,422	350,000		-36%
All Sockeye				**236,495**			
Pink							
Nooksack/Samish	0%		0	99,172	50,000		98%
Skagit	0%		0	615,406	330,000		86%
Stillaguamish	0%		0	254,690	155,000		64%
Snohomish	0%		0	274,193	120,000		128%
South Sound	4%		600	13,999	25,000		-44%
Hood Canal	16%		26,001	27,556	125,000		-78%
Juan de Fuca	15%		0	6,338			
All Pink			**26,601**	**1,291,354**			
Fall Chum							
Nooksack/Samish	1%		1,090	79,482	20,800		282%
Skagit	1%		252	46,071	40,000		15%
Stillaguamish	0%		46	34,964	13,100		167%
Snohomish	0%		239	35,583	10,200		249%
South Sound	16%		83,501	399,761	64,350		521%
Hood Canal	4%		66,448	95,473	39,900		139%
Juan de Fuca	2%		2	2,722	3,600		-24%
All Fall Chum			**151,578**	**694,056**			

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

With Alternative 3, Cedar River sockeye salmon fisheries would be closed and escapement is predicted to increase by approximately 92,600 fish, bringing escapement to slightly over the goal of 300,000 (Table 4.3-13a). Catch of Baker River sockeye is predicted to be zero. The predicted increase in Cedar River sockeye escapement by approximately 24 percent would constitute a moderate beneficial impact. The increased escapement of Baker River sockeye would constitute a small (low) beneficial impact relative to Alternative 1 (Table 4.3-13b). Modeled harvest of Puget Sound pink salmon are predicted to decline by more than 393,000 compared to Alternative 1. Spawning escapement is predicted to increase by a small margin in the Skagit and South Puget Sound management units, and by a substantial margin (ranging from 89 to 143 percent) in other management units. As with Alternative 1, pink salmon escapements are not predicted to meet the escapement goals for the South Sound and Hood Canal management units.

Escapement of most naturally-spawning fall and winter chum salmon management units is predicted to increase by more than 100 percent compared to Alternative 1 (Table 4.3-13a). As with Alternative 1, chum salmon escapement is predicted to meet the co-managers' escapement goals by substantial margins in all but the Skagit and Strait of Juan de Fuca management units. The increase in escapement for the Skagit management unit is predicted to be low compared to Alternative 1, and the Strait of Juan de Fuca management unit is not predicted to meet its escapement goal (Table 4.3-13b).

Based on the predicted increases in escapement of naturally-spawning fish that would occur under Alternative 3 relative to Alternative 1, the impacts of Alternative 3 on populations in the two sockeye salmon management units would be beneficial, but low. Impacts to all other populations of coho salmon, fall-winter chum salmon, and pink salmon would be moderately to substantially beneficial. However, as explained previously, for populations where escapements exceed current goals by substantial margins, the potential for density-dependent declines in productivity based on competition for mates, food or territory would be heightened, with the result that natural production by these populations is unlikely to increase proportionate to the predicted increase in spawning escapement.

Table 4.3-13b Performance of Alternative 3 (Escapement goal management at the population level) relative to Alternative 1 for coho, sockeye, pink, and chum salmon.

	Changes Relative to Alternative 1						
	Wild Exploitation Rate	Southern U.S.Catch	Total Mortality	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Coho							
Nooksack/Samish	-37%	(33829)	(6,151)	6,090	74%	beneficial	substantial
Skagit	-31%	(37474)	(36,580)	36,263	49%	beneficial	substantial
Stillaguamish	-29%	(10161)	(10,969)	10,823	45%	beneficial	substantial
Snohomish	-25%	(62948)	(51,002)	50,193	37%	beneficial	substantial
South Sound	-22%	(131138)	(23,503)	22,859	49%	beneficial	substantial
Hood Canal	-30%	(34978)	(9,662)	9,521	50%	beneficial	substantial
Juan de Fuca	-8%	(8513)	(1,529)	1,499	9%	beneficial	low
All Coho		**(319041)**	**(139396)**	**137248**	42%		
Sockeye							
Skagit		(250)		250			
South Sound		(92600)		(67,494)			
All Sockeye		**(92850)**		**250**			
Pink							
Nooksack/Samish		(7184)	(7,184)	7,184	8%	beneficial	low
Skagit		(184614)	(184,611)	184,614	43%	beneficial	substantial
Stillaguamish		(90690)	(90,690)	90,690	55%	beneficial	substantial
Snohomish		(101193)	(101,192)	101,193	58%	beneficial	substantial
South Sound		(719)	(716)	716	5%	beneficial	low
Hood Canal		(7466)	(7,491)	7,491	37%	beneficial	substantial
Juan de Fuca		(1490)	(1,490)	1,490	31%	beneficial	substantial
All Pink		**(393356)**	**(393374)**	**393378**	44%		
Fall Chum							
Nooksack/Samish		(53648)	(43,872)	43,872	123%	beneficial	substantial
Skagit		(4001)	(3,834)	3,834	9%	beneficial	low
Stillaguamish		(21531)	(20,564)	20,564	143%	beneficial	substantial
Snohomish		(54045)	(17,983)	17,983	102%	beneficial	substantial
South Sound		(277757)	(248,838)	248,838	165%	beneficial	substantial
Hood Canal		(152539)	(45,091)	45,091	89%	beneficial	substantial
Juan de Fuca		(135)	(137)	137	5%	beneficial	low
All Fall Chum		**(563,656)**	**(380,319)**	**380,319**	121%		

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003

4.3.2.4 Alternative 4 – No Action/No Authorized Take

Impacts to Unlisted Puget Sound Salmon Populations

Under Alternative 4, the modeled Southern U.S. catch of unlisted salmon species originating from Puget Sound is 70,260 coho salmon, zero sockeye salmon, 6,459 pink salmon, and 38,877 fall and winter chum salmon. The predicted catch would be the same under all scenarios.

Under Alternative 4, the No Authorized Take alternative, catch of unlisted salmonids would be limited to terminal areas when naturally-spawning chinook salmon are absent. The effect of Alternative 4 is predicted to be a further reduction in catch and exploitation rates, with further increases in escapement of both natural- and hatchery-origin salmonids compared to Alternative 2 or 3. The exploitation rates on coho salmon populations are predicted to decline to 6 to 8 percent. These rates are predicted to be lower than with Alternative 1 by substantial margins (25 to 49%) (Table 4.3-14b). Spawning escapement is predicted to increase substantially (by 168,000 for all management units) relative to Alternative 1. Exploitation rate goals are predicted to be met for all management units, by margins ranging from 34 to 68 percent (see Table 4.3-14a). With Alternative 4, Cedar River sockeye salmon fisheries would be closed and escapement is predicted to increase by approximately 92,600 fish, bringing escapement to slightly more than the goal of 300,000. Baker River sockeye salmon catch is predicted to be zero. The predicted increase in Cedar River sockeye escapement by approximately 24 percent would constitute a moderate beneficial impact. The increased escapement of Baker River sockeye would constitute a small (low) beneficial impact relative to Alternative 1.

Under Alternative 4, exploitation rates in Puget Sound fisheries for pink salmon are predicted to be zero for the Nooksack, Skagit, Stillaguamish, Snohomish, and South Puget Sound management units. Spawning escapement is predicted to increase by a low amount for the Nooksack and South Sound management units, and substantially for the Skagit, Stillaguamish, Snohomish, Hood Canal, and Strait of Juan de Fuca management units, compared to the outcome of Alternative 1 (Table 4.3-14b). As with Alternative 2 or 3, it is predicted that escapement goals for pink salmon would be substantially exceeded. Also as with Alternative 2 or 3, although escapements would increase for the South Puget Sound and Hood Canal pink salmon management units, the escapement goals still would not be met.

Table 4.3-14a Performance of Alternative 4 relative to exploitation rate objectives or escapement goals for coho, sockeye, pink, and fall-winter chum salmon.

						Performance vs Standards	
	Wild Exploitation Rate	Exploit. Rate Objective	Southern U.S. Catch	Natural Escapement	Escapement Goal	Exploitation Rate	Escapement
Coho							
Nooksack/Samish	7%	75%	2,463	15,305		-68%	
Skagit	6%	60%	6,409	110,022		-54%	
Stillaguamish	8%	50%	5,205	34,840		-42%	
Snohomish	8%	60%	1,910	187,066		-52%	
South Sound	6%		13,784	97,804			
Hood Canal	7%	65%	33,886	30,345		-58%	
Juan de Fuca	6%	40%	6,603	18,819		-34%	
All Coho			**70,260**	**494,201**			
Sockeye							
Skagit	0%		0	12,073	3,000		302%
South Sound	0%		0	224,422	350,000		-36%
All Sockeye				**236,495**			
Pink							
Nooksack/Samish	0%		0	99,172	50,000		98%
Skagit	0%		0	615,406	330,000		86%
Stillaguamish	0%		0	254,690	155,000		64%
Snohomish	0%		0	274,193	120,000		128%
South Sound				14,596	25,000		-42%
Hood Canal	10%		6,459	47,387	125,000		-62%
Juan de Fuca	15%		0	6,338			
All Pink			**6,459**	**1,311,782**			
Fall Chum							
Nooksack/Samish	1%		1,066	79,501	20,800		282%
Skagit	1%		252	46,071	40,000		15%
Stillaguamish	0%		46	34,964	13,100		167%
Snohomish	0%		239	35,583	10,200		249%
South Sound	7%		36,912	441,499	64,350		586%
Hood Canal			360	99,621	39,900		150%
Juan de Fuca	2%		2	2,722	3,600		-24%
All Fall Chum			**38,877**	**739,961**			

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-14b Performance of Alternative 4 (No Fishing) relative to Alternative 1 for coho, sockeye, pink, and chum salmon.

	Changes Relative to Alternative 1						
	Wild Exploitation Rate	Southern U.S.Catch	Total Mortality	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Coho							
Nooksack/Samish	-43%	(38752)	(7,185)	7,123	87%	beneficial	substantial
Skagit	-31%	(36084)	(36,715)	36,398	49%	beneficial	substantial
Stillaguamish	-29%	(6864)	(10,969)	10,823	45%	beneficial	substantial
Snohomish	-25%	(74810)	(51,002)	50,193	37%	beneficial	substantial
South Sound	-49%	(232599)	(51,361)	50,718	108%	beneficial	substantial
Hood Canal	-35%	(9023)	(11,473)	11,333	60%	beneficial	substantial
Juan de Fuca	-8%	(8402)	(1,529)	1,499	9%	beneficial	low
All Coho		**(406534)**	**(170234)**	**168087**	52%		
Sockeye							
Skagit		(250)		250			
South Sound		(92600)		(67,494)			
All Sockeye		**(92850)**		**250**			
Pink							
Nooksack/Samish		(7184)	(7,184)	7,184	8%	beneficial	low
Skagit		(184614)	(184,611)	184,614	43%	beneficial	substantial
Stillaguamish		(90690)	(90,690)	90,690	55%	beneficial	substantial
Snohomish		(101193)	(101,192)	101,193	58%	beneficial	substantial
South Sound		(1319)	(1,313)	1,313	10%	beneficial	low
Hood Canal		(27008)	(7,597)	27,322	136%	beneficial	substantial
Juan de Fuca		(1490)	(1,490)	1,490	31%	beneficial	substantial
All Pink		**(413498)**	**(394077)**	**413806**	46%		
Fall Chum							
Nooksack/Samish		(53672)	(43,891)	43,891	123%	beneficial	substantial
Skagit		(4001)	(3,834)	3,834	9%	beneficial	low
Stillaguamish		(21531)	(20,564)	20,564	143%	beneficial	substantial
Snohomish		(54045)	(17,983)	17,983	102%	beneficial	substantial
South Sound		(324346)	(290,576)	290,576	193%	beneficial	substantial
Hood Canal		(218627)	(49,240)	49,239	98%	beneficial	substantial
Juan de Fuca		(135)	(137)	137	5%	beneficial	low
All Fall Chum		**(676,357)**	**(426,225)**	**426,224**	136%		

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003

Fall and winter chum salmon harvest under Alternative 4 is predicted to be about 39,000, a decrease relative to Alternative 1 of 676,357. Escapements of naturally-spawning fall and winter chum salmon are predicted to increase substantially – by 426,224 fish under Alternative 4, or more than 100 percent of the escapement goals for the Nooksack, Stillaguamish, Snohomish, Mid-Hood Canal, and South Puget Sound units. However, it is predicted that the escapement goal for the Strait of Juan de Fuca unit, for which the run size entering Puget Sound is predicted to be below the escapement goal, would not be achieved (see Table 4.3-14b).

Based on the predicted increases in escapement of naturally-spawning fish that would occur under Alternative 4 relative to Alternative 1, the impact of Alternative 4 on escapements of sockeye salmon, Nooksack-Samish and South Sound pink salmon, and Skagit and Strait of Juan de Fuca chum salmon are predicted to be beneficial, but of low magnitude. Impacts to all other populations of coho, fall-winter chum, and pink salmon are predicted to be substantially beneficial. However, as discussed above, escapement far in excess of current escapement goals raises the potential of intra- and inter-specific density-dependent reductions in productivity due to competition for mates, food or territory. For many coho salmon management units, exploitation rate objectives are based on stock recruit functions which would predict that large increases in escapement would not result in substantial increases in progeny (personal communication via e-mail from William Beattie, Northwest Indian Fisheries Commission, Conservation Management Coordinator, to The William Douglas Company, February 17, 2004).

4.3.3 Non-Salmonid Fish Species

Unlisted non-salmonid fish species potentially affected by the Proposed Action include the groundfish and forage fish species discussed in Subsections 3.3.3, Non-Salmonid Fishes (Groundfish): Affected Environment, and 3.3.4, Forage Species (Pacific Herring, Sandlance, Smelt): Affected Environment. Impacts of the Proposed Action or alternatives to groundfish species would result from changes in the incidental catch of these species in marine salmon fisheries. Impacts to forage fish species would be related to possible changes in the predator-prey relationship resulting from changes in the marine abundance of salmon.

According to Palsson (2002), marine salmon anglers take approximately 0.65 groundfish per trip. Therefore, with Alternative 1, the incidental catch of groundfish species in sport salmon fisheries is predicted to be approximately 241,765 groundfish, based on the area-wide average catch per trip. Species comprising the recreational catch include Pacific halibut, other flatfish, lingcod, rockfish

(*Sebastes spp.),* Pacific cod, and dogfish, but the species composition of groundfish caught incidentally during salmon fishing has not been quantified. Under Alternative 1, it is likely that sportfishing effort would vary somewhat under the different scenarios, but it is difficult to predict how that variability would affect the incidental catch of groundfish.

Under Alternative 2, 3, or 4 there would be no marine sport fisheries in Puget Sound, so incidental catch of groundfish would be reduced by 100 percent with either of these alternatives. As discussed in Subsection 3.3.3, commercial fisheries targeting salmon attempt to avoid incidental harvest of groundfish species, and landings of groundfish species in commercial salmon fisheries are rarely reported.

Under Alternative 2, most commercial salmon fisheries in marine areas would be closed (the marine fisheries that would occur under Alternative 2 are nearshore using beach seines or set gillnets and therefore are anticipated to have a negligible impact on groundfish), and under Alternative 3 or 4, all commercial salmon fisheries in marine areas would be closed. Therefore, incidental catch of groundfish under either of these alternatives would be eliminated relative to Alternative 1. This would represent a substantial beneficial impact to these species. Chinook and coho salmon are key predators of sandlance, herring, and smelt, the predominant forage fish species present in Puget Sound. Sockeye, chum and pink salmon, particularly as juveniles, feed predominately on small, free-swimming crustacea, but adults occasionally feed on forage fish species. The direct impacts of the Proposed Action or alternatives would be related to reductions in catch under Alternative 2, 3, or 4 that would potentially increase predation by adult salmon on these forage fish species during the period in which fisheries would otherwise take place. Other effects would be indirect in nature, and are discussed below in Subsection 4.3.8, Indirect and Cumulative Effects.

4.3.4 Fish Habitat

The primary impacts of salmon fisheries on fish habitat occur as a result of tribal and sport fisheries in river areas, and include disruptions of spawning beds by wading fishermen and boat traffic, and, to a lesser extent, degradation of streamside habitat. As required by the Magnuson-Steven's Conservation and Management Act, NMFS conducted an essential fish habitat (EFH) consultation on the 2003 4(d) determination and concluded that Alternative 1 (the Proposed Action) would not adversely affect designated EFH for chinook salmon. NMFS is currently conducting an EFH consultation on the ~~2004~~ 2005–2009 4(d) determination that will be complete for the Final Environmental Impact Statement. However, since the anticipated fishery structure of the Proposed Action is similar to that of the 2003 fisheries Resource Management Plan, the effects on EFH are also likely to be similar. Therefore, at this time, NMFS does not anticipate Alternative 1 will adversely affect designated EFH. Fisheries modeled under Alternatives 2 and 3 are predicted to increase the level of fishing effort in freshwater areas and, potentially, would result in a possible low adverse impact on fish habitat. Fisheries modeled under Alternative 4 are predicted to decrease fishing effort in freshwater areas relative to Alternative 1, and are therefore predicted to eliminate the potential impact to fish habitat from these sources and would thus be considered to have a no to low beneficial impact. However, regardless of the alternative considered, these effects would occur to some degree through the occurrence of fisheries other than those addressed in Alternative 1 (the Proposed Action); e.g., recreational freshwater trout or steelhead fisheries, that do not take listed Puget Sound salmon species.

4.3.5 Marine-Derived Nutrients from Spawning Salmon

The input of nutrients into freshwater systems associated with the return of adult salmon is, at the simplest level, directly related to the biomass of spawners of all species. However, as described in Affected Environment (Subsection 3.3.6, Marine-Derived Nutrients from Spawning Salmon), the processes by which juvenile chinook and other species benefit directly and indirectly from this source of nutrients comprise a highly complex transport web.

~~Nutrients provided by adult salmon to freshwater systems are, at the simplest level, directly related to the biomass of spawners of all species. However, as described in the Affected Environment (Subsection 3.3.5, Marine-Derived Nutrients from Spawning Salmon), highly complex processes determine how juvenile chinook salmon and other species benefit directly and indirectly from this source of nutrients.~~

This subsection refers to the modeled spawning escapement of all salmon species, converted to carcass biomass predicted to result from implementation of the Proposed Action or alternative harvest management regimes, and assesses the nutrient-related effects on the production and survival of juvenile chinook. At the current state of scientific inquiry in this field, variability in the factors affecting salmon-derived nutrient loading; and the state of technical tools necessary to quantify nutrient loading, it is not possible to quantify nutrient loading in any one Puget Sound river system, or to measure the differences in growth and survival of juvenile chinook in a system that would result from different spawner abundance of all salmon species.

~~in any one Puget Sound river system, or the differences in growth and survival of juvenile chinook in a system that would result from different spawner abundance of all salmon species, are not available.~~

~~Nutrient loading is affected by spawner density, which varies greatly among species and river reaches, and by stream flow, water temperature, stream channel structure, and a multitude of other factors that affect carcass and nutrient availability, decomposition, and retention (see Subsection 3.3.5, Marine-Derived Nutrients from Spawning Salmon: Affected Environment).~~

The following analysis compares adult salmonid escapement and spawner biomass among alternatives for Scenario B, because this scenario is the most likely combination of chinook abundance and fisheries to occur over the duration of the Proposed Action. The variability in escapement associated with the other Canadian/Alaskan fishery and abundance scenarios (A, C, or D) is noted, but does not influence the relative magnitude of the potential impact of the alternatives.

It must be noted that added nutrients, above current levels, may not be desirable in all streams. The Washington Department of Ecology reports that more than 2,600 bodies of water throughout Washington are listed under Section 303(d) of the Clean Water Act as Category 5, "polluted." For those waters, and others with lesser water quality problems, increased nutrient loads may not provide a benefit to fish and wildlife. Lackey (2003) reminds us that federal and state legislation has, for many years, focused on reducing the nutrient and toxic pollutant input associated with human development, so intentionally managing salmonids to increase nutrient input has complex implications for public policy.

4.3.5.1 Alternative 1 – Proposed Action/Status Quo

To compare the consequences of the Proposed Action or alternatives, the biomass of spawning salmon is compared for ~~four~~ three river systems – the Skagit River, Snohomish River, and Stillaguamish River~~, and the Green-Duwamish River~~. These systems offer examples that contrast the variation in total spawner biomass in different systems, and the contribution of chinook salmon to total spawner biomass. For this analysis, biomass was approximated from modeled escapements and average weights for each species (i.e., 15 pounds for chinook, 12 pounds for chum, 6 pounds for coho, and 4 pounds for pink salmon) (personal communication with Robert Hayman, Skagit Systems Cooperative, Salmon Recovery Biologist, August 19, 1999). Sockeye salmon are not included in this accounting, because they spawn only in the Baker River drainage of the Skagit basin and in the Cedar River (Lake Washington system), and therefore are not broadly representative of the species composition in Puget Sound watersheds with spawning salmon. Salmon escapement in other river systems in Puget Sound varies from that in the three example watersheds. Pink salmon are not generally abundance, except in the Nooksack River, and recently in the Green River, whereas chum salmon are widely distributed and spawn in large and small river and stream systems.

Under Alternative 1, the co-managers' proposed harvest plan, total spawner biomass is projected to exceed 2.86 million pounds in the Skagit River system, 1.80 million pounds in the Snohomish River system, and 1.01~~0~~ million pounds in the Stillaguamish River system~~, and 0.15 million pounds in the Green-Duwamish River system~~ (Table 4.3.5-1). In the Skagit, Stillaguamish, and Snohomish River systems, chinook salmon contribute a small proportion (i.e., 4% to 7%) of the total biomass, while coho, pink, and chum salmon each comprise much larger proportions. ~~By contrast, in the Green-Duwamish River, coho and chum salmon escapement is relatively low, but chinook salmon comprise 59 percent of total spawner biomass.~~ Hatchery-origin chinook salmon comprise a relatively small proportion of chinook salmon escapement ~~to~~in the Skagit~~, Stillaguamish,~~ and Snohomish River systems~~, but a large proportion of chinook salmon escapement to the Green-Duwamish River system,~~ but have contributed up to 55 percent in the North Fork of the Stillaguamish River. Chinook spawning escapement is predicted to vary from 3 percent higher to 24 percent lower than Scenario B[xiii], if abundance and Canadian/Alaskan fisheries varies as specified in Scenarios A, C, or D. Total spawning escapement would also vary with changes in overall abundance and Canadian/Alaskan fisheries harvest levels, but information is not currently available to quantify the amount.

Table 4.3.5-1 Biomass (pounds) of spawning salmon in the Skagit, Snohomish, and ~~Green~~ ~~r~~Stillaguamish Rivers, under Alternative 1.

	Chinook	Coho	Pink	Chum	Total
Skagit	193,104	441,744	1,723,168	506,840	2,864,856
Snohomish	73,511	821,238	692,000	211,200	1,797,949
Stillaguamish	34,215	144,102	656,000	172,800	1,007,117

~~Chinook~~	~~Coho~~	~~Pink~~	~~Chum~~	~~Total~~
~~203,310~~	~~441,744~~	~~1,723,168~~	~~506,840~~	~~2,875,061~~
~~76,089~~	~~821,238~~	~~692,000~~	~~211,200~~	~~1,800,527~~
~~87,285~~	~~42,377~~	~~0~~	~~18,111~~	~~147,773~~
~~34,830~~	~~144,102~~	~~656,000~~	~~172,800~~	~~1,007,732~~

The extent to which these escapements promote or constrain the productivity of natural chinook salmon populations cannot be quantified, due to factors discussed above and the lack of basin-specific empirical understanding of the relationship between escapement, nutrient loading, and salmon productivity. Intuitively, any factor that increases the growth rate of juvenile chinook salmon could, potentially, increase their survival through their freshwater, estuarine, and early marine life stages, but this effect has not been empirically demonstrated for Puget Sound chinook. Chinook populations that characteristically produce high proportions of yearling smolts will be more likely to benefit, given their

[xiii] Spawning escapements projected to occur under Alternative 1 may vary substantially from the example provided above for some systems in some years. In the Skagit system, for example, total spawner biomass ranged from 1.0 to 5.2 million pounds in 1998 – 2002 (personal communication with Robert Hayman, Skagit River System Cooperative, August 2003). Units for which harvest is managed under exploitation rate objectives are predicted to experience variable escapement, increasing or decreasing in direct relation to total abundance. For some units managed under escapement goals, recent experience suggests that escapement may also exceed goals depending on abundance, but less so than under exploitation rate management since all abundance above the goal is considered available for harvest.

extended freshwater residence, as is predicted to juvenile coho salmon and steelhead, all of which reside in freshwater for more than one year before smolting. However, ocean-type chinook populations, and pink and chum salmon, might also benefit from increased nutrient loading, particularly if it increases prey availability in estuarine areas.

If nutrient loading currently imposes a primary constraint on juvenile salmon survival, then the consequences of Alternative 1 are predicted to maintain the status quo in this regard. If production and availability of the ~~Nutrient-related constraint of productivity rests on the assumption that the~~ preferred prey of juvenile coho salmon is limited by current nutrient loading from salmon carcasses~~such that, at some point in their early life history~~, the growth and survival of juvenile salmon is reduced under current conditions. This hypothesis is supported for some salmon species by numerous studies that consistently show increased growth rates among juvenile coho and steelhead when carcass loading is increased (Bilby et al. 1998; and Wipfli et al. 1999). However, information is insufficient to identify in which populations of Puget Sound chinook, or other salmon species, survival might be affected.

If habitat conditions or other physical and biotic factors currently limit survival, maintaining recent escapements will have little or no effect on chinook productivity. For example, circumstantial evidence suggests this is the case in the Skagit River. The magnitude of peak river flow during the chinook incubation period, presumably due to increased risk of scour and sediment deposition in spawning areas, has correlated very closely with ~~Age-0~~ chinook smolt production (Seiler et al. 2002 and 2000). There is no odd-even year pattern of chinook smolt abundance or survival rate, as is predicted to be expected if the observed variation in pink salmon carcass loading affected chinook survival. Though such an effect is predicted to be statistically difficult to detect, given the overwhelming influence of incubation period flow, there is no significant correlation between chinook salmon smolt abundance and escapement of other species, even when the effects of flow are taken into account (personal communication with Robert Hayman, Skagit River System Cooperative, Salmon Recovery Planner, August 19, 1999).

This hypothesis will continue to be tested when the productivity of systems in which salmon escapement has recently increased substantially is reassessed. Under Alternative 1, such monitoring is required, and adjustment of management objectives is mandated, if studies determine that the productivity of chinook or other salmon species is nutrient-limited.

Implementation of Alternative 1 would also maintain current conditions among the wide variety of other aquatic and terrestrial species that feed directly on carcasses or utilize marine derived nutrients. Because the abundance of returning salmon varies annually, their potential nutrient contribution will also vary over the short term from the baseline level examined in this assessment. Direct consumers of carcasses – aquatic invertebrates, fish, mammals, and birds – will experience this annual fluctuation in abundance, whereas indirect plant or animal consumers will be less affected because these nutrients are stored and re-cycled within the local trophic web. This assessment cannot practically examine the range of possible effects of Alternative 1 on all fish and wildlife species that utilize marine derived nutrition. Ignoring, for the moment, the likelihood of annual variation in salmon escapement, the current level of carcass nutrient will persist under Alternative 1, so major changes in the distribution and abundance of consumer species is not anticipated.

4.3.5.2 Alternative 2 – Escapement Goal Management at the Management Unit Level

Under Alternative 2, Scenario B, total salmon spawner biomass is predicted to be 3.91 million pounds in the Skagit River (37~~6~~% higher than with Alternative 1), 1.84 million pounds in the Snohomish system (2% higher than with Alternative 1), and 1.40 million pounds in the Stillaguamish River system (39% higher than with Alternative 1)~~, and 0.20 million pounds in the Green-Duwamish River system (34% higher than with Alternative 1)~~ (Table 4.3.5-2)[xiv].

Assuming no scouring floods and sufficient carcass retention time, a broader distribution of carcasses throughout the river system might enhance primary and secondary ~~local~~ production (e.g., increase the production of aquatic algae, some riparian plant species, and invertebrate consumers at lower trophic levels)~~vity~~. Detailed analysis of spawner distribution is not available for this assessment; however, it may be possible that the predominant abundance of pink and chum spawners is predicted to be sufficient to supply the nutrients essential to the production of salmon prey species. This assumes that the carcasses are retained, and that marine-derived nutrients drive production of prey in habitat that is utilized by juvenile chinook salmon. However, increase in spawner abundance~~presence of carcasses~~, and resultant higher productivity, might ~~be inhibited by~~not result in higher survival of juvenile salmon if other habitat factors, such as incubation period flows or the availability of suitable spawning or rearing habitat limits survival. If, on the other hand, habitat is not limiting, Alternative 2 could have a beneficial effect on nutrient loading and subsequent production. ~~Therefore, a~~Although spawner biomass is predicted to be substantially higher with Alternative 2 compared to Alternative 1 for all~~ of~~

[xiv] Note, however, that these increases in total spawner biomass, comprise fewer spawners of some species (e.g., fewer chinook and/or coho in the Stillaguamish and Snohomish systems). Because species are distributed differently in the watersheds, their nutrient inputs, and effects, will not be equal, pound for pound.

three ~~the four~~ of the example systems, it is not possible for these reasons to predict the difference in effects on the productivity of chinook salmon or other species.

Table 4.3.5-2 Biomass (pounds) of spawning salmon in the Skagit, Snohomish, and ~~Green~~ Stillaguamish ~~r~~Rivers, under Alternative 2.

	Chinook	Coho	Pink	Chum	Total
Skagit	239,163	659,322	2,461,623	552,851	3,912,959
Snohomish	69,046	244,914	1,096,771	426,993	1,837,725
Stillaguamish	13,560	172,134	801,439	410,333	1,397,467

~~Chinook~~	~~Coho~~	~~Pink~~	~~Chum~~	~~Total~~
~~250,956~~	~~659,322~~	~~2,461,623~~	~~552,851~~	~~3,924,752~~
~~82,123~~	~~1,122,396~~	~~1,096,771~~	~~426,993~~	~~2,728,284~~
~~87,000~~	~~62,951~~	~~0~~	~~47,971~~	~~197,922~~
~~37,020~~	~~209,040~~	~~1,018,762~~	~~419,565~~	~~1,684,387~~

For chinook salmon populations that would be managed under exploitation rate objectives with Alternative 1 (i.e., the Skagit, Stillaguamish, and Snohomish management units), changing to escapement goal management is predicted to result in more stable numbers of spawners, provided that these goals were consistently achieved. This outcome is predicted to depend on accurate forecasting methods and low management error (see Subsection 4.3.8, Indirect and Cumulative Effects). The objectives for populations for which harvest is already managed to achieve escapement goals is predicted to not change with Alternative 2, but under the Puget Sound chinook abundance scenarios considered by this review, escapement goal management is predicted to virtually preclude marine harvest. Spawning escapement relative to Alternative 1 is predicted to increase as a result, particularly where terminal fisheries could not completely harvest the surplus of all species.

The abundance and production of other aquatic and terrestrial species that feed directly on salmon carcasses and eggs, or utilize marine-derived nutrients, is likely to increase under Alternative 2. Higher spawner abundance will increase the local abundance of avian and mammalian predators, as they are attracted to spawning streams. Many studies (see Subsection 3.3.6) indicate that production of aquatic invertebrates will increase, and provide more food for their predators. Effects could be manifest as increased over-winter survival and increased productivity in subsequent years for many species. Quantifying these effects is not possible in this assessment, because baseline abundance and production, or increase, has not been measured at the watershed or population scale for affected species. Again, this conclusion rests on the assumption that other environmental factors not constraining their survival and production.

4.3.5.3 Alternative 3 – Escapement Goal Management at the Population Level with Terminal Fisheries Only

The spawning biomass for all species of salmon, and resultant nutrient loading, is predicted to increase substantially relative to Alternative 1, if Alternative 3 were implemented. Under Alternative 3, total biomass of spawning salmon is predicted to be 3.91 million pounds, or 36 percent higher in the Skagit River system~~,–~~, 2.73 million pounds or 52 percent higher in the Snohomish River system, and 1.68 million pounds, or 67 percent higher in the Stillaguamish River system~~, and 34 percent higher in the Green-Duwamish River system~~, relative to Alternative 1 (Table 4.3.5-3). ~~As with Alternative 2,~~T~~ the contribution of chinook salmon to total nutrient loading is predicted to be slightly less than with Alternative 1, because the virtual closure of all marine-area fisheries is predicted to result in proportionately greater escapement of other species~~hese total biomass estimates comprise higher escapement levels of all species in each of the three example rivers than under Alternative 1, but particularly higher abundance of coho, pink and chum salmon.

The effect of the projected increase in total salmon escapement on the productivity of chinook or other salmon species in these example systems, or within the Puget Sound ESU in general, cannot be quantified with current information due to the degree of variability in the environmental factors discussed above. As described above, juvenile chinook salmon with extended freshwater rearing (particularly those that smolt as yearlings) are predicted to be more likely to benefit from Alternative 3. But the nutrient loading (i.e., carcass density) thresholds necessary to support optimal primary and secondary productivity have not been determined for any Puget Sound basin. Therefore, the consequences to individual populations of implementing Alternative 3 are unknown, and are predicted to vary among different river systems. Also, if current habitat conditions create a primary constraint on system capacity and productivity, any beneficial effects of increased spawner abundance and nutrient loading may be offset by increased competition for suitable spawning habitat, redd superimposition, or overcrowding of rearing habitat. If, on the other hand, habitat is not limiting, Alternative 3 could have a beneficial effect on nutrient loading and subsequent production. Therefore, although spawner biomass is predicted to be substantially higher compared to Alternative 1 for all~~ four~~ three of the example systems, it is not possible for these reasons to predict the difference in effects on the productivity of chinook salmon or other species.

Table 4.3.5-3 Biomass (pounds) of spawning salmon in the Skagit, Snohomish, and ~~Green~~ Stillaguamish ~~r~~Rivers, under Alternative 3.

	Chinook	Coho	Pink	Chum	Total
Skagit	239,182	659,322	2,461,623	552,851	3,912,978
Snohomish	80,514	1,122,396	1,096,771	426,993	2,726,675
Stillaguamish	36,690	209,040	1,018,762	419,565	1,684,057

The beneficial effects of implementing Alternative 3 on other aquatic and terrestrial species cannot be quantified, but the qualitative effects, discussed under Alternative 2 above, might also result under Alternative 3.

~~Chinook~~	~~Coho~~	~~Pink~~	~~Chum~~	~~Total~~
~~250,937~~	~~659,322~~	~~2,461,623~~	~~552,851~~	~~3,924,734~~
~~69,514~~	~~244,914~~	~~1,096,771~~	~~426,993~~	~~1,838,192~~
~~87,000~~	~~62,951~~	~~0~~	~~47,971~~	~~197,922~~

~~13,545~~	~~172,134~~	~~801,439~~	~~410,333~~	~~1,397,452~~

4.3.5.4 Alternative 4 – No Action/No Authorized Take

Preclusion of all fisheries that harvest listed chinook salmon, as envisioned under Alternative 4, is predicted to result in substantially higher spawning escapement of all salmon species, and possibly substantially higher nutrient loading than is predicted to occur with Alternative 1. Total spawner biomass in the three example river systems is predicted to be virtually identical to that predicted under Alternative 3, i.e., 37 percent higher in the Skagit River system, 52 percent higher in the Snohomish River system, and 67 percent higher in the Stillaguamish River system~~, and 98 percent higher in the Green-Duwamish River system~~, compared to Alternative 1 (Table 4.3.5-4).

As noted in the preceding discussion, the effects of higher spawner biomass cannot be assumed to increase the productivity of chinook or other salmon species. Increases in productivity are predicted to be expected where nutrient input now limits prey availability, with consequent effect on the growth and survival of juvenile salmon. Increase in survival is predicted to only be realized if other habitat constraints on survival were addressed. Competition for suitable spawning areas, and other density-dependent factors may also counteract the potential nutrient-related benefit to growth and survival of juvenile chinook salmon. Therefore, although spawner biomass is predicted to be substantially higher with Alternative 4 compared to Alternative 1 for all ~~four~~ three of the example systems, it is not possible for these reasons to predict the difference in effects on the productivity of chinook salmon or other species.

Table 4.3.5-4 Biomass (pounds) of spawning salmon in the Skagit, Snohomish, and ~~Green~~ ~~r~~Stillaguamish Rivers, under Alternative 4.

	Chinook	Coho	Pink	Chum	Total
Skagit	239,182	660,132	2,461,623	552,851	3,913,788
Snohomish	80,514	1,122,396	1,096,771	426,993	2,726,675
Stillaguamish	36,690	209,040	1,018,762	419,565	1,684,057

~~Chinook~~	~~Coho~~	~~Pink~~	~~Chum~~	~~Total~~
~~250,956~~	~~660,132~~	~~2,461,623~~	~~552,851~~	~~3,925,562~~
~~82,562~~	~~1,122,396~~	~~1,096,771~~	~~426,993~~	~~2,728,723~~
~~158,370~~	~~88,024~~	~~0~~	~~52,980~~	~~299,374~~

~~37,020~~	~~209,040~~	~~1,018,762~~	~~419,565~~	~~1,684,387~~

4.3.6 Selectivity on Biological Characteristics of Salmon

Puget Sound fisheries regimes would vary substantially between the Proposed Action and alternatives considered in this Environmental Assessment, with respect to their selective effects on target species. This section qualitatively compares their effects, focusing on chinook salmon since that is the subject of the Proposed Action. It must be stated at the outset that a quantitative or theoretical analysis of the selective effects of current or historical fishing regimes has not been done in Puget Sound, except on a limited basis (Hard 2004 and as described in Subsection 3.3.7). As described in the Affected Environment (Subsection 3.3.7), long-time series of data describing the age composition and size of chinook salmon in catch and on the spawning grounds exist for many Puget Sound chinook salmon populations. However, the quality of the data vary greatly from population to population. Better data generally exist for returns to hatcheries. The causes for observed variation or trends in these biological characteristics are highly complex and confounded with each other, as discussed in Subsection 3.3.7. Although there is some indication that fisheries may be responsible for some proportion of the trends in size-at-age observed for some Puget Sound chinook populations, ~~T~~the influence of fisheries selectivity on variation and trends cannot be isolated from environmental and other causes. Furthermore, historical data reflect a constantly-changing fishing regime in fisheries inside and outside of Washington, particularly during the last decade (1991–2001). The selective effects of historically higher fishing pressure, for all gear types, are likely to have declined substantially as exploitation rates on Puget Sound chinook salmon have fallen (PSIT and Washington Department of Fish and Wildlife 2004). The relative harvest rates exerted by different gear types, and the distribution of effort by different gear types, have changed dramatically over the last 30 years. Furthermore, fishing regimes like those envisioned under Alternative 2 or 3 have never existed in Puget Sound, so their effects are necessarily a matter of conjecture.

Review of the scientific literature (discussed in Subsection 3.3.7) suggests that Puget Sound fisheries would exert some degree of selectivity on the size- or age-composition of chinook salmon, but available data do not indicate any changes or trends in the age composition of catch or escapement over the last several decades. As discussed in Subsection 3.3.7, the available data suggests that fisheries may exert some selective effects on some Puget Sound chinook populations, but do not indicate significant declines in size-at-age in the natural components of populations with moderate to high exploitation rates as might be expected. Hard (2004) concluded that selective effects over a 25 year period would be negligible or low at harvest rates less than approximately 40 percent. Further simulation with available data suggests that even for the hatchery components of populations with exploitation rates in excess of

50 percent and observed declines in size-at-age for ages most vulnerable to selective fishing effects, fisheries generally explain only a modest fraction of the observed trends (see Subsection 3.3.7). Exploitation rates on most chinook salmon populations associated with Puget Sound fisheries during the ~~period 2004~~ 2005–2009 fishing seasons are projected to fall well below this level in fishing regimes examined in this Environmental Impact Statement. The potential selective effects of fisheries will continue to be re-examined on a regular basis as part of the monitoring, evaluation, and adaptive management provisions of the Proposed Action or alternatives.

Since the pattern of exploitation rates across alternatives is similar for each scenario and cannot be quantitatively related to changes in size or age except on a very gross scale, the results have been combined across scenarios and are presented only by alternative for the purposes of the selective effects discussion.

4.3.6.1 Alternative 1 – Proposed Action/Status Quo

The Proposed Action represents a diverse spatial and temporal array of commercial net and recreational hook-and-line fisheries in marine and freshwater areas of Puget Sound. Some net fisheries would operate in the Strait of Juan de Fuca, Rosario Strait, and the Strait of Georgia, where stocks originating in Puget Sound and British Columbia commingle. These fisheries target sockeye, pink, and chum salmon, and harvest relatively few chinook salmon. Non-treaty purse seine vessels are required to release chinook salmon, and seines are designed to reduce the catch of immature chinook. In aggregate, these fisheries are likely to exert relatively low selective effects on chinook salmon.

Gillnet fisheries predominate commercial harvest of chinook salmon in other marine and freshwater areas in Puget Sound; e.g., Bellingham Bay/Samish Bay, Skagit Bay/Saratoga Passage, Port Susan/Possession Sound, central and south Puget Sound, and Hood Canal. The selectivity of gillnet gear is directly related to the mesh size, which is commonly expressed as the stretched diagonal dimension. Fishing regulations specify the mesh dimension for each gillnet fishery; different mesh sizes are specified for each target species. Chinook-directed gillnet fisheries typically use 6½-inch mesh, which is ineffective in capturing the smallest and largest size classes of chinook salmon. Pink- and coho-directed salmon fisheries typically use smaller mesh (e.g., 5-inch), which captures fewer large chinook, and a larger number of smaller chinook salmon. Capture efficiency is also affected by many other factors, including ambient light, water clarity, net design (hanging), and current. ~~The size- or age-composition of chinook salmon before and after they encounter a net fishery has not been experimentally compared in Puget Sound, so the vulnerability of different ages or sizes of chinook salmon has not been quantified.~~

Each year, Puget Sound fisheries during the ~~period 2004~~ 2005–2009 fishing seasons will harvest varying proportions of five cohorts of chinook salmon (i.e., Age-2, 3, 4, 5, and 6 fish). During that period, Puget Sound fisheries will affect the dominant age classes of five brood cycles (brood years 2001–2005). As discussed in Subsection 3.3.7, the majority of harvest will be of Age-3 to Age-5 fish, with Age-4 fish comprising the largest proportion. The primary concern is that Puget Sound fisheries might remove a large proportion of older, larger chinook salmon, or chinook that, if not harvested, would be larger and older at maturity, and that depleted of these age and size classes, spawners that escape fisheries would be less productive. However, the magnitude of the immediate effect on the cohorts of a population that are vulnerable to fishing in a given year will depend on fishing pressure (exploitation rate) and how the fishing season is structured. Under Alternative 1, annual exploitation rates would range from 17 to 76 percent on Puget Sound chinook management units depending on the scenario; rates would be below 40 percent for 10 of the 15 management units (Table 4.3.6.1-1). Southern U.S. exploitation rates would range from 5 to 68 percent depending on the scenario and management unit; rates would be below 40 percent for twelve of the fifteen management units (Table 4.3.6.1-1). For most natural units, then, under Alternative 1, two-thirds of the management units would experience total exploitation rates below the level where selective effects might occur (Hard 2004). Only three management units (Green-Duwamish, Nisqually and Skokomish) would experience exploitation rates above this level directly as a result of southern U.S. fisheries (primarily in Puget Sound) (Table 4.3.6.1-2). Commercial fisheries would not operate continuously through the fishing season. In most fishing areas, commercial openings would be scheduled for one to three days per week. This *pulsed* schedule is designed to distribute harvest mortality and escapement across the entire migration timing of the population(s) present in that area. Recreational fisheries would generally open for longer periods, though effort is expected to be much higher on weekends and holidays. Recreational fisheries that target immature chinook salmon in the winter and spring (November through April) would be open for intermittent month-long periods (i.e., they would not operate continuously for 6 months).

If the Alternative 1 fisheries regime were implemented for the ~~2004~~ 2005–2009 ~~management years~~fishing seasons, it would be expected to exert minor changes to the age and size composition of most Puget Sound chinook salmon populations that, absent fishing, would spawn naturally. Each year, the fishery will influence the age and size composition of spawners in that year, and in three or four subsequent years (i.e., when the youngest cohort contributing to that year's fishery matures). As a result, fisheries implemented under Alternative 1 during the ~~2004~~ 2005–2009 fishing seasons would affect the dominant age classes of five brood cycles (brood years ~~2001~~ 2002–2005). Similarly, the composition of spawners in ~~2004~~ 2005–~~2006~~2009 will have already been influenced by fisheries prior to ~~2004~~ 2005. If, as some studies assert, the productivity of a given population is, under adverse freshwater conditions, more dependent on the higher fecundity and spawning success (i.e., number of fertilized eggs per female) of older, larger fish, then the productivity of the period ~~2004~~ 2005–2009 broods might be lower as a result of fishing. Data are not available to estimate the magnitude of the short-term effect (i.e., the reduction in recruits per spawner for, say, the ~~2004~~ 2005 brood) for any of the affected broods, nor has it been estimated empirically for any previous brood year. Smolt production is strongly influenced by complex environmental factors, and is particularly sensitive to the magnitude of high flows during the incubation season (Seiler et al 2000). Though redds constructed by older or larger females may be somewhat less vulnerable to high flow, the reduction in productivity implied by a slightly lower proportion of older spawners cannot be estimated in the face of high uncertainty about flow conditions that will prevail in the winters of ~~2004~~ 2005–2010.

Further circumstantial evidence suggests that the long-term selective effects of fisheries are predicted to be minor, if not undetectable. The average fecundity of mature Skagit River summer chinook salmon has not declined from 1973 to the present (Orrell 1976; and SSC 2002). The age composition of Skagit River summer/fall chinook salmon harvested in the terminal area has varied widely over the last 30 years, particularly with respect to the proportions of Age-3 and Age-4 fish, but there is no declining trend in the contribution of Age-5 fish, which has averaged 15 percent (Henderson and Hayman 2002; and R. Hayman, Skagit Systems Cooperative December 9, 2002, personal communication).

As described in Subsection 3.3.7, no decline in average age has been detected for other Puget Sound chinook salmon populations for which data are available (Figure 3.3.7-2), including the Green-Duwaumish which commonly experienced fishery exploitation rates of 60 to 70 percent through the early 1990s. Collectively, the mixture of upward and downward observed trends in size-at-age for the Puget Sound chinook salmon populations analyzed, and the fact that the expected trends estimated by the harvest model generally explain only a modest fraction (<50%) of corresponding observed trends, suggest that environmental influences are large on the observed size trends. It was not possible from the present analysis to discriminate reliably between harvest and environmental effects on growth and size. Declining total exploitation rates on most natural chinook salmon stocks in Puget Sound in the last ten years (1991–2001) from averages of 70 to 90 percent to averages of 30 to 50 percent, due in part to decline in exploitation rates in Puget Sound fisheries, would suggest that selective pressure has also been reduced. Exploitation rates are expected to remain lower during implementation of the Proposed

Action. To the extent that effects have been detected, they would be expected to decrease under these lower rates unless the use of selective gear types increases.

In light of the information presented above, implementation of Alternative 1 is predicted to have a no to low negative effect on size and age as a result of the size-selective effects of fishing.

Table 4.3.6.1-1. Range of expected total exploitation rates by Puget Sound chinook management unit during the period ~~2004~~ 2005–2009.

Puget Sound Chinook	**Alternative 1**		**Alternative 2**		**Alternative 3**		**Alternative 4**	
(Management Unit/Population)	**minimum**	**maximum**	**minimum**	**maximum**	**minimum**	**maximum**	**minimum**	**maximum**
Dungeness Spring	0.22	0.29	0.19	0.26	0.19	0.26	0.19	0.26
Western Strait-Hoko	0.23	0.30	0.19	0.26	0.19	0.26	0.19	0.26
Elwha	0.22	0.30	0.19	0.26	0.19	0.26	0.19	0.26
Nooksack Spring	0.20	0.26	0.14	0.20	0.14	0.20	0.14	0.20
Skagit								
Spring	0.23	0.28	0.12	0.17	0.12	0.17	0.12	0.17
Upper Sauk								
Suiattle								
Upper Cascade								
Summer/Fall	0.48	0.56	0.32	0.43	0.32	0.43	0.32	0.43
Lower Sauk								
Upper Skagit								
Lower Skagit								
Stillaguamish	0.17	0.20	0.52	0.67	0.08	0.11	0.08	0.11
Snohomish	0.19	0.23	0.10	0.23	0.10	0.13	0.09	0.13
Lake Washington	0.31	0.38	0.18	0.25	0.18	0.25	0.18	0.25
Green-Duwamish	0.49	0.63	0.36	0.56	0.36	0.56	0.18	0.25
Puyallup	0.49	0.50	0.57	0.71	0.57	0.71	0.18	0.25
Nisqually	0.64	0.76	0.61	0.73	0.61	0.73	0.16	0.23
White Spring	0.20	0.20	0.22	0.46	0.22	0.46	0.02	0.03
Mid-Canal	0.26	0.34	0.19	0.28	0.19	0.28	0.19	0.28
Skokomish	0.45	0.63	0.43	0.61	0.43	0.61	0.19	0.28

Exploitation rates greater than 0.4 are shaded.

Table 4.3.6.1-2. Range of expected southern U.S. exploitation rates by Puget Sound chinook management unit during the period ~~2004~~ 2005–2009.

Puget Sound Chinook (Management Unit/Population)	**Alternative 1** minimum	**Alternative 1** maximum	**Alternative 2** minimum	**Alternative 2** maximum	**Alternative 3** minimum	**Alternative 3** maximum	**Alternative 4** minimum	**Alternative 4** maximum
Dungeness Spring	0.05	0.05	0.01	0.01	0.01	0.01	0.01	0.01
Western Strait-Hoko	0.05	0.05	0.01	0.01	0.01	0.01	0.01	0.01
Elwha	0.05	0.05	0.01	0.01	0.01	0.01	0.01	0.01
Nooksack Spring	0.07	0.07	0.01	0.01	0.01	0.01	0.01	0.01
Skagit								
Spring	0.14	0.15	0.02	0.02	0.02	0.02	0.02	0.02
Upper Sauk								
Suiattle								
Upper Cascade								
Summer/Fall	0.16	0.18	0.00	0.01	0.00	0.01	0.00	0.01
Lower Sauk								
Upper Skagit								
Lower Skagit								
Stillaguamish	0.11	0.12	0.43	0.60	0.02	0.02	0.02	0.02
Snohomish	0.13	0.14	0.03	0.16	0.10	0.13	0.03	0.03
Lake Washington (Cedar River	0.20	0.23	0.05	0.05	0.05	0.05	0.05	0.05
Green-Duwamish	0.36	0.51	0.18	0.42	0.18	0.42	0.05	0.05
Puyallup	0.35	0.39	0.39	0.57	0.39	0.57	0.05	0.05
Nisqually	0.53	0.68	0.47	0.63	0.47	0.63	0.07	0.08
White Spring	0.17	0.19	0.20	0.46	0.20	0.46	0.01	0.01
Mid-Canal	0.12	0.13	0.05	0.05	0.05	0.05	0.05	0.05
Skokomish	0.26	0.50	0.23	0.46	0.23	0.46	0.05	0.05

Exploitation rates greater than 0.4 are shaded.

4.3.6.2 Alternative 2 – Escapement Goal Management at the Management Unit Level

Implementation of Alternative 3 for the ~~2004~~ 2005–2009 ~~management years~~fishing seasons would preclude marine net and recreational fisheries in Puget Sound except for a small marine net fishery in Tulalip Bay, and substantially reduce exploitation rates on most chinook salmon natural management units. The size-selective effects of pre-terminal net fisheries predicted to occur under Alternative 1, would not occur. Except for the limited Tulalip Bay fishery, gillnet fishery effects would be confined to those associated with in-river fisheries, and further confined to fisheries directed at other species in most rivers. The selective effects of recreational fisheries, which with Alternative 1 would operate under a 22-inch minimum size restriction, would also be eliminated.

The consequences of implementing Alternative 2, however, cannot be quantified in terms of a change in the age- or size-composition of chinook spawners during the period 200~~4~~5–2009. Though exploitation rates would be lower for most populations relative to Alternative 1, these would be declines from already-low rates for most populations in the ESU. In addition, although overall, rates would be lower than under Alternative 1, exploitation rates would generally be greater than 40 percent for many of the same management units noted under Alternative 1. The range of exploitation rates for two additional management units (White River [upper end of range only] and Stillaguamish) are anticipated to exceed 40 percent, significantly greater than the rates anticipated under Alternative 1. Seven management units could exceed 40 percent exploitation rate as compared with five management units under Alternative 1, although the lower end of the range for the Skagit summer/fall and Green-Duwamish management units would be below 40 percent under Alternative 2 (Table 4.3.6.1-1). Six management units would be expected to exceed 40 percent exploitation in southern U.S. fisheries compared with three under Alternative 1 (Table 4.3.6.1-2). However, where exploitation rates would be lower than under Alternative 1, it is reasonable to expect that the proportion of older and larger fish in the escapement in many rivers would increase slightly; i.e., decreasing selective effects. On the other hand, the shift to terminal-area fishing could increase the use of selective gear types; i.e., gillnets and hook-and-line recreational gear, and the greater number of management units anticipated to exceed 40 percent exploitation could mean an increase in selective effects compared with Alternative 1. For these reasons, there is too much uncertainty to predict the effects of implementing Alternative 2 on selective fishing effects.

4.3.6.3 Alternative 3 – Escapement Goal Management at the Population Level with Terminal Fisheries Only

Implementation of Alternative 3 for the ~~2004~~ 2005–2009 management years would preclude marine net and recreational fisheries in Puget Sound, and substantially reduce exploitation rates on most chinook salmon natural populations. The size-selective effects of pre-terminal net fisheries predicted to occur under Alternative 1, would not be occur under Alternative 3. Gillnet fishery effects would be confined to those associated with in-river fisheries, and further confined to fisheries directed at other species in most rivers. The selective effects of marine recreational fisheries, which with Alternative 1 would operate under a 22-inch minimum size restriction, would also be eliminated.

Since, except for the Tulalip Bay and Stillaguamish fisheries in Alternative 2, the fisheries under Alternative 3 would be identical to those under Alternative 2, it is also anticipated that the selective fishing effects would be similar. Under Alternative 3, 6 management units out of 15 would be anticipated to exceed 40 percent exploitation rate, as compared with five under Alternative 1 and seven under Alternative 2. Five management units would be anticipated to exceed 40 percent exploitation rate in southern U.S. fisheries as compared with three under Alternative 1 and six under Alternative 2. For the reasons described under Alternative 2, there is too much uncertainty to predict the effects of implementing Alternative 3 on selective fishing effects.

4.3.6.4 Alternative 4 – No Action/No Authorized Take

The closing of all fisheries that involve any take of listed Puget Sound chinook salmon would substantially lower exploitation rates on all populations relative to Alternative 1, and would eliminate any size- and age-selective effects associated with Puget Sound gillnet and recreational fisheries. The short-term consequences would include a substantial increase in escapement to all chinook salmon-producing rivers, and there would likely be some increase in proportions of ages and size represented in the spawning population. Given that observed size-selective effects of fisheries ~~have not been observed in~~ are modest, at best, for some Puget Sound chinook salmon populations, and decreases in exploitation rates would, in most cases, be from levels that are anticipated to cause low levels of size-selective effects at most, implementation of Alternative 3 is predicted to have no to low beneficial effects compared to Alternative 1.

4.3.7 Hatchery-Related Fishery Effects On Salmon: Straying and Overfishing

As discussed in Subsection 3.3.7 of this Environmental Impact Statement, there are two hatchery-related effects to natural-origin salmon associated with fishing. The first is straying of hatchery-origin fish that are not caught, onto the spawning grounds where they may interact with natural populations potentially leading to a decrease in overall natural population productivity. Since not all hatchery fish return to the hatchery, any increases in hatchery returns could be expected to increase the probability for higher numbers of hatchery fish spawning in the wild. The much greater escapements of hatchery coho and chum salmon could exacerbate inter-species predation, competition and genetic diversity effects in some areas. The second hatchery-related effect is the potential to overfish natural populations while pursuing harvestable hatchery-origin fish. One of the purposes of the Proposed Action is to create opportunities to harvest commingled populations, including hatchery-raised chinook, while providing an adequate level of protection to natural chinook salmon populations. In attempting to maximize harvest of hatchery fish, the commingled natural fish could be overharvested; i.e., harvested at a rate that is not sustainable based on the underlying productivity of the natural population. The potential effects on Puget Sound chinook salmon populations from overfishing are discussed in Section 4.3.1, which quantifies the impacts of the Proposed Action and alternatives in terms of exploitation rate and escapement of natural Puget Sound chinook populations. These effects will not be discussed further here.

Estimated escapement patterns for chinook salmon under the Proposed Action or alternatives for purposes of evaluating the two potential hatchery-related effects on natural-origin salmon are presented in Tables 4.3.7-1 through 4.3.7-5 by scenario. Potential contribution of hatchery-origin chinook salmon adults to the naturally-spawning population is presented in Table 4.3.7-7. Estimated escapement patterns for coho and chum are presented in Tables 4.3.7-8 and 4.3.7-9. The model runs on which these numbers are based are found in Appendix B. These are the Puget Sound salmon species with the largest hatchery production, and therefore the species with the greatest potential for hatchery-related effects. Puget Sound hatchery production of pink and sockeye salmon is relatively small by comparison. Results for chinook salmon are presented by alternative and scenario, with the discussion of comparison among alternatives focused on Scenario B, since that is the most likely to occur during implementation of the Proposed Action (see Subsection 4.2, Basis for Comparison of Alternatives and Approach to Alternatives Analysis, for background discussion.)

4.3.7.1 Straying of Hatchery Chinook

Under the alternatives analyzed, hatchery escapement would vary in concert with natural escapement. Alternative 4 (No Authorized Take/Status Quo) is predicted to result in the highest escapement levels, for both hatchery- and naturally-spawning chinook, regardless of scenario. In most cases, Alternative 1 is predicted to result in the lowest overall hatchery escapement levels, and the lowest natural escapement for the Strait of Juan de Fuca, North Puget Sound, and Hood Canal populations (Table 4.3.7-1). Total natural chinook escapement is predicted to show no to low changes (-6% to +3%) under Alternatives 2 or 3 compared with Alternative 1, and low to moderate changes in total hatchery escapement, with the direction of change depending on the scenario. Compared with Alternative 1, Alternative 4 is predicted to result in substantial increases in total natural escapement of chinook salmon when abundance is similar to that in 2003 (Scenarios A or B), and moderate increases in escapement when abundance is low (Scenarios C or D). Hatchery escapements under Alternative 4 are predicted to substantially increase under all scenarios (62 to 89%) (Table 4.3.7-1).

Table 4.3.7-1. Comparisons of hatchery- and naturally-spawning chinook salmon escapement with the Proposed Action or alternatives by scenario.

CHINOOK	Scenario A						Scenario B					
	Comparisons to the Proposed Action						Comparisons to the Proposed Action					
	Natural Escapment			Hatchery Escapement			Natural Escapment			Hatchery Escapement		
	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1
Juan de Fuca												
Dungeness Spring	2%	2%	2%				2%	2%	2%			
Western Strait-Hoko	3%	3%	3%				3%	3%	3%			
Elwha	2%	2%	2%				2%	2%	2%			
Regional Average	2%	2%	2%				3%	3%	3%			
North Sound												
Nooksack Spring	9%	9%	9%				13%	13%	13%			
Nooksack/Samish summer-fall				237%	237%	0%				1%	1%	1%
Skagit												
Spring	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%	9%	9%
Summer/Fall	26%	26%	26%				26%	26%	26%			
Stillaguamish	-61%	6%	6%				-60%	7%	7%			
Snohomish	-9%	8%	9%	-12%	8%	19%	-6%	10%	10%	-9%	20%	20%
Tulalip Tribal Hatchery				99%	7974%	7974%				101%	7990%	7990%
Regional Average	-5%	11%	12%	78%	85%	9%	-4%	13%	13%	0%	10%	10%
South Sound												
Lake Washington (Cedar River)	1%	1%	1%	18%	18%	18%	0%	0%	0%	19%	19%	19%
Green-Duwamish	0%	0%	81%	19%	19%	116%	0%	0%	75%	19%	19%	109%
Puyallup	-50%	-50%	37%	-53%	-53%	99%	-50%	-50%	31%	-54%	-54%	86%
Nisqually	-1%	-1%	202%	0%	0%	204%	-2%	-2%	190%	-2%	-2%	191%
White Spring	-32%	-32%	25%				-31%	-31%	23%			
Gorst, Grovers, Minter, Chambers				31%	31%	42%				29%	29%	40%
& McAllister, Deschutes												
Regional Average	-16%	-16%	69%	3%	3%	96%	-17%	-17%	64%	2%	2%	89%
Hood Canal												
Mid-Canal	4%	4%	4%				5%	5%	5%			
Skokomish	1%	1%	105%	1%	1%	100%	0%	0%	92%	0%	0%	88%
Hoodsport H, Dewato, Union,	6%	6%	6%	-67%	-67%	237%	6%	6%	6%	-66%	-66%	235%
& Tahuya tribs.												
Regional Average	2%	2%	54%	26%	26%	77%	2%	2%	48%	26%	26%	77%
Average	-6%	0%	33%	17%	19%	89%	-5%	0%	31%	-9%	-6%	84%

CHINOOK	Scenario C						Scenario D					
	Comparisons to the Proposed Action						Comparisons to the Proposed Action					
	Natural Escapment			Hatchery Escapement			Natural Escapment			Hatchery Escapement		
	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1
Juan de Fuca												
Dungeness Spring	2%	2%	2%				3%	3%	3%			
Western Strait-Hoko	3%	3%	3%				4%	4%	4%			
Elwha	2%	2%	2%				3%	3%	3%			
Regional Average	3%	3%	3%				3%	3%	3%			
North Sound												
Nooksack Spring	9%	9%	9%				13%	13%	13%			
Nooksack/Samish summer-fall				0%	0%	0%				121%	121%	1%
Skagit												
Spring	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Summer/Fall	27%	27%	27%				27%	27%	27%			
Stillaguamish	-44%	7%	7%				-42%	7%	7%			
Snohomish	9%	9%	9%	20%	20%	20%	9%	9%	9%	20%	20%	20%
Tulalip Tribal Hatchery				9517%	9517%	9517%				9484%	9484%	9484%
Regional Average	2%	13%	13%	10%	10%	10%	4%	13%	13%	50%	50%	10%
South Sound												
Lake Washington (Cedar River)	-4%	-4%	-4%	0%	0%	0%	-5%	-5%	-5%	24%	24%	24%
Green-Duwamish	0%	0%	27%	31%	31%	66%	0%	0%	21%	33%	33%	61%
Puyallup	-33%	-33%	28%	-26%	-26%	120%	-35%	-35%	19%	-30%	-30%	96%
Nisqually	-2%	-2%	108%	-1%	-1%	109%	-1%	-1%	104%	0%	0%	105%
White Spring	-1%	-1%	27%				-1%	-1%	23%			
Gorst, Grovers, Minter, Chambers				44%	44%	55%				46%	46%	57%
& McAllister, Deschutes												
Regional Average	-8%	-8%	37%	9%	9%	70%	-8%	-8%	32%	15%	15%	69%
Hood Canal												
Mid-Canal	5%	5%	5%				5%	5%	5%			
Skokomish	-1%	-1%	40%	-1%	-1%	38%	-1%	-1%	32%	-1%	-1%	32%
Hoodsport H, Dewato, Union,	6%	6%	6%	-56%	-56%	212%	6%	6%	6%	-54%	-54%	207%
& Tahuya tribs.												
Regional Average	2%	2%	22%	26%	26%	77%	2%	2%	19%	26%	26%	77%
Average	-1%	3%	19%	-3%	-3%	64%	0%	3%	18%	14%	14%	62%

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, November 2004.

Substantial differences (greater than 30%) in escapement from Alternative 1 are shaded.

Table 4.3.7-2. Comparisons of hatchery- and naturally-spawning chinook salmon escapement with the Proposed Action or alternatives under Scenario A.

CHINOOK	Alternative 1 - Proposed Action		Alternative 2 - Escapement Goal/Manag. Unit Level		Alternative 3 - Escapement Goal/Pop Level/Terminal Only		Alternative 4 - No Listed Take		Comparisons to the Proposed Action: Natural Escapement			Comparisons to the Proposed Action: Hatchery Escapement		
	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1
Juan de Fuca														
Dungeness Spring	--	352	--	360	--	360	--	360	2%	2%	2%			
Western Strait-Hoko	--	785	--	807	--	807	--	807	3%	3%	3%			
Elwha	--	2,125	--	2,172	--	2,172	--	2,172	2%	2%	2%			
Regional Average									2%	2%	2%			
North Sound														
Nooksack Spring	--	388	--	422	--	422	--	422	9%	9%	9%			
Nooksack/Samish summer-fall	10,044	--	33,887	--	33,887	--	10,083	--				237%	237%	0%
Skagit														
Spring	1,136	1,921	1,229	2,073	1,230	2,074	1,230	2,074	8%	8%	8%	8%	8%	8%
Summer/Fall	118	11,633	147	14,656	147	14,656	147	14,656	26%	26%	26%			
Stillaguamish	--	2,322	--	903	--	2,468	--	2,468	-61%	6%	6%			
Snohomish	4,564	5,073	4,024	4,634	4,933	5,475	5,432	5,504	-9%	8%	9%	-12%	8%	19%
Tulalip Tribal Hatchery	98	--	195	--	7,906	--	7,906	--				99%	7974%	7974%
Regional Average									-5%	11%	12%	78%	85%	9%
South Sound														
Lake Washington (w Cedar River index)	4,632	305	5,448	307	5,449	307	5,449	307	1%	1%	1%	18%	18%	18%
Green-Duwamish	5,016	5,819	5,948	5,800	5,948	5,800	10,827	10,558	0%	0%	81%	19%	19%	116%
Puyallup	2,338	2,392	1,100	1,200	1,100	1,200	4,656	3,286	-50%	-50%	37%	-53%	-53%	99%
Nisqually	4,911	1,106	4,913	1,100	4,913	1,100	14,908	3,338	-1%	-1%	202%	0%	0%	204%
White Spring	--	1,468	--	1,000	--	1,000	--	1,831	-32%	-32%	25%			
Gorst, Grovers, Minter, Chambers & McAllister, Deschutes	29,528	--	38,545	--	38,547	--	41,786	--				31%	31%	42%
Regional Average									-16%	-16%	69%	3%	3%	96%
Hood Canal														
Mid-Canal	--	531	--	552	--	552	--	552	4%	4%	4%			
Skokomish	6,104	1,211	6,174	1,218	6,175	1,218	12,214	2,482	1%	1%	105%	1%	1%	100%
Hoodsport H, Dewato, Union, Tahuya trib	5,594	591	1,851	625	1,851	625	18,833	625	6%	6%	6%	-67%	-67%	237%
Regional Average									2%	2%	54%	26%	26%	77%
Total	109,447	42,438			138,057	37,627	195,999	55,708	Ave -6%	0%	22%	17%	19%	89%

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, March 2003 and November 2004.

Substantial differences (greater than 30%) in escapement from Alternative 1 are shaded.

Table 4.3.7-3. Comparisons of hatchery- and naturally-spawning chinook salmon escapement with the Proposed Action or alternatives under Scenario B.

CHINOOK	Alternative 1 - Proposed Action		Alternative 2 - Escapement Goal/Manag. Unit Level		Alternative 3 - Escapement Goal/Pop Level/Terminal Only		Alternative 4 - No Listed Take		Comparisons to the Proposed Action: Natural Escapment			Comparisons to the Proposed Action: Hatchery Escapement		
	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1
Juan de Fuca														
Dungeness Spring	--	336	--	344	--	344	--	344	2%	2%	2%			
Western Strait-Hoko	--	750	--	772	--	772	--	772	3%	3%	3%			
Elwha	--	2,031	--	2,079	--	2,079	--	2,079	2%	2%	2%			
Regional Average									3%	3%	3%			
North Sound														
Nooksack Spring	--	365	--	412	--	412	--	412	13%	13%	13%			
Nooksack/Samish summer-fall	9,855	--	9,906	--	9,906	--	9,906	--				1%	1%	1%
Skagit														
Spring	1,088	1,845	1,188	2,009	1,189	2,010	1,189	2,010	9%	9%	9%	9%	9%	9%
Summer/Fall	110	11,029	139	13,935	139	13,935	139	13,935	26%	26%	26%			
Stillaguamish	--	2,281	--	904	--	2,446	--	2,446	-60%	7%	7%			
Snohomish	4,342	4,901	3,947	4,603	5,203	5,368	5,203	5,368	-6%	10%	10%	-9%	20%	20%
Tulalip Tribal Hatchery	96	--	192	--	7,730	--	7,730	--				101%	7990%	7990%
Regional Average									-4%	13%	13%	0%	10%	10%
South Sound														
Lake Washington (w Cedar River index)	4,449	294	5,273	295	5,274	295	5,274	295	0%	0%	0%	19%	19%	19%
Green-Duwamish	5,019	5,816	5,982	5,800	5,981	5,800	10,470	10,153	0%	0%	75%	19%	19%	109%
Puyallup	2,424	2,419	1,109	1,200	1,109	1,200	4,506	3,160	-50%	-50%	31%	-54%	-54%	86%
Nisqually	5,007	1,126	4,920	1,100	4,920	1,100	14,587	3,261	-2%	-2%	190%	-2%	-2%	191%
White Spring	--	1,459	--	1,000	--	1,000	--	1,792	-31%	-31%	23%			
Gorst, Grovers, Minter, Chambers & McAllister, Deschutes	28,954	--	37,477	--	37,479	--	40,641	--				29%	29%	40%
Regional Average									-17%	-17%	64%	2%	2%	89%
Hood Canal														
Mid-Canal	--	504	--	527	--	527	--	527	5%	5%	5%			
Skokomish	6,213	1,237	6,220	1,231	6,221	1,231	11,662	2,370	0%	0%	92%	0%	0%	88%
Hoodsport H, Dewato, Union, Tahuya tribs	5,372	562	1,850	597	1,850	597	17,983	597	6%	6%	6%	-66%	-66%	235%
Regional Average									2%	2%	48%	26%	26%	77%
Total	109,447	42,438			138,057	37,627	195,999	55,708	Aver -5%	0%	22%	-9%	-6%	84%

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, March 2003 and November 2004.
Substantial differences (greater than 30%) in escapement from Alternative 1 are shaded.

Table 4.3.7-4. Comparisons of hatchery- and naturally-spawning chinook salmon escapement with the Proposed Action or alternatives under Scenario C.

CHINOOK	Alternative 1 - Proposed Action		Alternative 2 - Escapement Goal/Manag. Unit Level		Alternative 3 - Escapement Goal/Pop Level/Terminal Only		Alternative 4 - No Listed Take		Comparisons to the Proposed Action: Natural Escapement			Comparisons to the Proposed Action: Hatchery Escapement		
	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1
Juan de Fuca														
Dungeness Spring	--	245	--	251	--	251	--	251	2%	2%	2%			
Western Strait-Hoko	--	545	--	564	--	564	--	564	3%	3%	3%			
Elwha	--	1,480	--	1,516	--	1,516	--	1,516	2%	2%	2%			
Regional Average									3%	3%	3%			
North Sound														
Nooksack Spring	--	278	--	304	--	304	--	304	9%	9%	9%			
Nooksack/Samish summer-fall	9,528	--	9,571	--	9,571	--	9,571	--				0%	0%	0%
Skagit														
Spring	788	1,331	865	1,460	865	1,460	865	1,460	10%	10%	10%	10%	10%	10%
Summer/Fall	80	8,033	102	10,215	102	10,215	102	10,215	27%	27%	27%			
Stillaguamish	--	1,620	--	909	--	1,738	--	1,738	-44%	7%	7%			
Snohomish	3,185	3,543	3,812	3,875	3,812	3,875	3,812	3,875	9%	9%	9%	20%	20%	20%
Tulalip Tribal Hatchery	58	--	5,531	--	5,531	--	5,531	--				9517%	9517%	9517%
Regional Average									2%	13%	13%	10%	10%	10%
South Sound														
Lake Washington (w Cedar River index)	3,082	223	3,084	214	3,084	214	3,084	214	-4%	-4%	-4%	0%	0%	0%
Green-Duwamish	4,558	5,801	5,950	5,800	5,950	5,800	7,558	7,367	0%	0%	27%	31%	31%	66%
Puyallup	1,478	1,798	1,100	1,200	1,100	1,200	3,250	2,293	-33%	-33%	28%	-26%	-26%	120%
Nisqually	4,972	1,119	4,914	1,100	4,914	1,100	10,408	2,330	-2%	-2%	108%	-1%	-1%	109%
White Spring	--	1,011	--	1,000	--	1,000	--	1,283	-1%	-1%	27%			
Gorst, Grovers, Minter, Chambers & McAllister, Deschutes	18,808	--	27,007	--	27,007	--	29,169	--				44%	44%	55%
Regional Average									-8%	-8%	37%	9%	9%	70%
Hood Canal														
Mid-Canal	--	367	--	385	--	385	--	385	5%	5%	5%			
Skokomish	6,147	1,239	6,080	1,221	6,080	1,221	8,513	1,730	-1%	-1%	40%	-1%	-1%	38%
Hoodsport H, Dewato, Union, Tahuya tribs	4,209	410	1,857	436	1,857	436	13,126	436	6%	6%	6%	-56%	-56%	212%
Regional Average									2%	2%	22%	26%	26%	77%
Total	109,447	42,438			138,057	37,627	195,999	55,708	Ave -1%	3%	22%	-3%	-3%	64%

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, March 2003 and November 2004.
Substantial differences (greater than 30%) in escapement from Alternative 1 are shaded.

Table 4.3.7-5. Comparisons of hatchery- and naturally-spawning chinook salmon escapement with the Proposed Action or alternatives under Scenario D.

CHINOOK	Alternative 1 - Proposed Action		Alternative 2 - Escapement Goal/Manag. Unit Level		Alternative 3 - Escapement Goal/Pop Level/Terminal Only		Alternative 4 - No Listed Take		Comparisons to the Proposed Action: Natural Escapement			Comparisons to the Proposed Action: Hatchery Escapement		
	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1
Juan de Fuca														
Dungeness Spring	--	231	--	237	--	237	--	237	3%	3%	3%			
Western Strait-Hoko	--	514	--	532	--	532	--	532	4%	4%	4%			
Elwha	--	1,395	--	1,431	--	1,431	--	1,431	3%	3%	3%			
Regional Average									3%	3%	3%			
North Sound														
Nooksack Spring	--	252	--	285	--	285	--	285	13%	13%	13%			
Nooksack/Samish summer-fall	9,370	--	20,673	--	20,673	--	9,424	--				121%	121%	1%
Skagit														
Spring	749	1,270	825	1,395	825	1,395	825	1,395	10%	10%	10%	10%	10%	10%
Summer/Fall	75	7,551	96	9,625	96	9,625	96	9,625	27%	27%	27%			
Stillaguamish	--	1,584	--	919	--	1,702	--	1,702	-42%	7%	7%			
Snohomish	3,007	3,399	3,596	3,720	3,596	3,720	3,600	3,720	9%	9%	9%	20%	20%	20%
Tulalip Tribal Hatchery	56	--	5,351	--	5,351	--	5,351	--				9484%	9484%	9484%
Regional Average									4%	13%	13%	50%	50%	10%
South Sound														
Lake Washington (w Cedar River index)	2,933	214	3,648	204	3,648	204	3,648	204	-5%	-5%	-5%	24%	24%	24%
Green-Duwamish	4,512	5,802	5,995	5,800	5,995	5,800	7,242	7,006	0%	0%	21%	33%	33%	61%
Puyallup	1,588	1,834	1,113	1,200	1,113	1,200	3,118	2,180	-35%	-35%	19%	-30%	-30%	96%
Nisqually	4,935	1,109	4,920	1,100	4,920	1,100	10,124	2,264	-1%	-1%	104%	0%	0%	105%
White Spring	--	1,011	--	1,000	--	1,000	--	1,246	-1%	-1%	23%			
Gorst, Grovers, Minter, Chambers & McAllister, Deschutes	17,893	--	26,063	--	26,063	--	28,157	--				46%	46%	57%
Regional Average									-8%	-8%	32%	15%	15%	69%
Hood Canal														
Mid-Canal	--	344	--	361	--	361	--	361	5%	5%	5%			
Skokomish	6,069	1,225	6,038	1,215	6,038	1,215	7,983	1,622	-1%	-1%	32%	-1%	-1%	32%
Hoodsport H, Dewato, Union, Tahuya tribs	4,010	384	1,854	408	1,854	408	12,309	408	6%	6%	6%	-54%	-54%	207%
Regional Average									2%	2%	19%	26%	26%	77%
Total	109,447	42,438			138,057	37,627	195,999	55,708	Ave 0%	3%	22%	14%	14%	62%

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, March 2003 and November 2004.

Substantial differences (greater than 30%) in escapement from Alternative 1 are shaded.

Relatively small numbers of juvenile hatchery chinook are released each year into the watersheds where the Nooksack spring, Skagit, Stillaguamish, White, Dungeness and Elwha chinook salmon populations spawn and rear, either as indicator stocks for research (e.g., the Skagit hatchery programs), or as supplementation to aid in the recovery of the naturally-spawning chinook salmon populations. With the exception of the Elwha River, releases do not exceed one million juveniles each year. The hatchery programs in these systems all use the native chinook salmon populations as broodstock. Juvenile and adult hatchery fish from all but the Skagit programs are deemed essential for the recovery of the Puget Sound Chinook ESU, and are therefore listed. Straying of Skagit hatchery-origin spawning adults to natural spawning areas is insignificant because the numbers of adult fish produced by the low numbers of juveniles released is not substantial. For the other hatchery programs, escapement of adult fish produced through the supplementation programs that return to natural spawning areas is a primary objective of the program, and therefore generally seen as having an overall beneficial effect.

Annual hatchery releases of more than one million juvenile chinook salmon occur in the Snohomish, Lake Washington, Green-Duwamish, Puyallup, Nisqually and Skokomish watersheds. The hatchery programs located in the Snohomish and Green-Duwamish watersheds propagate chinook salmon derived from the native stock. Hatcheries in the Sammamish, Puyallup, Nisqually and Skokomish watersheds operate where native populations are no longer believed to exist. The hatchery and wild adult chinook salmon populations returning to these watersheds are indistinguishable from each other. With the exception of the Snohomish watershed, the majority of the returning adults are believed to be predominately first-generation, hatchery-origin fish, and any natural production is generally managed for composite escapements of hatchery- and wild-origin fish. Hatchery programs in these areas have been in place for 40 to 100 years. Given the stock origin of propagated fish, or the lack of native chinook salmon populations in these watersheds, continued straying of hatchery-origin spawning adults to natural spawning areas at present levels in these systems is unlikely to have a significant adverse effect on the extant natural-origin chinook salmon populations.

However, to the extent that increases in the contribution of hatchery-origin adults on the natural spawning grounds increase risks such as predation on naturally-produced salmon, or competition with naturally-produced salmon for food, and rearing and spawning areas, a reduction in the contribution of hatchery-origin adults on the natural spawning grounds would be considered a beneficial effect. Information is not currently available to determine with certainty what levels of hatchery contribution to naturally-spawning chinook populations in Puget Sound result in what levels of risk or benefit. State, tribal and federal agencies are currently engaged in on-going cooperative efforts to develop this understanding. Therefore, for the purpose of this analysis, a reduction in hatchery contribution will be considered a benefit, and the impact analysis metrics described in Subsection 4.3, Fish, will be used to describe the magnitude of change. All programs used in the analysis of the Proposed Action and alternatives would have significant hatchery contribution rates to natural spawning grounds regardless of the alternative or scenario (Table 4.3.7-9).

Under the alternative fishing regimes analyzed, the same factors that would cause natural escapements to increase (or decrease) would also result in higher (or lower) hatchery escapements. Since not all hatchery fish return to the hatchery, any increases in hatchery returns could be expected to increase the probability for higher numbers of hatchery fish spawning in the wild. Table 4.3.7-6 provides examples of stray rates for several key chinook salmon populations, where stray rate is defined as the proportion of the total hatchery-origin escapement not removed from the natural environment through trapping, or the number of hatchery-origin salmon that otherwise strayed from their point of release. The predicted contribution of hatchery fish to natural escapement is then computed by calculating the number of hatchery fish that would not return to the hatchery using the proportions in Table 4.3.7-6, and dividing that number by the natural escapement.

Table 4.3.7-6. Estimated 1996–2002 average number of hatchery-origin chinook salmon that spawn in the wild as a proportion of the hatchery-origin escapement for key Puget Sound chinook hatchery salmon populations under consideration (hatchery fish spawning in the wild/total hatchery fish returning).

Population	Average Hatchery Stray Rate (1996-2002)
Nooksack	
North Fork	.35
South Fork	.05
Snohomish	
Skykomish	.32
Snoqualmie	.09
Green-Duwamish	.40

Source: Puget Sound Technical Recovery Team Abundance and Productivity Tables (2003).

Stray rates are not yet available for other systems, pending evaluation of mass-marked hatchery-origin returns in future years. When that information is available, it will be used to assess the contribution of hatchery-origin fish to natural escapement. The results of that assessment are expected to indicate that hatchery fish stray rates for South Puget Sound and Hood Canal watersheds will be similar to or exceed that of the Green River, with proportionally greater risks of potential impacts to any natural-origin chinook salmon populations. Therefore, the populations in Table 4.3.7-6 will be used as examples to indicate the relative impact of the Proposed Action or alternatives.

Alternative 1 – Proposed Action/Status Quo

No change from current baseline conditions would result from implementation of Alternative 1.

Modeled scenarios for Alternative 1 showed little variation and no consistent pattern of hatchery contribution rates across the three representative systems (Nooksack spring, Snohomish and Green-Duwamish) (Table 4.3.7-7). For the Nooksack spring system, the modeled stray rate is predicted to be the same across modeled scenarios. For the Snohomish system, the modeled stray rate is predicted to be lowest under Scenario D (30% reduction in abundance with maximum Canadian/Alaskan fisheries), followed by Scenario B (high abundance and maximum Canadian/Alaskan fisheries). Scenario C (30% reduction in abundance with Canadian/Alaskan fisheries similar to those in 2003), and Scenario A (high abundance and Canadian/Alaskan fisheries similar to those in 2003) are predicted to have the same and the lowest hatchery contribution rate, respectively. The Green-Duwamish River system is predicted to have the lowest stray rate under Scenario D or Scenario C, followed by Scenario B or Scenario A.

Hatchery strays are predicted to average approximately 93 percent of total natural escapement in the Nooksack spring system; 50 to 51 percent of total natural escapement in the Snohomish River system; and 52 to 58 percent of total natural spawners in the Green-Duwamish River system (Puget Sound Technical Recovery Team 2003).

Hatchery contribution rates of out-of-watershed-origin chinook salmon at these levels indicate a substantial potential risk of adverse ecological and genetic effects to the indigenous natural-origin populations through competition and genetic introgression, respectively. However, hatchery-origin fish straying within these watersheds are predominately of native-population-origin, which is expected to attenuate the potential for adverse ecological and genetic effects. In addition, Nooksack hatchery chinook salmon are considered essential to the recovery of the ESU, and are therefore listed along with the natural-origin fish. Given these circumstances, straying hatchery fish are expected to result in a low to moderate short-term risk of adverse impact to the ability of natural populations to sustain themselves. Impacts over the long-term would also be expected to be low to moderate, since Alternative 1 is the baseline condition.

Table 4.3.7-7. Hatchery contribution to natural spawning escapement by scenario and alternative for five representative Puget Sound chinook populations.

CHINOOK		Scenario A				Scenario B				Scenario C				Scenario D			
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 1	Alt 2	Alt 3	Alt 4	Alt 1	Alt 2	Alt 3	Alt 4	Alt 1	Alt 2	Alt 3	Alt 4
Nooksack Spring	Escapement to the hatchery	9,150	9,952	9,150	9,952	7,924	8,112	8,112	8,112	5,778	5,919	5,919	5,919	5,448	5,589	5,589	5,589
North Fork Nooksack	strays from hatchery to grounds	3,203	3,483	3,203	3,483	2,773	2,839	2,839	2,839	2,022	2,072	2,072	2,072	1,907	1,956	1,956	1,956
	% of hatchery return to hatchery	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
	total strays on grounds	4,927	5,359	4,927	5,359	4,267	4,368	4,368	4,368	3,111	3,187	3,187	3,187	2,933	3,009	3,009	3,009
South Fork Nooksack	strays from hatchery to grounds	458	498	458	498	396	406	406	406	289	296	296	296	272	279	279	279
	% of hatchery return to hatchery	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
	total strays on grounds	482	524	482	524	417	427	427	427	304	312	312	312	287	294	294	294
Snohomish	Escapement to the hatchery	4,564	4,024	4,933	5,432	4,342	3,947	5,203	5,203	3,185	3,812	3,812	3,812	3,007	3,596	3,596	3,600
Skykomish	strays from hatchery to grounds	1,461	1,288	1,579	1,738	1,389	1,263	1,665	1,665	1,019	1,220	1,220	1,220	962	1,151	1,151	1,152
	% of hatchery return to hatchery	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
	total strays on grounds	2,148	1,894	2,322	2,556	2,043	1,857	2,449	2,449	1,499	1,794	1,794	1,794	1,415	1,692	1,692	1,694
Snoqualmie																	
	strays from hatchery to grounds	411	362	444	489	391	355	468	468	287	343	343	343	271	324	324	324
	% of hatchery return to hatchery	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
	total strays on grounds	451	398	488	537	429	390	515	515	315	377	377	377	297	356	356	356
Green-Duwamish	Escapement to the hatchery	5,016	5,948	5,948	10,827	5,019	5,982	5,981	10,470	4,558	5,950	5,950	7,558	4,512	5,995	5,995	7,242
	strays from hatchery to grounds	2,007	2,379	2,379	4,331	2,007	2,393	2,393	4,188	1,823	2,380	2,380	3,023	1,805	2,398	2,398	2,897
	% of hatchery return to hatchery	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	total strays on grounds	3,344	3,965	3,965	7,218	3,346	3,988	3,988	6,980	3,039	3,967	3,967	5,039	3,008	3,997	3,997	4,828

CHINOOK	Hatchery Contribution to Natural Spawning				Hatchery Contribution to Natural Spawning				Hatchery Contribution to Natural Spawning				Hatchery Contribution to Natural Spawning			
	Alt 1	Alt 2	Alt 3	Alt 4	Alt 1	Alt 2	Alt 3	Alt 4	Alt 1	Alt 2	Alt 3	Alt 4	Alt 1	Alt 2	Alt 3	Alt 4
Nooksack Spring	93%	93%	93%	93%	93%	93%	93%	93%	93%	93%	93%	93%	93%	93%	93%	93%
Snohomish	51%	49%	51%	56%	50%	49%	55%	55%	51%	56%	56%	56%	50%	55%	55%	55%
Green-Duwamish	57%	68%	68%	68%	58%	69%	69%	69%	52%	68%	68%	68%	52%	69%	69%	69%

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, November 2004.

Alternative 2 – Escapement Goal Management at the Management Unit Level

Under Alternative 2, the hatchery contribution rate is predicted to remain the same for the Nooksack spring system and increase within the Green-Duwamish River system, compared to Alternative 1. The hatchery contribution rate for the Snohomish River system is predicted to decline slightly under high abundance conditions (similar to those in 2003), and increase under low abundance conditions compared with Alternative 1. The magnitude of stray rates under Alternative 2 would be similar to those under Alternative 1.

Summary of Scenario Differences

As with Alternative 1, no consistent pattern of hatchery contribution rates was indicated across modeled scenarios among the three representative systems under Alternative 2 (Table 4.3.7-7). For the Nooksack spring system, the stray rate is predicted to be consistent across scenarios. For the Snohomish system, the modeled stray rate was lowest under Scenario A (high abundance and Canadian/Alaskan fisheries similar to those in 2003), and Scenario B (high abundance and maximum Canadian/Alaskan fisheries), followed by Scenario D (30% reduction in abundance with maximum Canadian/Alaskan fisheries), and Scenario C (30% reduction in abundance with Canadian/Alaskan fisheries similar to those in 2003). For the Green-Duwamish River system, the modeled stray rate was lowest under Scenarios A and C which had the same predicted stray rate, followed by Scenario B and Scenario D.

As with Alternative 1, there is little predicted variation in hatchery contribution rates across scenarios under Alternative 1 (Table 4.3.7-7). Hatchery strays are predicted to average approximately 93 percent of total natural escapement in the Nooksack spring system; 49 to 56 percent of total natural escapement in the Snohomish River system; and 68 to 69 percent of total natural spawners in the Green-Duwamish River system (Puget Sound Technical Recovery Team 2003).

Comparison of Alternative 2 with Alternative 1 (Proposed Action/Status Quo)

Under Alternative 2, Scenario B, the hatchery contribution rate is predicted to remain the same for the Nooksack spring system; increase by 11 percent for the Green-Duwamish River system, and decline by 1 percent for the Snohomish River system compared to Alternative 1 (Table 4.3.7-7). The magnitude of stray rates under Alternative 2 is predicted to be similar to those predicted under Alternative 1.

Under Alternative 2, Scenarios A, C, or D, the hatchery contribution rate is predicted to remain the same for the Nooksack spring system and increase for the Green-Duwamish River system by 11 to 17 percent compared to Alternative 1. The hatchery contribution rate for the Snohomish River system is predicted to decrease by 1 percent under Scenario A (same as Scenario B), and increase by 5 percent under Scenarios C or D, compared with Alternative 1 (Table 4.3.7-7). The differences in hatchery contribution rate between Alternative 2 and Alternative 1 would be greater under low abundance conditions (Scenarios C or D) than under high abundance conditions (Scenarios A or B) for the Snohomish and Green-Duwamish River systems.

As described under Alternative 1, the population origin of straying hatchery fish, and on-going hatchery reform measures implemented to reduce risks to natural-origin chinook salmon, bear upon any assessment of risk posed by straying hatchery fish to natural-origin fish populations. The hatchery contribution rates estimated under Alternative 2 could be expected to have an elevated adverse affect on the genetic diversity, and potentially on the productivity of natural-origin chinook salmon populations, relative to Alternative 1 for the Snohomish and Green-Duwamish River systems; however, again, the hatchery-origin fish straying within these watersheds are predominantly of native population-origin, which is expected to attenuate the potential for adverse ecological and genetic effects. Scenario B, the most likely to occur over the duration of the Proposed Action (the 2005~~4~~–2009 fishing seasons), is predicted to result in a no to low change in the hatchery contribution rate for the Nooksack spring and Snohomish systems, and a moderate change in the Green-Duwamish system hatchery contribution rate compared to Alternative 1. The greater potential for adverse effects would come from substantial increases in the escapements of hatchery coho and chum salmon that would occur in these areas. The much greater escapement of hatchery coho and chum salmon (Tables 4.3.7-8 and 4.3.7-9) could exacerbate inter-species predation, competition, and genetic diversity effects in some areas. Therefore, primarily as a result of straying non-chinook salmon species, moderate to substantial short- and long-term risks are predicted under Alternative 2 for hatchery fish straying at the levels described above to contribute, combined with other factors for decline, to impairment of the ability of natural populations to sustain themselves.

Alternative 3 – Escapement Goal Management at the Population Level with Terminal Fisheries Only

Under Alternative 1, the hatchery contribution rate is predicted to remain the same for the Nooksack spring system; increase for the Green-Duwamish River system, and have at most a low increase for the Snohomish River system compared to Alternative 1.

Summary of Scenario Differences

As with Alternative 1 or 2, modeled scenarios showed little variation in hatchery contribution rates among the three representative systems. The hatchery contribution rate is predicted to be consistent across scenarios for the Nooksack spring and Green-Duwamish River systems. For the Snohomish system, the modeled stray rate was lowest under Scenario A (high abundance and Canadian/Alaskan fisheries similar to those in 2003). Hatchery contribution rates under Scenarios B (high abundance and maximum Canadian/Alaskan fisheries), D (30% reduction in abundance with maximum Canadian/Alaskan fisheries), or C (30% reduction in abundance with Canadian/Alaskan fisheries similar to those in 2003) are predicted to be higher, but within 1 percent of each other.

Hatchery strays are predicted to average approximately 93 percent of total natural escapement in the Nooksack spring system; 51 to 56 percent of total natural escapement in the Snohomish River system; and 68 to 69 percent of the total natural spawners in the Green-Duwamish River system (Puget Sound Technical Recovery Team 2003).

Comparison of Alternative 3 with Alternative 1 (the Proposed Action/Status Quo)

Under Alternative 3, Scenario B, the hatchery contribution rate is predicted to remain the same for the Nooksack spring system, increase by 5 percent for the Green-Duwamish River system, and increase 11 percent for the Snohomish River system compared to Alternative 1 (Table 4.3.7-7). The magnitude of the hatchery contribution rates under Alternative 3 would be similar to the rates under Alternative 1 or 2.

With the exception of Scenario A for the Snohomish system, Alternative 3 Scenarios A, C, or D are predicted to result in hatchery contribution rates relative to Alternative 1 of within 1 percent of those described for Scenario B. Hatchery contribution rates under Alternative 3, Scenario A, for Snohomish chinook salmon are predicted to be the same as Alternative 1, or 5 percent lower than under Scenario B. Hatchery contribution rates are predicted to range from 55 to 56 percent under Scenarios C and D for the Snohomish River system, and 68 to 69 percent under all scenarios for the Green-Duwamish River system (Table 4.3.7-7).

As described above, the population origin of straying hatchery fish, and on-going hatchery reform measures being implemented to reduce risks to natural-origin chinook salmon, bear upon any assessment of risk posed by the straying hatchery fish to natural-origin fish populations. The hatchery contribution rates estimated under Alternative 3 could be expected to have an elevated adverse affect on the genetic diversity, and potentially on the productivity of the Green-Duwamish and Snohomish system natural-origin chinook salmon populations, relative to Alternative 1; however, again, the hatchery-origin fish straying within these watersheds are predominantly of native population-origin, which is expected to attenuate the potential for adverse ecological and genetic effects. Scenario B, the most likely to occur over the duration of the Proposed Action (the 2005~~4~~–2009 fishing seasons), is predicted to result in a no to low change in the hatchery contribution rate for the Nooksack spring and Snohomish systems, and a moderate change in the Green-Duwamish system contribution rate compared with Alternative 1. The greater potential for adverse effects would come from substantial increases in the escapements of hatchery coho and chum salmon. The much greater escapement of hatchery coho and chum salmon (Tables 4.3.7-8 and 4.3.7-9) could exacerbate inter-species predation, competition, and genetic diversity effects in some areas. Under Alternative 3, primarily as a result of straying of non-chinook species, there would be moderate to substantial short- and long-term risk that hatchery fish straying at the levels described above may contribute, combined with other factors for decline, to impairment of the ability of natural populations to sustain themselves.

Alternative 4 – No Action/No Authorized Take

The estimated hatchery contribution rate comparisons under Alternative 4 would be very similar to those estimated under Alternative 3.

Summary of Scenario Differences

Under Alternative 4, hatchery contribution rates are predicted to differ by 1 percent or less across scenarios for each system (Table 4.3.7-7). Hatchery strays would average approximately 93 percent of total natural escapement in the Nooksack spring system; 55 to 56 percent of total natural escapement in the Snohomish River system; and 68 to 69 percent of total natural spawners in the Green-Duwamish River system (Puget Sound Technical Recovery Team 2003).

Comparison of Alternative 4 with Alternative 1 (the Proposed Action/Status Quo)

The estimated hatchery contribution rates under Alternative 4, Scenario B, would be the same as those estimated under Alternative 3. The results of Scenarios A, C, or D are also predicted to be the same as Alternative 3, except for Scenario A for the Snohomish system (Table 4.3.7-7). The estimated contribution of hatchery-origin spawners to the Snohomish system natural escapement is predicted to increase to 56 percent, compared with 51 percent under Scenario A for Alternative 3 and Alternative 1. However, the magnitude of contribution rates is predicted to be the same as that of Alternative 3, so the level of hatchery-related effects to natural-origin chinook salmon populations associated with Alternative 4 would be unlikely to differ from effects surmised under Alternative 3. The much greater escapements of hatchery coho and chum salmon could exacerbate inter-species predation, competition, and genetic diversity effects in some areas. Under Alternative 4, particularly because of the substantial increases in non-chinook hatchery escapements, there would be moderate to substantial short- and long-term risks that hatchery fish straying at the levels described above may contribute, combined with other factors for decline, to impairment of the ability of natural populations to sustain themselves.

Summary

Hatchery contribution rates of chinook, coho, and chum salmon were predicted to be substantial for all alternatives. Chinook hatchery contribution rates were not predicted to change significantly with change in abundance or the magnitude of northern fisheries; varying 7 percent or less among scenarios for each alternative. The modeled differences in hatchery chinook contribution rates among alternatives were generally low, except for the Green-Duwamish River system where hatchery contribution rates are predicted to increased by as much as 17 percent under low abundance conditions when compared with Alternative 1. The much greater escapements of hatchery coho and chum salmon could exacerbate inter-species predation, competition, and genetic diversity effects in some areas. Particularly because of substantial increases in non-chinook hatchery escapements, there would likely be moderate to substantial short- and long-term risks that hatchery fish straying at the levels described above may contribute, combined with other factors for decline, to impairment of the ability of natural populations to sustain themselves under Alternatives 2, 3, or 4. Under Alternative 1, straying hatchery fish are expected to result in a low to moderate short-term risk of adverse impact to the ability of natural populations to sustain themselves. Impacts over the long-term are also expected to be low to moderate, since Alternative 1 is the baseline condition.

4.3.7.2 Straying of Coho and Chum Salmon

Both total hatchery and natural escapement for coho and chum salmon would show substantial increases (39% to 236%) in escapement under Alternatives 2, 3, or 4 compared with Alternative 1. For each alternative, the change in hatchery escapement is predicted to be 2 to 2.5 times the change in natural escapement (Tables 4.3.7-8 and 4.3.7-9). As with chinook salmon, changes in hatchery and natural escapements would vary by region and management unit. Stray rate estimates are not available for the coho and chum salmon management units in Tables 4.3.7-8 and 4.3.7-9.

Table 4.3.7-8. Comparisons of hatchery- and natural-spawning coho salmon escapement with the proposed action and alternatives. Substantial differences (greater than 30%) in escapement from Alternative 1 are shaded.

COHO	Alternative 1 - Proposed Action		Alternative 2 - Escapement Goal/Manag. Unit Level		Alternative 3 - Escapement Goal/Pop Level/Terminal		Alternative 4 - No Listed Take		Comparisons to the Proposed Action						
										Natural Escapment			Hatchery Escapement		
	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural		Alt2/Alt1	Alt3/Alt1	Alt4/Alt1	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1
Juan de Fuca															
Juan de Fuca	9,513	17,320	17,622	18,819	17,622	18,819	21,732	18,819		9%	9%	9%	1	85%	128%
Regional Average										9%	9%	9%	85%	85%	128%
North Sound															
Nooksack/Samish	27,508	8,182	56,057	14,272	56,057	14,272	56,057	15,305		74%	74%	87%	1	104%	104%
Skagit	5,840	73,624	9,241	109,887	9,241	109,887	9,253	110,022		49%	49%	49%	1	58%	58%
Stillaguamish	1,173	24,017	1,239	28,689	1,317	34,840	1,317	34,840		19%	45%	45%	0	12%	12%
Snohomish	13,494	136,873	17,854	165,820	30,938	187,066	30,938	187,066		21%	37%	37%	0	129%	129%
Regional Average										41%	51%	55%	50%	76%	76%
South Sound															
South Sound	119,369	47,086	233,962	69,945	233,962	69,945	293,781	97,804		49%	49%	108%	1	96%	146%
										49%	49%	108%	96%	96%	146%
Hood Canal															
Hood Canal	11,379	19,012	37,046	28,533	37,046	28,533	41,214	30,345		50%	50%	60%	2	226%	262%
Regional Average										44%	44%	64%	63%	63%	162%
Total	62,859	197,456			230,334	309,828	306,719	334,498	Aver	39%	45%	56%	87%	101%	120%

Table 4.3.7-9. Comparisons of hatchery- and natural-spawning chum salmon escapement with the proposed action and alternatives. Substantial differences (greater than 30%) in escapement from Alternative 1 are shaded.

CHUM	Alternative 1 - Proposed Action		Alternative 2 - Escapement Goal/Manag. Unit Level		Goal/Pop Level/Terminal Only		Alternative 4 - No Listed Take		Comparisons to the Proposed Action						
										Natural Escapment			Hatchery Escapement		
	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural		Alt2/Alt1	Alt3/Alt1	Alt4/Alt1	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1
Juan de Fuca															
Juan de Fuca	--	2,585	--	2,722	--	2,722	--	2,722		5%	5%	5%			
Regional Average										5%	5%	5%			
North Sound															
Nooksack/Samish	7,936	35,610	17,713	79,482	17,713	79,482	17,717	79,501		123%	123%	123%	123%	123%	123%
Skagit	1,834	42,237	2,000	46,071	2,000	46,071	2,000	46,071		9%	9%	9%	9%	9%	9%
Stillaguamish	700	14,400	1,631	34,194	1,668	34,964	1,668	34,964		137%	143%	143%	133%	138%	138%
Snohomish	7,200	17,600	43,262	35,583	43,262	35,583	43,262	35,583		102%	102%	102%	501%	501%	501%
Regional Average										93%	94%	94%	192%	193%	193%
South Sound															
South Sound	17,540	150,923	46,459	399,761	46,459	399,761	51,310	441,499		165%	165%	193%	165%	165%	193%
Regional Average										165%	165%	193%	165%	165%	193%
Hood Canal															
Hood Canal	37,637	50,382	145,084	95,473	145,084	95,473	207,023	99,621		89%	89%	98%	285%	285%	450%
Regional Average										89%	89%	98%	285%	285%	450%
Total	72,846	313,736			256,149	693,285	322,981	739,961	Aver	90%	91%	96%	203%	204%	236%

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, March 2003 and November 2004.

4.3.8 Indirect and Cumulative Effects

4.3.8.1 Indirect Effects

Indirect effects on fish species are those that would be further removed from the direct effects. In the case of listed and unlisted salmonid species affected by the Proposed Action, the primary direct effect would be changes in spawning escapement brought about by changes in catch, and the primary indirect effect would be resulting changes in abundance of the progeny of these spawning populations. Because the action considered in this Environmental Impact Statement applies to a~~ six~~ five-year resource management plan, changes in abundance would be limited to the progeny of spawners returning from ~~2004~~ 2005 to 2010; i.e., progeny returning in~~ 2006~~ 2007–2015. The extent to which increased abundance of the progeny of these spawners may affect spawning abundance in subsequent years depends on freshwater and marine habitat conditions that influence survival, and on the fishing regimes that will be in place after 2010. Of these, marine conditions are thought to play the dominant short-term role.

In the case of chinook salmon, changes in spawning escapement would, theoretically, be most evident in the abundance of progeny returning as Age-3 and Age-4 spawners, though there would also be changes in abundance for Age-2 (precocious) spawners, and the relatively small proportion of chinook populations returning as Age-5 and Age-6 spawners. Similarly, for other species, changes in spawning escapement would apply to subsequent brood years according to the species age-at-maturity profiles. As noted in Subsection 4.3.1, these effects could be beneficial or negative, depending on the magnitude of change and the productivity characteristics of the particular watershed from which a population originates. An indirect effect that would likely result from fishery closures under Alternative 2 is the expected reduction in the amount of lost fishing gear in marine areas closed to fishing and, conversely, an increase in lost fishing gear in those terminal fisheries where fishing may increase. Changes in the number of lost or derelict nets affect the amount of unintended mortality on salmonids and other species that become entangled in lost nets and, to a lesser extent, lost sport fishing tackle. This issue is discussed in Subsection 3.3.5 (~~, ~~Fish Habitat Affected by Salmon Fishing): Affected Environment and Subsections 4.8.1 (Marine Birds) and 4.8.3 (Marine Invertebrates): Environmental Consequences.

A potential advantage to Alternative 1, which makes use of exploitation rate management strategies for many populations, is that, properly applied, exploitation rate management strategies are more robust about uncertainties in key parameters like survival and management error (Walters and Parma 1996) than fixed escapement goal strategies like those in Alternatives 2 and 3. ~~Given the imprecision of abundance forecasts, t~~This can be an important advantage, especially when combined with a strategy to use conservative parameters in forecasting (Fieberg ~~in press~~ 2004). Exploitation management strategies can also result in less variable harvests from year to year (Hilborn and Walters 1992; Walters and Parma 1996), an important factor for fishermen that rely on fishing for their family income. Also, in practical terms, true fixed escapement goal harvest management is difficult to impossible to implement. When direct and incidental harvest is regulated under several jurisdictions (national and international), it is not possible to actually reduce harvest exploitation rates to zero when threshold escapement levels cannot be achieved, although they can be significantly reduced.

Fieberg (2004) considered the uncertainty associated with estimating population productivity and with managing fisheries (i.e., management and forecast error) to achieve escapement thresholds or target exploitation rates under several harvest management strategies. His analysis showed that, given the uncertainty associated with estimating population productivity, and with implementing harvest management, imposing exploitation rate harvest objectives could result in more stable harvest than a fixed escapement goal strategy, without increasing the risk of population extinction.

Fieberg examined the probability of extinction (as measured over 50 years and compared with the probability under a minimal harvest condition) using several risk criteria, and found that it was consistently greater using a fixed escapement goal management strategy than under exploitation rate strategies regardless of the risk criterion used. The probability of extinction was significantly increased under the fixed escapement goal strategy when survival rates were biased (survival was actually lower than assumed). The exploitation rate strategies showed low or no increased probability of extinction under biased survival compared with unbiased estimates of survival. The reason is that the optimal parameters; i.e., harvest objectives (critical escapement threshold and exploitation rate designed to maximize harvest), under the fixed escapement goal strategy are close to the risk criteria as compared to those of the exploitation rate strategies. Therefore, even slight errors in the determination of the optimal parameters would result in probabilities of extinction greater than the risk criteria. The probability of extinction was greatly reduced when management buffers (i.e. setting escapement thresholds high to accommodate forecast and management error, or setting exploitation targets lower) were used such that the probability of extinction was low across all management strategies under unbiased survival rates. When survival rates were biased as may be the case in actual harvest management, the probability of extinction was once again much higher for the fixed escapement goal strategy compared with the exploitation rate strategies, although significantly lower than without the use of management buffers.

Expected harvest was generally equivalent for different management strategies[xv], except when forecast error was very high, because in this circumstance a high threshold is required to maintain low extinction risk. Exploitation rate strategies generally require 'trading' lower exploitation rate objectives for lower thresholds, thereby constraining harvest in high abundance years in exchange for allowing more harvest in low abundance years, again while maintaining low extinction risk. In general, increasing threshold parameters will result in more variable yields over time, but may also increase the average long-term harvest (relative to the same strategy employed with a lower threshold and lower exploitation rate parameter). Thus, there are tradeoffs in terms of maximizing catch versus reducing variability in catch that can be controlled to some extent by adjusting threshold parameters or adjusting exploitation rate parameters.

These tradeoffs are also inherent in the various harvest strategies. In a sense, the exploitation rate strategy, similar to that proposed in Alternative 1, trades lower escapement thresholds for lower exploitation rates when forecasted abundances are above these thresholds. As such, the exploitation rate strategy would harvest more fish at low forecasted abundances than the fixed escapement goal strategy of Alternatives 2 or 3, but fewer fish at high forecasted abundances.

The analysis clearly identifies the elevated extinction risk associated with failing to incorporate uncertainty in estimating populations parameters (e.g., productivity) when determining the optimal harvest threshold. It also points out the risk of underestimating the true critical escapement threshold for a population, whether the harvest strategy involves escapement thresholds or exploitation rates.

Regardless of the strategy, the methods used to optimize the strategies are likely to be as important as the strategy itself. Fieberg's analysis demonstrated the advantage of using management buffers. The results suggest that using buffers may provide a high degree of insurance against over-harvesting without a big loss in terms of realized harvest. Harvest benefits were very slightly decreased, while reducing the risk of extinction. The Proposed Action incorporates such buffers by setting the low abundance threshold substantially above the critical level, and by incorporating management error in the simulation model used to determine RERs.

[xv] Because Fieberg concluded that absolute zero harvest below an escapement threshold was impractical, all the management strategies he evaluated had some level of harvest allowed below the escapement threshold, although it was minimal under some strategies. Therefore, his escapement goal strategies were not exactly the same as those of Alternatives 2 and 3 in which no harvest occurs at abundances below the escapement threshold.

Another advantage of Alternative 1 compared to Alternative 2 (or 3) is that, at higher abundances, Alternative 1 would be expected to return even more chinook spawners than under fixed escapement goal management as exemplified by Alternative 2. The high abundance scenarios (Scenarios A and B) support this for some systems (e.g., the Stillaguamish River, Snohomish River, Puyallup River). As population abundance increases above current levels, this would be expected to be the case for more chinook river systems. Conversely, under significantly lower abundance, Alternative 1 would be expected to return fewer spawners than under fixed escapement goals for Alternatives 2 or 3, although the current modeling of Scenarios B and D do not reflect this even at a 30 percent reduction in abundance from current levels.

Indirect Effects of Alternative 2 (Escapement Goal Management at the Management Unit Level or Alternative 3 (Escapement Goal Management at the Population Level) on Listed Chinook and Chum Salmon Populations

The direct effects of predicted spawning escapement for Alternative 2, Scenario B (considered the most likely abundance scenario) compared to Alternative 1, Scenario B were predicted to be of a low to moderate beneficial nature for 11 of the 22 populations in the listed Puget Sound Chinook Evolutionarily Significant Unit. (Modeled results of spawning escapement showed an increase from 2% to 26%.) Given favorable river and marine survival conditions, and fishing regimes resembling those in place prior to the action, these increases could result in low to moderate increases in spawning returns. However, similar decreases in exploitation rates for some of these same chinook salmon populations observed in recent years have not been accompanied by increases in natural-origin spawners. This suggests that habitat factors may be the primary constraint on natural production (NMFS 2004 [4(d) determination]), and therefore increases in parental escapement would not result in increased abundance in subsequent generations.

Modeled results of changes in chinook salmon spawning escapement for the remaining populations varied. Most notably, escapement was predicted to decline by 60 percent for the North Fork and South Fork Stillaguamish chinook salmon populations. Escapement of the Puyallup River fall and White River Spring chinook salmon populations both were predicted to decline substantially (50% and 31%, respectively). Changes of these magnitudes would be much more likely to have measurable effects on abundance and escapement of the subsequent brood years. As noted in Subsection 4.3.1.2, however, escapements of the North Fork Stillaguamish, Puyallup and White River chinook salmon populations under Alternative 2 were predicted to meet current-condition escapement goals. Therefore, it is not necessarily accurate to assume that the indirect effect of Alternative 2 would be substantially negative.

The indirect effects of Alternative 3 would be essentially the same as Alternative 2, with the exception that the Stillaguamish chinook salmon management unit, where escapement was predicted to decline 60 percent relative to Alternative 1 under Alternative 2, would increase by approximately 7 percent relative to Alternative 1, under Alternative 3.

Fixed escapement goal management strategies, as in Alternative 2 or 3, are less robust to uncertainties in key parameters like survival and management error~~. Given the imprecision of abundance forecasts, this could be an important advantage~~ (Fieberg 2004 ~~*in press*~~).

Indirect Effects of Alternative 4 (No Fishing) on Listed Chinook and Chum Salmon Populations

The direct effects of Alternative 4 (No Fishing) would be an increase in escapement for all Puget Sound chinook salmon populations relative to Alternative 1 (the Proposed Action). In North Puget Sound and the Strait of Juan de Fuca, increases in chinook salmon escapement would be very similar to the increases under Alternative 2 or 3. In South Puget Sound and Hood Canal, increases in chinook salmon escapement are predicted to range from 5 percent for the Mid-Hood Canal chinook salmon population, to 190 percent for the Nisqually chinook salmon population. In addition to the substantial increase in spawning escapement for the Nisqually chinook salmon population, increases of 75 percent for the Green River population, 31 percent for the Puyallup River population, and 92 percent for the Skokomish River population were predicted by the model. Increased escapements of this magnitude could result in moderate to substantial increases in the spawning escapement of subsequent brood years. However, there is also a possibility that escapements substantially in excess of current-condition escapement goals would result in decreased survival owing to overcrowding of available freshwater spawning and rearing habitat, and increased competition for food. However, much less severe decreases in exploitation rates for some of these same populations observed in recent years have not been accompanied by increases in natural-origin chinook salmon spawners. This suggests that habitat factors may be the primary constraint on natural production (NMFS 2004 [4(d) determination]), and therefore increases in parental escapement would not result in increased abundance in subsequent generations.

Indirect Effects of Alternative 2 or 3 on Other Salmon Species

As noted in Subsections 4.3.2.2 and 4.3.2.3, Alternative 2 or 3 would substantially increase escapement of coho, pink, and fall chum salmon relative to Alternative 1. Modeling results predicted that overall escapement of naturally-spawning fish would increase from 44 percent to 136 percent depending on the species and the harvest management alternative selected. While this could have the effect of substantially increasing escapement of subsequent brood years, modeled escapements in many management units substantially exceed current-condition escapement goals, and could result in decreased productivity. For many coho salmon management units, exploitation rate objectives are based on stock recruit functions which would predict that large increases in escapement would not result in substantial increases in progeny (personal communication via e-mail from William Beattie to The William Douglas Company, February 17, 2004). There would be similarly large increases in the escapement of hatchery-origin spawners, with the likely result that there would be increased straying of hatchery fish to the spawning grounds. The indirect effects on sockeye populations would be low or none. Indirect effects on steelhead populations would be low or none owing to the very small changes in catch on this species under either Alternative 2 or 3.

4.3.8.2 Cumulative Effects of the Proposed Action or Alternatives on Fish Species

NEPA defines cumulative effects as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR1508.7). For the purpose of this discussion, the terms "effects" and "impacts" will be considered synonymously with "consequences," and consequences may be negative or beneficial. This subsection presents an analysis of the cumulative effects (negative or beneficial) of the Proposed Action on fish resources in the context of other local, state, tribal, and federal management activities in the Puget Sound region.

The geographic scope of the cumulative effects analysis area includes the entire Puget Sound region. The analysis area covers both inland and marine environments that are managed under laws, policies, regulations, and plans having a direct or indirect impact on fish. The substantive scope of the cumulative effects analysis is predicated on a review of laws, policies, regulations, and plans that specifically pertain to fish-related management activities or that have an indirect negative or beneficial effect on fish resources. These laws, policies, regulations, and plans are described in Section 1 and Appendix F. Due to the geographic scope of the analysis area, it is not feasible to analyze all habitat-specific activities that are occurring, have occurred in the past, or that will occur in the future in a quantitative manner. By reviewing applicable laws, policies, regulations, and plans, the analysis captures the objectives of management activities that are occurring or are planned to occur that may interface with fish resources within the Puget Sound region. It is assumed that no management activity is occurring or would occur outside of an implemented law, policy, regulation, or sanctioned plan at the federal, tribal, state, or local level. Although the analysis is necessarily qualitative, it provides a thorough review of other activities within the region that, when combined with the Proposed Action, could have a negative or beneficial affect on fish resources. Table 4.3.8.2-1 summarizes the potential cumulative effects of implementing the Proposed Action or alternatives with the effects of these existing plans, policies, programs, and laws.

The Proposed Action is implementation of the Puget Sound Chinook Harvest Resource Management Plan (RMP), jointly prepared by the Washington Department of Fish and Wildlife (WDFW) and the Puget Sound Treaty Tribes (co-managers). Factors common to the relationship between the RMP and the various existing plans, policies and programs include: 1) the Resource Management Plan would provide protection to Puget Sound chinook salmon by conserving the productivity, abundance, and diversity of populations within the Puget Sound Chinook Evolutionarily Significant Unit (ESU), while managing harvest of strong salmon stocks; and 2) conserving productivity requires biological integrity in the freshwater systems in which salmon spawn and rear. As shown in Table 4.3.8.2-1, the RMP would be consistent with the intent and policies of each of the federal, tribal, state, and local plans, programs, and laws reviewed for the cumulative effects analysis, and is predicted to enhance the benefits of these other measures as they relate to the conservation and/or enhancement of fish and wildlife habitat and fish populations.

Table 4.3.8-1. Federal, Tribal, Washington state, and local plans, policies, and programs that influence fish within the Puget Sound Action Area: 2004.

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of earliest to most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
Fish and Wildlife Coordination Act, 1956, as amended in 1964 (FWCA).	The FWCA recognizes "the vital contribution of our wildlife resources to the Nation, the increasing public interest and significance thereof due to expansion of our national economy and other factors, and to provide that wildlife conservation shall receive equal consideration and be coordinated with other features of water-resource development programs through the effectual and harmonious planning, development, maintenance, and coordination of wildlife conservation and rehabilitation."	The Resource Management Plan would allow the harvest of salmon in coordination with ongoing conservation and rehabilitation efforts for chinook salmon. With an estimated value of $35 million ($16.2 million commercial plus $18.8 million recreational), the Puget Sound fishing industries are important to the Nation's economy. The Proposed Action would be consistent with the FWCA by recognizing the vital contribution of Puget Sound chinook salmon to the Nation and our national economy. It is predicted that implementation of the Resource Management Plan, in combination with the FWCA, would strive to balance considerations of the national economy, while also providing for fish conservation.
Washington State Shoreline Management Act of 1971 (SMA).	The SMA was adopted in Washington in 1972 with the goal of "prevent[ing] the inherent harm in an uncoordinated and piecemeal development of the state's shorelines." The provisions of this law are designed to guide the development of the shoreline lands in a manner that will promote and enhance the public interest. The law expresses the public concern for protection against adverse effects to public health, the land and its vegetation and wildlife, and the aquatic life of the waters.	Rearing habitat within shoreline areas of Washington State is essential to conserving the productivity of Puget Sound chinook salmon. Consequently, the Proposed Action would be consistent with the SMA by ensuring that harvest works in concert with habitat protection efforts under the SMA. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the SMA, would protect fish from adverse effects associated with uncoordinated and piecemeal development of the state's shorelines.
The National Marine Sanctuaries Act. Also known as Title III of the Marine Protection, Research, and Sanctuaries Act of 1972 **(MPRSA)**.	The MPRSA authorizes the Secretary of Commerce to designate and manage areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or a esthetic qualities as National Marine Sanctuaries. One of the purposes and policies of the MPRSA is "to maintain the natural biological communities in the national marine sanctuaries, and to protect, and, where appropriate, restore and enhance natural habitats, populations, and ecological processes."	Protecting the marine environment where chinook salmon mature is important to conserving the productivity of Puget Sound chinook salmon. Consequently, the Proposed Action would be consistent with the MPRSA by maintaining chinook salmon populations of the natural biological communities in the marine environment. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the MPRSA, would strive to restore and enhance natural habitats, populations, and ecological processes of fish.

Table 4.3.8-1. Federal, Tribal, Washington state, and local plans, policies, and programs that influence fish within the Puget Sound Action Area: 2004 *(continued)*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of earliest to most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
Coastal Zone Management Act of 1972 (CZMA), as amended through The Coastal Zone Protection Act of 1996.	The CZMA declares the national policy is "to preserve, protect, develop, and where possible, to restore or enhance, the resources of the Nation's coastal zone for this and succeeding generations by "the protection of natural resources, including wetlands, floodplains, estuaries, beaches, dunes, barrier islands, coral reefs, and fish and wildlife and their habitat, within the coastal zone."	Chinook salmon are one of the Nation's resources within the CZMA's coastal zone. The Proposed Action would be consistent with the CZMA by encouraging preservation and protection of Puget Sound chinook salmon and their habitat within the coastal zone for existing and succeeding generations, and by ensuring that harvest is consistent with the production and capacity of the habitat. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the CZMA, would preserve, protect, restore or enhance the fish resources of the Nation's coastal zone.
Marine Mammal Protection Act of 1972, as amended through 1996 (MMPA).	The MMPA establishes a Federal responsibility to conserve marine mammals, with management vested in the Department of Commerce for cetaceans and pinnipeds other than walrus. The MMPA states that the "Secretary must undertake a program of research and development for improving fishing methods and gear to reduce to the maximum extent practical the incidental taking of marine mammals in commercial fishing." To meet this requirement, the "Secretary must issue regulations to reduce to the lowest practical level the taking of marine mammals incidental to commercial fishing operations." Secretary of Commerce has issued regulation that prohibits deterrent devices that might seriously injure or kill a marine mammal and for fishermen to report unintentional marine mammal mortality.	The Proposed Action would be consistent with the MMPA to conserve marine mammals because the fisheries would be in compliance with Department of Commerce regulations to reduce to the lowest practical level the take of marine mammals incidental to commercial fishing operations. Although not specifically addressed in the Resource Management Plan, Department of Commerce regulations require Puget Sound fishermen to use non-lethal deterrent devices and to report unintentional marine mammal mortality. As chinook salmon are prey of marine mammals, implementation of the Resource Management Plan, in combination with the MMPA, is predicted to potentially reduce the amount of available prey for marine mammals over what would have been available had the fisheries not occurred. It is also true that the fisheries reduce the number of salmon in the short term because they are removing fish, some of which would otherwise spawn. Over the long term, however, it is expected that the RMP will aid in the recovery of the populations by ensuring that enough fish escape to produce more in subsequent generations as habitat improves.

Table 4.3.8-1. Federal, Tribal, Washington state, and local plans, policies, and programs that influence fish within the Puget Sound Action Area: 2004 *(continued)*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of earliest to most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
The Endangered Species Act of 1973, as amended through December, 1996 (ESA).	The purpose of the ESA is "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species…" On July 10, 2000, NMFS issued a rule under section 4(d) of the ESA (referred hereafter as the 4(d) Rule). The 4(d) Rule provided limits on the application of the take prohibitions; i.e., take prohibitions would not apply to the plans and activities set out in the rule if those plans and activities adequately address criteria of the rule, including that implementation and enforcement of the resource management plan will not appreciably reduce the likelihood of survival and recovery of affected threatened ESUs.	The Puget Sound Chinook Salmon ESU is listed as threatened under the ESA. The Proposed Action to implement the Puget Sound Chinook Salmon Resource Management Plan includes a condition that the Secretary of Commerce will determine whether the Resource Management Plan adequately addresses the criteria outlined in Limit 6 of the ESA 4(d) Rule. Consequently, the Proposed Action would be consistent with the ESA by meeting these criteria designed to foster goals and objectives of the ESA, including to avoid appreciably reducing the likelihood of survival and recovery of Puget Sound chinook salmon ESU. The ESA would not only have a beneficial impact to listed Puget Sound chinook salmon, but species listed under the ESA also include predators of chinook salmon such as bull trout and bald eagle. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the ESA, would potentially have both unquantifiable beneficial and adverse impacts on fish resources.
United States of America, Plaintiff, Quinault Tribe of Indians on its own behalf and on behalf of the Queets Band of Indians, et al., Intervenor-Plaintiffs, v. State of Washington, Defendant, Thor C. Tollefson, Director, Washington State Department of Fisheries, et al., Intervenor-Defendants, Case number C70-9213, February 12, 1974 (Boldt Decision).	The Boldt Decision reaffirmed the rights of Washington Indian tribes to fish in accustomed places, and allocated 50 percent of the annual catch to treaty tribes. Judge Boldt held that the government's promise to secure the fisheries for the tribes was central to the treaty-making process, and that the tribes had an original right to the fish, which they extended to white settlers. Judge Boldt ordered the state to take action to limit fishing by non-Indians. The court decision recognized that "assuring proper spawning escapement is the basic element of conservation involved in restricting the harvest of salmon and Steelhead." The decision further defined adequate production escapement as "… that level of escapement from each fishery which will produce viable offspring in numbers to fully utilize all natural spawning grounds and propagation facilities reasonable and necessary for conservation of the resource…"	The objectives and principles of the Resource Management Plan jointly developed by the co-managers include compliance with the requirements of the Boldt Decision. The Boldt Decision would not have an appreciable effect on the total harvest, but addresses which party and where the harvest can occur. The Boldt Decision encourages the conservation of the species. The Resource Management Plan would conserve the productivity, abundance, and diversity of chinook salmon populations within the ESU. Therefore, it is predicted that implementation of the Resource Management Plan, in combination with the Boldt Decision, would have a beneficial impact on fish resources.

1 Table 4.3.8-1. Federal, Tribal, Washington state, and local plans, policies, and programs that influence fish within the Puget Sound Action Area:
2 2004 *(continued)*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of earliest to most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
State of Washington, Chapter 76.09 of the Revised Code of Washington (RCW), Forest Practices Act (FPA), 1974.	The FPA defines a plan to protect public resources while assuring that Washington continues to be a productive timber-growing area. The FPA regulates activities related to growing, harvesting or processing timber on all local government, state and private forest lands. The Washington Forest Practices Board was established in 1975 by the Legislature under the State Forest Practices Act. By law, the board is charged with establishing rules to protect the state's natural resources while maintaining a viable timber industry. Those rules, as embodied in the Washington Administrative Code (WAC), specifically consider the effects of various forest practices on fish, wildlife and water quality, as well as on capital improvements of the state or of its political subdivisions.	The Proposed Action would be consistent with the intent of the FPA to protect the natural resources of Washington State. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the FPA, would have a net beneficial impact on fish resources.
The Clean Water Act, 1977, (CWA). A 1977 amendment to the Federal Water Pollution Control Act (FWPCA) was titled "The Clean Water Act."	The objective of the CWA is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. As stated in the CWA, maintaining or restoring water quality "provides for the protection and propagation of fish, shellfish, and wildlife…"	The fisheries that would be allowed by the Resource Management Plan are predicted to have minimal to negligible effect on the Nation's water quality. Primarily because the CWA would maintain water quality that provides for the protection and propagation of fish, it is predicted that implementation of the Resource Management Plan, in combination with the CWA, would have a net beneficial impact on fish resources.
The Treaty between the Government of Canada and the Government of the United States of America concerning Pacific Salmon, 1985, including 1999 revised annexes (Pacific Salmon Treaty).	The Pacific Salmon Treaty calls on the U.S. and Canada (Parties) to conduct its fisheries as to "prevent overfishing and provide for optimum production." The Pacific Salmon Treaty defines "overfishing" as "fishing patterns which result in escapements significantly less than those required to produce maximum sustainable yields [MSY]." Annex IV, Chapter 3, Chinook Salmon of the Pacific Salmon Treaty further states that the Parties shall establish a chinook management program that "sustains healthy stocks and rebuilds stocks that have yet to achieve MSY or other biologically-based escapement objectives." Salmon subject to the Pacific Salmon Treaty includes Pacific salmon stocks which originate in the waters of one Party and subject to interception by the other Party.	Puget Sound chinook salmon are intercepted in Canadian fisheries under the authority of the Pacific Salmon Treaty. The Resource Management Plan accounts for all sources of fishery-related chinook salmon mortality, including mortality related to Canadian fisheries. Although the Resource Management Plan would allow exploitation rates that would result in escapements less than those required to produce maximum sustainable yields in some years, the Resource Management Plan would, overall, sustain healthy populations and rebuild stocks toward maximum sustainable yield. Consequently, the Proposed Action would be consistent with the Pacific Salmon Treaty. Accordingly, it is predicted that the implementation of the Resource Management Plan, in combination with the Pacific Salmon Treaty, would have a net beneficial impact on fish resources.

Table 4.3.8-1. Federal, Tribal, Washington state, and local plans, policies, and programs that influence fish within the Puget Sound Action Area: 2004 *(continued)*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of earliest to most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
State of Washington, Chapter 36.70A RCW Growth Management – Planning by Selected Counties and Cities. Commonly referred to as the Growth Management Act **(GMA)**. Adopted by the state in 1990.	The GMA guides the development and adoption of comprehensive land use plans and development regulations of counties and cities within the state of Washington. The goals of the GMA include: "[m]aintain and enhance natural resource-based industries, including productive timber, agricultural, and fisheries industries" and "[p]rotect the environment and enhance the state's high quality of life, including air and water quality, and the availability of water."	The fisheries that would be allowed by the Resource Management Plan are predicted to have minimal to negligible effect on Washington State water quality. It is predicted that implementation of the Resource Management Plan would provide protection for fish conservation, and would not conflict with planned growth objectives of the GMA.
Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl, commonly referred to as the Northwest Forest Plan **(NFP)**, 1994.	The NFP is an integrated, comprehensive design for ecosystem management, intergovernmental and public collaboration, and rural community economic assistance for federal forests in western Oregon, Washington, and northern California. The management direction of the NFP consists of extensive standards and guidelines, including land allocations that comprise a comprehensive ecosystem management strategy. Aquatic conservation strategy objectives outlined in the NFP (Attachment A of the NFP) include, but are not limited to: "Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations and communities are uniquely adapted;" and, "Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities."	The Proposed Action would be consistent with the intent of NFP to maintain and restore the distribution, diversity, and complexity of watersheds. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the NFP, would have a net beneficial impact on fish resources.

Table 4.3.8-1. Federal, Tribal, Washington state, and local plans, policies, and programs that influence fish within the Puget Sound Action Area: 2004 *(continued)*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of earliest to most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
Magnuson-Stevens Conservation and Management Act, as amended through October 11, 1996 (MSCMA).	The stated purpose of the MSCMA is "to promote domestic commercial and recreational fishing under sound conservation and management principles." The MSCMA is "to provide for the preparation and implementation, in accordance with national standards, of fishery management plans which will achieve and maintain, on a continuing basis, the optimum yield from each fishery." The MSCMS defines the term "optimum," with respect to the yield from a fishery, as the amount of fish which -- a) will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems; b) is prescribed as such on the basis of the maximum sustainable yield from the fishery, as reduced by any relevant economic, social, or ecological factor; and c) in the case of an overfished fishery, provides for rebuilding to a level consistent with producing the maximum sustainable yield in such fishery. The National Standards that serve as the overarching objectives for fishery conservation and management include:	Based on consistency with the National Standards addressed below, it is predicted that implementation of the Resource Management Plan, in combination with the MSCMA, would have a net beneficial impact on fish resources.
	• Conservation and management measures shall prevent overfishing. The terms "overfishing" and "overfished" mean a rate or level of fishing mortality that jeopardizes the capacity of a fishery to produce the maximum sustainable yield on a continuing basis.	• The Resource Management Plan provides for rebuilding to a level consistent with producing the maximum sustainable yield in the fishery. Consequently, the Proposed Action would be consistent with the National Standard that the management plan "shall prevent overfishing," as defined in the MSCMA.
	• Conservation and management measures shall be based upon the best scientific information available.	• The objectives of the Resource Management Plan include adequately addressing the criteria of a management plan under Limit 6 of the ESA 4(d) Rule. ESA requires the Secretary of Commerce to make such determinations on the basis of the best scientific and commercial data available. Consequently, the Proposed Action would be consistent with the National Standard of the MSCMA to use the best scientific information available.

Table 4.3.8-1. Federal, Tribal, Washington state, and local plans, policies, and programs that influence fish within the Puget Sound Action Area: 2004 *(continued)*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of earliest to most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
Magnuson-Stevens Conservation and Management Act, as amended through October 11, 1996 (MSCMA), *continued*	• To the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated populations of fish shall be managed as a unit or in close coordination.	• For harvest management purposes, the Resource Management Plan defines 15 Puget Sound chinook salmon management units. The Resource Management Plan defines a management unit as a "stock or group of [chinook salmon] stocks which are aggregated for the purpose of achieving a management objective." The Resource Management Plan places limits to the cumulative fishery-related mortality to each Puget Sound chinook salmon population or management unit throughout its entire range. Thus, the Resource Management Plan accounts for all sources of fishery-related chinook salmon mortality throughout its range. The Proposed Action would be consistent with the National Standard of the MSCMA to manage populations throughout its range.
	• Conservation and management measures shall take into account and allow for variations among, and contingencies in, fisheries, fishery resources, and catches.	• As outlined in the Resource Management Plan, in managing fisheries in-season, the co-managers would implement guidelines established during the pre-season planning process to meet conservation requirements. However, these guidelines could be modified in-season based on in-season assessments of effort, catch, abundance, and escapement, while still meeting conservation requirements. Consequently, the Proposed Action would be consistent with the National Standard of the MSCMA to allow contingencies in fisheries.
	• Conservation and management measures shall minimize by-catch.	• The Resource Management Plan is based on limits to the cumulative fishery-related mortality to each Puget Sound chinook salmon population or management unit. The Proposed Action would limit the cumulative mortality, which includes by-catch, to these limits. Consequently, the Proposed Action would be consistent with the National Standard of the MSCMA to minimize by-catch.

Table 4.3.8-1. Federal, Tribal, Washington state, and local plans, policies, and programs that influence fish within the Puget Sound Action Area: 2004 *(continued)*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of earliest to most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
Gravel to Gravel, Regional Salmon Recovery Policy for the Puget Sound and the Coast of Washington, Western Washington Treaty Tribes, July 25, 1997 (Gravel to Gravel Policy).	Major elements of the Gravel to Gravel Policy are to provide habitat protection and restoration, ensuring abundant spawners, managing fisheries, and integrating hatchery production.	The Proposed Action would be consistent with the Gravel to Gravel policy of managing fisheries to ensure abundant spawners. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the Gravel to Gravel Policy, would have a beneficial impact on fish resources.
Policy of Washington Department of Fish and Wildlife and Western Washington Treaty Tribes Concerning Wild Salmonids (Wild Salmon Policy). Adopted by Washington Fish and Wildlife Commission on December 5, 1997. (Despite the title, the tribal governments have not adopted this Wild Salmon Policy.)	The stated goals of the Wild Salmon Policy include restoring Washington stocks of wild salmon and steelhead to healthy, harvestable runs by "managing commercial and sport fishing to ensure enough wild runs return to spawn while providing fishing opportunities where possible."	The Proposed Action would be consistent with the Wild Salmon Policy's intent to manage commercial and recreational fishing to ensure enough wild salmon return to spawn while providing fishing opportunities where possible. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the Wild Salmon Policy, would have a beneficial impact on fish resources.
Statewide Strategy to Recover Salmon, September 21, 1999 (SSRS).	The goal of the SSRS is to "[r]estore salmon, steelhead, and trout populations to healthy and harvestable levels and improve the habitats on which fish rely." The SSRS is the long-term vision or guide for salmon recovery within the State of Washington.	The Proposed Action would be consistent with the intent of SSRS to restore salmon populations to healthy and harvestable levels. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the SSRS, would have a beneficial impact on fish resources.
Local Plans, Policies, and Programs	Local activities that influence cumulative effects to fish include, but are not limited to: **Water Supply Projects:** Local water departments operate and maintain water reservoirs, pump stations, and water mains to deliver drinkable water to their customers. Local projects have minimized the adverse impacts of water withdrawal by installing additional water gauges to monitor flows and regulate water use, reducing water intake during critical environmental periods, and by purchasing existing water rights to return water to the system.	Many of these local activities are conducted in cooperation with federal, tribal, and state actions. The fisheries that would be allowed by the Resource Management Plan are predicted to have minimal to negligible effect on Washington State water quality. Because many of these local plans, policies, and programs would maintain water quality that provides for the protection and propagation of fish, it is predicted that the implementation of the Resource Management Plan, in combination with local plans, policies, and programs, would have a net beneficial impact on fish resources.

Table 4.3.8-1. Federal, Tribal, Washington state, and local plans, policies, and programs that influence fish within the Puget Sound Action Area: 2004 *(continued)*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of earliest to most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
Local Plans, Policies, and Programs, *continued*	**Levee Maintenance:** A levee is a natural or manmade structure, usually earthen or riprap, which parallels the course of a river. It functions to prevent flooding of the adjoining countryside. However, it also confines the flow of the river resulting in higher, faster water flow. In recent years, local levee maintenance projects have included setting back or removing levees. **Stormwater Management:** Surface water runoff results from rainfall or snow melt that does not infiltrate the ground or evaporate due to impervious surfaces. instead, this runoff flows onto adjacent land, or into watercourses, or is routed into storm drainage collection systems managed by local entities. Local cities and counties are in the process of developing watershed plans, subbasin plans, and revising codes to minimize the adverse impacts of surface water runoff. **Wastewater Treatment Projects:** Municipal wastewater treatment plants process domestic sewage, and commercial and industrial wastewaters. Stormwater and groundwater infiltration may also enter wastewater treatment plants, though efforts are being made to segregate these flows. Local cities and counties are in the process of developing facilities plans and revising codes to minimize adverse impacts associated with wastewater treatment projects. **Salmon Recovery Efforts:** Local communities are undertaking activities to protect listed species and their habitat. Examples of activities conducted include, but are not limited to: reducing barriers to fish passage; improving habitat forming processes; increasing channel diversity; improving estuarine habitat; and enhancing streamside vegetation. **Watershed Conservation Plans:** As mandated by the 1998 state of Washington Watershed Management Act and Salmon Recovery Planning Act, counties are conducting watershed planning to address water quality, water quantity, and salmon habitat issues.	

4.4 Tribal Treaty Rights and Trust Responsibility

This section qualitatively evaluates the Proposed Action and alternatives with respect to their impact on the ability of the Puget Sound tribes to exercise their treaty rights to harvest salmon. Subsection 3.4, Tribal Treaty Rights and Trust Responsibilities – Affected Environment, described how these treaty rights were interpreted and affirmed by federal courts in U.S. v. Washington, and subsequent judicial oversight of the tribes' co-management role and harvest allocation. As explained in Subsection 3.4, the role of the federal government's oversight of Puget Sound fisheries is to assure that treaty rights are protected by federal, state, and local government entities, and to ensure that harvest actions implemented by the co-managers meet the requirements of the Endangered Species Act. The following discussion also evaluates the implications under federal trust responsibility of implementing the Proposed Action or one of the alternatives.

The substantial negative consequences of Alternative 2, 3, or 4 are presented here in a legal context, relative to the scope of conservation measures that are granted to NMFS as it implements the Endangered Species Act, complies with treaty rights, and fulfills its trust responsibility. The reader is referred to Subsections 4.5, Treaty Indian Ceremonial and Subsistence Salmon Uses; 4.6, Economic Activity and Value; and 4.7, Environmental Justice, of this Environmental Impact Statement for more detailed discussion of the economic and cultural consequences to the Puget Sound tribes.

The following comparison of the impacts of the four alternatives is based on Scenario B, which assumes that the abundance of Puget Sound chinook salmon will be similar to that projected in 2003, and that intercepting fisheries in British Columbia (Canada) and Alaska will harvest at the maximum level allowed under the Puget Salmon Treaty (PST) Annex 4 Chapter 3. Though the different abundance and northern fishery scenarios examined elsewhere in this Environmental Impact Statement imply different harvest levels in Puget Sound, the difference among alternatives with respect to qualitative impacts on the exercise of treaty rights would not change.

4.4.1 Alternative 1 – Proposed Action/Status Quo

Implementation of Alternative 1 would have low or no impact on treaty fisheries as they are currently conducted. Provided that the abundance of salmon stocks is sufficient to allow harvestable surpluses of the magnitude modeled under this alternative, the tribes are predicted to be able to continue accessing their usual and accustomed fishing areas, and to harvest substantial numbers of coho, sockeye, pink, chum salmon, and steelhead (see Table 4.7-5 in Subsection 4.7, Environmental Justice). The chinook salmon conservation measures contained in the Resource Management Plan (Appendix A to this

Environmental Impact Statement) imply relatively moderate constraints on access to these species, in order to reduce incidental impact to listed chinook salmon. Under Alternative 1, chinook salmon harvest would be substantially restricted, relative to historical levels, because of conservation requirements necessary to protect weak chinook populations. However, these restrictions would be voluntarily adopted by the tribes, in consultation with the State of Washington (Washington Department of Fish and Wildlife), as co-managers of Puget Sound fisheries.

Alternative 1 meets the requirement of the Secretarial Order that the restriction: 1) does not discriminate against Indian activities, and 2) incorporates voluntary tribal measures to achieve the necessary conservation purpose (Secretarial Order Number 3206, June 5, 1997). Alternative 1 would comport with the legal requirement that restriction on treaty fisheries be implemented in the least restrictive manner necessary in order to continue tribal access to naturally- and hatchery-produced salmon, while conserving natural populations. Therefore, Alternative 1 is predicted to be consistent with the federal trust responsibility to protect and provide tribal fishing opportunities. However, it is important to note that the Puget Sound tribes do not construe the fishing opportunity or harvest that would occur under Alternative 1 as satisfying treaty rights given the reduction in tribal harvest opportunity and catch that has occurred with the decline of Puget Sound salmon populations over the last several decades.

The proposed Resource Management Plan states that, for many populations, fishery exploitation rates would be constrained well below their exploitation rate ceiling- (see discussion in Section 2, Alternatives Including the Proposed Action, Subsection 2.3.1, Alternative 1 – Proposed Action/Status Quo), at the discretion of the co-managers, while units are recovering. This principle implies that tribes will voluntarily forego access to chinook salmon and other species from more productive and abundant units, in the interest of protecting weaker units, and promoting recovery of the Evolutionarily Significant Unit.

4.4.2 Alternative 2 – Escapement Goal Management at the Management Unit Level

Under Alternative 2, salmon fisheries in Puget Sound would be confined to terminal (i.e., freshwater) areas of Puget Sound and the Strait of Juan de Fuca. Terminal areas are defined as locations containing only populations returning to a single river system; such as, the Skagit River. Fisheries under the jurisdiction of the Pacific Fisheries Management Council, including Marine Catch Area 4B from May to September, would continue to operate. Puget Sound fisheries would also be constrained to meet harvest objectives for other species.

Reduction of treaty fishing opportunities to this extent would substantially preclude the exercise of treaty rights confirmed in U.S. v. Washington. Therefore, implementing Alternative 2 would be inconsistent with the federal trust responsibility, and would make the United States subject to litigation for damages. Alternative 2 would not implement measures that tribes have voluntarily proposed to achieve the necessary conservation purpose, whereas the Secretarial Order prescribes deference to these voluntary measures. Managing Puget Sound fisheries to achieve management-unit-specific escapement goals, and precluding marine fisheries as a means of certainty to achieve these goals, would place substantial constraint on tribal fisheries. The magnitude of harvest is predicted to be substantially reduced (78%) under Alternative 2, relative to Alternative 1. Though non-Indian recreational salmon harvest in freshwater is substantial for all management units, the majority of freshwater harvest, under Alternative 2 would be taken by Indian net fisheries.

Alternative 2 is predicted to substantially reduce access to usual and accustomed fishing areas and the exercise of treaty fishing rights compared to Alternative 1. For some tribes, the opportunity to harvest some species of salmon or steelhead is only available in marine areas. In some cases, harvest of those species would be precluded because they are either not produced in streams within their usual and accustomed fishing areas, or are produced at such low abundance that harvest would be precluded. Under Alternative 2, these species would be entirely unavailable to some tribes, effectively eliminating the exercise of treaty rights on those species by those tribes. Closure of pre-terminal marine fisheries due to the presence of commingled listed chinook salmon, would effectively preclude tribal access to harvest of Fraser River sockeye and pink salmon, and chum salmon originating in southern British Columbia. The Fraser River sockeye and pink fisheries, in particular, are of great economic and cultural consequence to tribes that would otherwise access this resource (see Subsections 4.5, Treaty Indian Ceremonial and Subsistence Salmon Uses; 4.6, Economic Activity and Value; and 4.7, Environmental Justice, of this Environmental Impact Statement).

4.4.3 Alternative 3 – Escapement Goal Management at the Population Level with Terminal Fisheries Only

The fishing regime envisioned by Alternative 3 would limit the exercise of treaty-reserved fishing rights to a greater extent than under Alternative 2, and would, therefore, be expected to result in a more substantial impact relative to Alternative 1. Reduction of treaty fishing opportunities to this extent would substantially preclude the exercise of treaty rights confirmed in U.S. v. Washington. Therefore, implementing Alternative 3 would be inconsistent with the federal trust responsibility, and would make the United States subject to litigation for damages. Alternative 3 would not implement measures that tribes have voluntarily proposed to achieve the necessary conservation purpose, whereas the Secretarial

Order (1997) prescribes deference to these voluntary measures. Managing Puget Sound fisheries to achieve management-unit-specific escapement goals, and precluding marine fisheries as a means of certainty to achieve these goals, would place substantial constraint on tribal fisheries.

Total salmon harvest is predicted to be 84 percent lower than under Alternative 1 (see Table 4.7.10). The escapement goals for individual populations prescribed by Alternative 3 infer lower harvestable abundance in the North Sound region, relative to Alternative 2, resulting in further reduction in fishing opportunity in the Stillaguamish River and Tulalip Bay (Marine Catch Area 8D).

Alternative 3 is predicted to substantially reduce access to usual and accustomed fishing areas and the exercise of treaty fishing rights compared to Alternative 1. As under Alternative 2, the closure of marine areas under Alternative 3 would effectively eliminate the exercise of treaty rights on some species by some Puget Sound tribes. Closure of pre-terminal marine fisheries due to the presence of commingled listed chinook salmon, would effectively preclude tribal access to harvest of Fraser River sockeye and pink salmon, and chum salmon originating in southern British Columbia. The Fraser River sockeye and pink salmon fisheries, in particular, are of great economic and cultural consequence to tribes that would otherwise access this resource (see Subsections 4.5, Treaty Indian Ceremonial and Subsistence Salmon Uses; 4.6, Economic Activity and Value; and 4.7, Environmental Justice, of this Environmental Impact Statement).

4.4.4 Alternative 4 – No Action/No Authorized Take

Under Alternative 4, no fishery-related mortality of listed Puget Sound chinook salmon would occur in salmon fisheries within the Puget Sound Action Area. Tribal salmon harvest would be limited to late-season fisheries for chum salmon and steelhead. Fisheries under the jurisdiction of the Pacific Fisheries Management Council, including troll fishing in Marine Catch Area 4B from May to September, would continue to operate. Implementing Alternative 4 would substantially limit the ability of Puget Sound tribes to obtain salmon or steelhead, since listed chinook are present, to a greater or lesser extent, throughout the year in most tribal usual and accustomed fishing areas and fisheries. Total salmon harvest is predicted to be reduced by 98 percent from the level predicted to occur under Alternative 1 (see Table 4.7.12). Implementing Alternative 4 would virtually eliminate access to usual and accustomed fishing areas in the Strait of Juan de Fuca and Puget Sound..

Elimination of treaty fishing opportunities on this broad scale would constitute substantial interference with Indian treaty fishing rights, which are property rights. The conservation standard of U.S. v. Washington and Secretarial Order Number 3206 require that any restriction on treaty fisheries be implemented in the least restrictive manner necessary to provide self-sustaining natural- and hatchery-produced salmon.. Such a severe limitation on the exercise of treaty rights would be inconsistent with the federal trust responsibility, and would make the United States subject to a damages claim. Alternative 4 would also fail to promote voluntary tribal measures to achieve the necessary conservation purpose as required by the Secretarial Order. The consequences of this alternative would thus have a substantial impact on the ability of Puget Sound tribes to exercise their treaty rights, and on the ability of the federal government to exercise its trust responsibility.

Alternative 4 could, legitimately, be eliminated from detailed examination in the Environmental Impact Statement because it implies violation of the trust responsibility of the federal government, and of the legal implication of Secretarial Order Number 3206 (1997), and thus is inconsistent with the purpose and need of the Proposed Action (see discussion in Section 2.3). However, the Settlement Agreement negotiated by the parties to Washington Trout v. Lohn, required analysis of a “No Take, No Harvest” alternative.

4.4.5 Indirect and Cumulative Effects

There are no predictable indirect effects on the exercise of treaty fishing rights by tribes which would not be directly affected by this action. Other than U.S. v. Washington and its various sub-proceedings, including its mandate for the Puget Sound Salmon and Steelhead Management Plan, there are no other relevant laws or policies that affect the exercise of treaty rights by Puget Sound or other tribes. Therefore, there are no indirect or cumulative effects to analyze for this element of the Environmental Impact Statement.

4.5 Treaty Indian Ceremonial and Subsistence Salmon Uses

This subsection analyzes the potential effects of the Puget Sound Chinook Harvest Resource Management Plan (the Proposed Action) or alternatives on the 17 treaty tribes that conduct ongoing treaty-based fishing activities within the Puget Sound Action Area, and the federally-recognized Snoqualmie and Samish tribes. The effects of the Proposed Action or alternatives on ceremonial and subsistence resource availability, access, and competition are considered in the context of the measurement guidelines described below.

Measurement Guidelines

In order to measure the degree of potential effect of the Proposed Action or alternatives, measurement guidelines are defined here, focusing on those factors that could affect tribal ceremonial and subsistence fishing.

Direct ceremonial and subsistence effects (occurring at the same time and place as the Proposed Action or alternatives) are predicated on changes in the availability of, access to, or competition for ceremonial and subsistence resources. Occurrences that could affect availability of fish resources to ceremonial and subsistence users include changes in resource abundance. Occurrences that could affect access to ceremonial and subsistence resources include regulatory barriers. Competition could increase from overall fishing effort being confined into a limited area that coincides with traditional tribal harvest areas.

In the context of the Proposed Action and alternatives evaluated in this Environmental Impact Statement, indirect ceremonial and subsistence effects (caused by the action but later in time or further removed in distance, but still reasonably foreseeable) include harvester responses to the direct effects (e.g., increased effort, costs and/or risk, or inability to go to traditional harvest places); a loss, reduction or increase of traditional food; effects on culturally significant activities (e.g., traditional harvest practices, participation or production; processing; distribution and sharing within and between tribes; ceremonial practices; transfer of knowledge/transmission of culture; satisfaction of eating traditional food/cultural preferences); and cultural identity.

For ceremonial and subsistence fishing, the following measurement guidelines are used, based on potential direct and indirect ceremonial and subsistence effects:

No Effect: No effect on availability of, access to, or competition for traditional ceremonial and subsistence resources.

- Would not affect key ceremonial and subsistence species (as measured by harvest effort, harvests, or cultural importance)
- Would not occur in an important use area for key ceremonial and subsistence resources
- Would be localized and represent a negligible geographic area relative to other areas of ceremonial and subsistence resource availability
- Would not result in a loss or reduction of traditional food
- Would not affect culturally significant activities
- Would not be measurable and/or expected, or would be of such a rare occurrence that it would be impossible to measure or detect potential effects.

Low: Small and infrequent effect on availability of, access to, or competition for traditional ceremonial and subsistence resources.

- Would not affect key ceremonial and subsistence species (as measured by harvest effort, harvests, or cultural importance)
- Would not occur in an important use area for key ceremonial and subsistence resources
- Would be localized and represent a small geographic area relative to other areas of ceremonial and subsistence resource availability
- Would result in a small and infrequent reduction of traditional foods
- Would affect culturally significant activities infrequently
- Would be measurable, but of small amount or infrequent occurrence
- Would not affect the overall pattern of ceremonial and subsistence uses.

Moderate: Moderate (e.g., within reasonable limits; medium, not excessive or extreme) effect on availability of, access to, or competition for traditional ceremonial and subsistence resources.

- Would affect key ceremonial and subsistence species (as measured by harvest effort, harvests or cultural importance)
- Would occur in an important use area for key ceremonial and subsistence resources
- Would represent a medium geographic area relative to other areas of ceremonial and subsistence resource availability
- Would result in a minor loss of traditional foods
- Would result in detectable effects on culturally significant activities
- Would be measurable at some level between low and substantial

- Could affect individual ceremonial and subsistence users, groups of users and/or the overall pattern of ceremonial and subsistence uses.

Substantial*:* Substantial (e.g., considerable in importance, value, degree, amount, or extent) effect on availability of, access to, or competition for traditional ceremonial and subsistence resources.

- Would occur frequently
- Would affect key ceremonial and subsistence species (as measured by harvest effort, harvests, or cultural importance)
- Would occur in an important use area for key ceremonial and subsistence resources
- Would represent a large geographic area relative to other areas of ceremonial and subsistence resource availability
- Would result in a measurable loss of traditional foods
- Would measurably affect culturally significant activities
- Would be measurable and/or expected
- Would substantially affect individual ceremonial and subsistence users, groups of users and/or the overall pattern of ceremonial and subsistence uses by communities.

4.5.1 Alternative 1 – Proposed Action/Status Quo

Alternative 1 would implement the ~~2003~~ Puget Sound Chinook Harvest Resource Management Plan during the 2005-2009 fishing seasons, a harvest management framework similar to that currently used by state and tribal co-managers within the action area since the year 2000. Under this alternative, all marine and freshwater areas currently fished would remain open to tribal fishers as long as the abundance of salmon populations remains sufficiently high to allow a harvestable surplus, and subject to in-season management to further constrain harvest of listed chinook salmon. The amount of fishing would vary from year to year depending on population status, but this alternative would allow some level of tribal fishing for ceremonial and subsistence purposes in all areas currently fished for coho, sockeye, pink, chum salmon, and steelhead.

Under the Proposed Action, tribal fishers would continue to have ceremonial and subsistence access to harvestable surpluses of all species, including chinook-directed harvests in terminal areas benefited by hatchery production. The Proposed Action would provide management flexibility that would allow tribes access to resources under variable abundance of chinook and other salmon species. Implementation of the Proposed Action would allow for continued ceremonial and subsistence harvests similar in size to the previous decade. However, Alternative 1 would impose considerable restriction on access to chinook salmon due to conservation measures that tribes voluntarily impose upon themselves.

Although Alternative 1 would be the most flexible of the four alternatives considered, and would provide tribes the greatest opportunity to harvest salmon for subsistence purposes, it would still represent a reduction in access and use from historical times. Overall, the Proposed Action would be a continuation of the status quo, and would have no direct adverse effect on tribal ceremonial and subsistence fishing within the action area because tribal fishing access would continue to be provided, and resource availability and competition for resources would not be affected.

This Environmental Impact Statement focuses on harvest levels predicted when Puget Sound chinook abundance and southern U.S. (SUS) fisheries are at the 2003 level, and intercepting Canadian/Alaskan fisheries are at the maximum allowed under the Pacific Salmon Treaty (Scenario B). Despite the variability in expected total harvest associated with lower abundance or northern fishery interceptions, it should be assumed that ceremonial and subsistence harvest would remain relatively constant for different northern fishery and abundance conditions, due to the high priority that tribal fishery managers place on meeting these essential requirements of tribal members and communities. In other words, it would be expected that commercial sales would be reduced, if necessary, to meet these constant subsistence requirements.

4.5.2 Alternative 2 – Escapement Goal Management at the Management Unit Level

The direct effect of Alternative 2 would be to eliminate tribal harvest opportunity in all marine salmon areas of Puget Sound, and to close or severely restrict opportunity in the Nooksack and Skagit Rivers. Because many tribes depend on marine-area fisheries for a significant part or all of their ceremonial and subsistence harvest, implementation of Alternative 2 would substantially reduce the availability of salmon for ceremonial and subsistence use,compared to availability under Alternative 1. All species of salmon have equal cultural importance to tribes, are key ceremonial and subsistence resources, and the different species are harvested depending upon individual and tribal preferences for ceremonial and personal or family consumption. For some tribes, species of salmon or steelhead that would be available under Alternative 1 would no longer be available for harvest with Alternative 2, because they either would not be produced in streams within tribal usual and accustomed fishing areas, or they would be produced at such low abundance that harvest would not be allowed.

Total salmon harvest in Puget Sound would be predicted to fall 78 percent with Alternative 2 (Scenario B), relative to Alternative 1. Total harvest of would fall 36 percent for chinook salmon, 60 percent for coho, 100 percent for sockeye, 85 percent for pink salmon, and 68 percent for chum. Within regions, total salmon harvest is predicted to decline 96 percent in the Strait of Juan de Fuca, 90 percent in North Sound, 58 percent in South Sound, and 31 percent in Hood Canal (see Table 4.7.8 in Subsection 4.7, Environmental Justice). The change in the number of salmon used for subsistence purposes cannot be quantified precisely from this comparison of total harvest, but it suggests that tribal access to salmon for subsistence purposes would be substantially reduced in all regions, and that access to chinook and sockeye salmon in particular would be precluded in some regions.

Subsistence and ceremonial harvest is afforded highest priority by the tribes, and therefore is likely to be more constant than commercial harvest as abundance or access varies. However, the severe constraint of marine fishing opportunity envisioned under Alternative 2, would likely have substantial negative impact on the economic well-being of tribal members and communities, thereby increasing the need for subsistence harvest.

Under Alternative 2, harvesters would be unable to fish in all marine areas within Puget Sound, or in major freshwater rivers. Consequently, tribal fishing in remaining freshwater areas would increase compared to levels under Alternative 1. Because certain freshwater areas would remain open, this alternative could result in increased harvester competition in those areas as fishers seek salmon. Competition would be likely to increase among tribes that share common usual and accustomed freshwater fishing areas, and with recreational fishers that may seek increased fishing opportunities in freshwater areas.

4.5.3 Alternative 3 – Escapement Goal Management at the Population Level with Terminal Fisheries Only.

Like Alternative 2, the direct effect of Alternative 3 would be to eliminate tribal harvest opportunity in all marine areas. However, Alternative 3 would further constrain tribal harvest opportunity in freshwater areas because regulating fishing to achieve population-specific escapement goals in the Stillaguamish and Snohomish Rivers would preclude access to chinook, pink, and coho salmon that would be available under Alternative 2. Opportunity in other freshwater areas would persist. Because many tribes depend on marine-area fisheries for a significant part or all of their ceremonial and subsistence harvest, implementation of Alternative 3 would substantially reduce the availability of salmon for ceremonial and subsistence use compared to availability under Alternative 1.

Total salmon harvest that would likely occur under Alternative 3 (Scenario B) is predicted to be 84 percent lower than under Alternative 1. Reductions in the total harvest of individual species would be slightly greater for chinook, coho, and pink salmon, and similar for sockeye, chum, and steelhead, relative to Alternative 2 (see Table 4.7.10 in Subsection 4.7, Environmental Justice). Reductions in total regional salmon harvest would be similar to Alternative 2, except in the North Sound region, where it is predicted that further reductions in chinook, coho, and pink salmon harvest would reduce total harvest by 99 percent. These negative effects are due to the preclusion of fishing in marine areas, where many tribes harvest a significant proportion, if not the majority, of their non-commercial salmon.

The actual reduction in the number of salmon that would be used for subsistence purposes under Alternative 3 cannot be precisely quantified. However, the preclusion of harvest in all marine areas, and in the Stillaguamish and Snohomish systems, would create substantial additional reduction in the availability of chinook, coho, and pink salmon in those areas, with particular impact to the tribes that fish in those areas. As noted for Alternative 2, as commercial harvest opportunity is reduced, the number of salmon required for subsistence purposes is likely to increase, as income and jobs are lost.

4.5.4 Alternative 4 – No Action/No Authorized Take

Under Alternative 4, all marine-area fisheries and most freshwater fisheries within the action area would be closed except for certain late-season freshwater fisheries for chum salmon (December – January) and steelhead (December – March). Total salmon harvest is predicted to decline 98 percent with Alternative 4, relative to Alternative 1. Fall chum harvest would be limited to the last two weeks of their spawning period, except in the Nisqually River, where a late-run of chum enters in December and January. Total chum salmon harvest is predicted to decline 92 percent, relative to Alternative 1, and would be effectively eliminated in the Strait of Juan de Fuca and Hood Canal regions (see Table 4.7.12 in Subsection 4.7, Environmental Justice). For those tribes that do not fish freshwater areas for chum salmon and steelhead, all fisheries would be closed.

The direct effect of Alternative 4 would be to substantially reduce availability and access to all riverine and marine salmon compared to Alternative 1. Access to chinook, coho, sockeye and pink salmon would be eliminated under Alternative 4, and only a few areas would remain open for fall chum salmon harvests (e.g., limited chum harvest in the Nooksack, Skagit, Green, Skokomish, and Puyallup Rivers; and unimpeded late-season chum harvest in the Nisqually River). As described in Subsection 3.5, Treaty Indian Ceremonial and Subsistence Salmon Uses – Affected Environment, all species of salmon are key ceremonial and subsistence resources (as measured by cultural importance), and different species are harvested depending upon individual and tribal preferences for ceremonial and personal or family consumption.

The areas closed to salmon fishing by Alternative 4 (e.g., the Puget Sound Action Area) are important historic and contemporary tribal harvest areas for ceremonial and subsistence salmon. Tribes rely on both marine and freshwater habitat of the action area for the harvest of ceremonial and subsistence salmon, and one Puget Sound tribe or another fishes the freshwater and marine areas within the Puget

Sound Action Area. For most tribes, the action area encompasses their entire usual and accustomed fishing grounds. The area that would be closed by Alternative 4 represents almost the entire geographic area of salmon availability. For these reasons, Alternative 4 would result in a substantial adverse direct effect on tribal ceremonial and subsistence fishing.

4.5.5 Indirect and Cumulative Impacts

4.5.5.1 Indirect Effects

Indirect effects are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects resulting from the direct effects on ceremonial and subsistence salmon uses include harvester responses to the direct effects (e.g., increased effort, costs and/or risk, and inability to go to traditional harvest places), the effects on an increase or loss of traditional foods, the effects on culturally significant activities associated with salmon uses (e.g., traditional harvest practices, participation or production; processing; distribution and sharing within and between tribes; ceremonial practices; transfer of knowledge/transmission of culture; satisfaction of eating traditional food/cultural preferences) and effects on cultural identity.

Alternative 1 – Proposed Action/Status Quo

Because the Proposed Action would result in no adverse effects due to reduced availability of or access to salmon aside from the conservation restrictions the tribes have voluntarily imposed upon themselves in consultation with the State of Washington, there would be no adverse indirect effects associated with Alternative 1.

Alternatives 2 or 3 – Escapement Goal Management

Tribal harvesters who rely on marine area fisheries would not be able to fish in their usual and accustomed fishing areas if Alternative 2 or 3 were implemented. Restrictions in several major freshwater rivers would greatly limit access to usual and accustomed fishing areas for those tribes.

With the closure of marine fishing areas and the restrictions on many rivers, implementation of the escapement goal type of management framework would be expected to result in a substantial reduction in the harvest of a traditional food important to Indian culture for tribes relying on those areas for salmon harvest. These tribal harvesters would likely be unable to harvest adequate numbers of salmon for the ceremonial and subsistence purposes described in the Affected Environment. Furthermore, the fishing closures anticipated under Alternatives 2 or 3 would effectively eliminate or significantly reduce culturally significant activities associated with salmon, including participation in traditional harvests; practicing traditional methods of harvesting and processing salmon, including community smokehouses; formal and informal distribution and sharing salmon within and between tribes; serving salmon for elder's dinners, community-wide dinners, or intertribal traditional dinners; reciprocity and exchanging salmon among kin and community members; sharing and informally distributing salmon – a practice that serves to bind the community in a system relationships and obligations; and gifting of salmon.

As described in the Affected Environment (Subsection 3.5, Treaty Indian Ceremonial and Subsistence Salmon Uses), salmon is an important traditional food that is intimately linked to ceremonial practices. Salmon is served during naming ceremonies, funerals, during one-year memorials after a death, and when students are honored. To tribes, a ceremony is incomplete if salmon is not present. With most salmon fishing opportunity precluded, conduct of first salmon ceremonies according to ancient tradition would be precluded in most areas. In addition, the satisfaction of eating traditional foods contributes to the overall well being of Indian people. Salmon is a favored food, and tribal members have developed preferences for various species as well as salmon caught in different waters (e.g., marine versus fresh or different rivers) or from different sections of a river. Alternatives 2 or 3 would result in a substantial loss of traditional foods for consumption by the Puget Sound tribes.

As described in the Affected Environment (Subsection 3.5), participation in a culture is at the core of cultural continuity and survival. Furthermore, in order to transfer cultural knowledge between generations, it is necessary for community members to participate in cultural practices. Harvesting, processing, preparing, and eating salmon in culturally-prescribed ways are important tribal activities for the transmission of a salmon fishing culture. Elders teach young people skills, and fishing is part of one's tribal education. The continual participation in culturally-significant activities serves to reinforce cultural values and ensure they are transmitted over time. For Indians within the action area, fishing for salmon has been for centuries, and continues to be, an integral part of tribal life. If access to harvesting salmon from marine waters were prohibited, as anticipated under Alternatives 2 or 3, Indian people within the action area who rely on marine salmon harvests would be subjected to being separated from a part of their cultural core, their cultural identity. Alternative 2 or 3 would eliminate marine salmon fishing and limit freshwater fishing to terminal fisheries. Without salmon fishing, associated cultural activities could not be practiced. Implementation of Alternative 2 or 3 would strike at the core of the cultural identity of the tribes within the action area who rely on salmon caught in marine areas.

Therefore, Alternative 2 or 3 would result in a substantial adverse indirect effect on tribal ceremonial and subsistence salmon fishing and use as compared with Alternative 1, because either would substantially affect individual ceremonial and subsistence users, groups of users, and the overall pattern of ceremonial and subsistence uses by communities.

Alternative 4 – No Action/No Authorized Take

Closure of salmon fishing in Puget Sound to the extent envisioned under Alternative 4, would, as stated above, essentially preclude exercise of Treaty fishing rights by the affected tribes. Salmon would continue to be available to tribal members from sources outside of Puget Sound and from conventional retail markets, but this acquisition would not substitute for salmon harvested locally, by local tribal members, from within their usual fishing areas. Obtaining salmon for ceremonial and subsistence purposes is inextricably associated with the practice of harvest according to ancient custom, on ancestral fishing grounds. Obtaining salmon from non-local sources would, in addition, necessarily incur relatively high cost and inconvenience, and could not, for most tribal people, be regarded as subsistence use.

With the closure of marine and freshwater fishing areas and access only to limited harvest of fall and winter chum and steelhead, Alternative 4would result in an abrupt and substantial reduction in the harvest of a traditional food important to Indian culture. To an even greater extent than Alternative 2 or 3, Alternative 4 would result in tribal harvesters being unable to harvest adequate numbers of salmon for the ceremonial and subsistence purposes described in Subsection 3.5 (Treaty Indian Ceremonial and Subsistence Salmon Uses – Affected Environment). Also to a greater extent than Alternative 2 or 3, fishing closures in Alternative 4 would affect a wide pattern of culturally-significant activities associated with salmon (including traditional harvest practices, participation in production, processing, distribution and sharing, ceremonial practices, transfer of culture, satisfaction of eating traditional foods, and cultural identity). All of the indirect effects described with Alternative 2 or 3 would apply to Alternative 4, and would be exacerbated by the near-total closure of tribal access to salmon within the action area.

Therefore, Alternative 4 would result in a substantial adverse indirect effect on tribal ceremonial and subsistence salmon fishing and uses compared to Alternative 1, because it would substantially affect individual ceremonial and subsistence users, groups of users and the overall pattern of ceremonial and subsistence uses by communities.

4.5.5.2 Cumulative Impacts

There are no predictable indirect effects on tribal use of salmon for subsistence or ceremonial purposes by Puget Sound tribes, or other tribes which would not be directly affected by this action. Other than

U.S. v. Washington and its various sub-proceedings, including its mandate for the Puget Sound Salmon and Steelhead Management Plan, there are no other relevant laws or policies that affect subsistence or ceremonial use by Puget Sound or other tribes. Therefore, there are no indirect or cumulative effects to analyze for this element of the Environmental Impact Statement.

4.6 Economic Activity and Value

The following sections describe the effects of implementing the Proposed Action and alternatives on commercial and sport fisheries and on the local and regional economy in the Puget Sound area. Economic impact indicators include sales by commercial salmon harvesters and processors, sales by businesses to sport fishing anglers, net economic values to commercial harvesters and processors, angler days, net economic values to sport anglers, and regional employment and personal income levels. Major effects on these indicators are summarized in Table 4.6-1, which characterizes the severity of predicted economic impacts. Based on an assessment of the annual variability in the economic impact indicators and on best professional judgment, the effects are characterized as follows: no impact (i.e., no change in economic impact indicators), low impact (i.e., less than a 2% change), moderate impact (i.e., 2 to 10% change), and substantial impact (more than 10% change). In addition, as described in the Section 4.3, *Fish*, implementing the Proposed Action could delay to some extent the recovery of several Puget Sound Chinook salmon populations. However, the effect that implementing Alternative 1 would have on the recovery period affecting the de-listing of the Puget Sound Chinook ESU cannot be determined with any reasonable degree of certainty. The harvest of Puget Sound Chinook salmon is only one of many factors that affect recovery and the incremental effect of harvest cannot be accurately isolated. Consequently, the extent to which the period of recovery is delayed cannot be determined, nor can it be determined whether the delay in the recovery of several populations within the multi-population Puget Sound Chinook ESU would affect the time in which the ESU would be de-listed. NMFS has stated that not all populations within the ESU would need to be at equally low risk in order to determine that the ESU was sufficiently recovered to be de-listed, and that there are probably multiple recovery scenarios. Nonetheless, a delay in de-listing could extend recovery efforts, which may impose additional costs on agencies responsible for recovery and additional costs for businesses and other entities to comply with take regulations. Although these additional costs cannot be estimated with any reasonable degree of accuracy, the costs could adversely affect businesses and other entities that impact Chinook salmon habitat in the Puget Sound area and the regional economy.

~~The following sections describe the effects of the Proposed Action and alternatives on salmon commercial fisheries, salmon sport fisheries, and regional economies in the Puget Sound area. Economic impact indicators include sales by commercial salmon harvesters and processors, sales by businesses to sport fishing anglers, net economic values to commercial harvesters and processors, angler days, net economic values to sport anglers, and regional employment and personal income levels. Major effects on these indicators are summarized in Table 4.6-1, which characterizes the~~

~~severity of predicted economic impacts. Based on an assessment of the annual variability in the economic impact indicators and on best professional judgment, the effects are characterized as follows: no impact (i.e., no change in economic impact indicators), low impact (i.e., less than a 2% change), moderate impact (i.e., 2 to 10% change), and substantial impact (more than 10% change).~~

The impact predictions presented in this section, which draw from the effects shown in Tables 4.6-2 through 4.6-19, are based on assumptions and data sources described in Appendix D. It should be noted that the direct employment effects of the Proposed Action and alternatives on the commercial salmon harvesting sector are evaluated using two measures: direct jobs and direct employment (Tables 4.6-3, 4.6-7, 4.6-11, and 4.6-15). "Direct jobs" represent both full-time and part-time jobs, whereas "direct employment" represents full-time equivalent (FTE) jobs. Nearly all of the "direct jobs" are part-time positions because of the seasonality of commercial salmon fishing in Puget Sound. Many persons engaged in commercial salmon fishing also participate in other fisheries and/or have other occupations. Consequently, the effect of changes in the salmon harvest associated with Alternatives 2, 3, or 4 on the number of "direct jobs" in commercial fishing is difficult to assess, and the numbers presented in Tables 4.6-3, 4.6-7, 4.6-11, and 4.6-15 should be interpreted as estimates of the number of potentially-affected persons employed in the salmon fishing industry,, as opposed to the number of persons who would necessarily become unemployed.

It also should be noted that estimated changes in net economic values to commercial salmon harvesters and processors under Alternatives 2, 3, or 4 exceed the estimates of net economic value under the Proposed Action/Status Quo. These results reflect consideration of the cost of unemployed labor and the potential loss of capital investments (i.e., boats and equipment) used for commercial fishing that would result from the substantial reductions in the commercial salmon harvest under Alternatives 2, 3, or 4. Substantial changes in the commercial harvest of salmon also would likely affect tribal commercial fishermen differently than non-tribal fishermen because of existing differences in alternative employment and capital investment opportunities; however, this issue, discussed more fully in Attachment C of Appendix D, and the associated effects on net economic values, could not be fully resolved for the analysis.

As discussed in Subsection 3.6, although nonuse values associated with the recovery of listed Puget Sound Chinook salmon are theoretically measurable and likely differ to some extent between the alternatives, existing data on recovery rates are too limited to reliably estimate these values.

4.6.1 Alternative 1 – Proposed Action/Status Quo

The Proposed Action would maintain commercial and sport fisheries at levels similar to conditions in the past.

4.6.1.1 Summary of Scenario Differences

Scenario A, which assumes high abundance and Canadian/Alaskan fisheries similar to those in 2003, is predicted generally to result in the highest levels of commercial and sport fishing activity, followed by Scenario B (high abundance with maximum Canadian/Alaskan fisheries); Scenario C (30% reduction in abundance with Canadian/Alaskan fisheries similar to 2003); and Scenario D (30% reduction in abundance with maximum Canadian/Alaskan fisheries).

The differences in commercial and sport fishing activity across the four scenarios are not predicted to be large. Compared to commercial salmon harvests under Scenario A, which are predicted to total an estimated 20.0 million pounds, Scenario B is predicted to result in harvests that would be about 99 percent of the levels under Scenario A; Scenario C harvests are predicted to be 98 percent of Scenario A levels; and Scenario D harvests are predicted to be 97 percent of Scenario A levels. In terms of sport fishing activity, Scenario B is predicted to result in angler trips that would be about 99 percent of the 1.4 million Scenario A trips; Scenario C trips are predicted to be 93 percent of Scenario A trips; and Scenario D trips are predicted to be 95 percent of Scenario A trips.

4.6.2 Alternative 2 – Escapement Goal Management at the Management Unit Level

Alternative 2, the management unit-based escapement alternative, is predicted to result in commercial and sport fishing activities at levels substantially below conditions in the past, but at levels greater than under Alternatives 3 or 4.

4.6.2.1 Summary of Scenario Differences

Under Alternative 2, Scenario A (high abundance and Canadian/Alaskan fisheries similar to those in 2003) is predicted to result in the highest levels of commercial and sport fishing activity, followed by Scenario B (high abundance with maximum Canadian/Alaskan fisheries); Scenario C (30% reduction in abundance with Canadian/Alaskan fisheries similar to 2003); and Scenario D (30% reduction in abundance with maximum Canadian/Alaskan fisheries). The differences in commercial and sport fishing activity are predicted to be relatively large across the four scenarios. Compared to commercial harvests under Scenario A, which are predicted to total an estimated 3.4 million pounds, Scenario B is predicted to result in harvests that would be approximately 99 percent of the levels under Scenario A; Scenario C harvests are predicted to be 84 percent of Scenario A levels; and Scenario D harvests are predicted to be 83 percent of Scenario A levels. In terms of sport fishing activity, Scenario B is predicted to result in angler trips that would be approximately 96 percent of the 231,900 Scenario A trips; Scenario C trips are predicted to be 71 percent of Scenario A trips; and Scenario D trips are predicted to be 67 percent of Scenario A trips.

4.6.2.2 Comparison of the Management Unit-Based Escapement Alternative (Alternative 2) to the Proposed Action

Relative to the Proposed Action, Alternative 2 is predicted to result in substantially reduced levels of commercial salmon harvests and sport fishing activity. Consequently, sales, employment, and personal income generated by commercial salmon harvests and sport fishing expenditures and net economic value also are predicted to be substantially smaller under Alternative 2 compared to the Proposed Action (Tables 4.6-5, 4.6-9, 4.6-13, 4.6-17 and 4.6-19). The reduction in net economic value (Table 4.6-18) associated with commercial fishing is predicted to be greater than the value under baseline conditions (the Proposed Action), because of the costs to society of unemployed labor resources and the expected loss in the value of capital investments (i.e., boats and equipment).

Under Alternative 2, Scenario B, commercial salmon harvests are predicted to be reduced by nearly 100 percent for non-tribal fishers and 72 percent for tribal fishers (Table 4.6-6), relative to levels under the Proposed Action, Scenario B. For sport fishing, angler trips are predicted to be reduced by 84 percent (Table 4.6-8). The severity of commercial and sport fishing effects is predicted to vary among the three economic regions within the Puget Sound Action Area. For non-tribal commercial salmon fishermen, harvest reductions are expected to be largest in the North Puget Sound and South Puget Sound/South Hood Canal regions, where commercial harvests are predicted to be eliminated; conversely, non-tribal commercial salmon harvests are expected to increase by 22 percent in the Strait of Juan de Fuca/North Hood Canal region (Table 4.6-6). For tribal commercial salmon fishermen, harvest reductions are predicted to range from 43 percent in the South Puget Sound/South Hood Canal region to 97 percent in the Strait of Juan de Fuca/North Hood Canal Region. Reductions in sport fishing trips are predicted to be substantial for all regions, ranging from 77 percent in the North Puget Sound region to 98 percent in the Strait of Juan de Fuca/North Hood Canal region (Table 4.6-8). For all regions, sport-fishing trips are expected to be eliminated in marine areas, with sport fishing for salmon limited to freshwater tributaries to Puget Sound. Under Scenario B, effects on regional sales, employment, and personal income are expected to follow the general direction and severity of regional changes in commercial harvests and sport fishing activity (Tables 4.6-7 and 4.6-9).

For Scenarios A, C, or D, Alternative 2 is expected to result in commercial and sport fishing impacts relative to the Proposed Action similar to those described for Scenario B. For non-tribal commercial salmon fishermen, reductions in harvests are anticipated to be nearly 100 percent under each scenario (Tables 4.6-2, 4.6-10, and 4.6-14). For tribal fishermen, harvest reductions are estimated to range from 72 percent under Scenario A (Table 4.6-2), to 76 percent under Scenarios C or D (Tables 4.6-10 and 4.6-14). Overall reductions in sport angler trips are predicted to range from 84 percent under Scenario A (Table 4.6-4), to 89 percent under Scenario D (Table 4.6-16).

In conclusion, the local economic effects of Alternative 2 under all scenarios are anticipated to be substantial and adverse relative to conditions under the Proposed Action for all three regions of the Puget Sound Action Area (Table 4.6-1). These effects would be most severe in communities dependent upon commercial fishing and sport fishing activities, and, potentially, in communities with seafood processing facilities. While substantially adverse in local areas, the adverse economic effects of Alternative 2 are anticipated to be low when viewed in the context of the overall economy of each region, because the estimated reductions in sales, employment, and personal income under the alternatives would be minor compared to total levels for each region. For example, total reductions in commercial and sport fishing-related employment under the worst case scenario (i.e., Scenario D) would be an estimated 621 full-time equivalent jobs in the North Puget Sound region, 368 jobs in the Strait of Juan de Fuca/North Hood Canal region, and 200 jobs in the South Puget Sound/South Hood Canal region (Table 4.6-17). Based on regional employment levels in 2000 (see Table 3.6-4), these job losses would represent 0.1 percent of the total jobs in the North Puget Sound region, 0.8 percent of the jobs in the Strait of Juan de Fuca/North Hood Canal region, and less than 0.1 percent of the jobs in the South Puget Sound/South Hood Canal region.

4.6.3 Alternative 3 – Escapement Goal Management at the Population Level with Terminal Fisheries Only

Alternative 3, the population unit-based escapement alternative, is predicted to result in commercial and sport fishing activities at levels similar to Alternative 2, but substantially below past conditions.

4.6.3.1 Summary of Scenario Differences

Under Alternative 3, Scenario A (high abundance and Canadian/Alaskan fisheries similar to those in 2003) is predicted to result in the highest levels of commercial and sport fishing activity, followed by Scenario B (high abundance with maximum Canadian/Alaskan fisheries); Scenario C (30% reduction in abundance with Canadian/Alaskan fisheries similar to 2003); and Scenario D (30% reduction in abundance with maximum Canadian/Alaskan fisheries). The differences in commercial and sport fishing activity are relatively large across the four scenarios. Compared to commercial harvests under Scenario A, which would total an estimated 2.8 million pounds, Scenario B is predicted to result in harvests that would be about 99 percent of the levels under Scenario A; Scenario C harvests would be 90 percent of Scenario A levels; and Scenario D harvests would be 89 percent of Scenario A levels. In terms of sport fishing activity, Scenario B is predicted to result in angler trips that would be about 95 percent of the 177,500 Scenario A trips; Scenario C trips would be 76 percent of Scenario A trips; and Scenario D trips would be 71 percent of Scenario A trips.

4.6.3.2 Comparison of the Population Unit-Based Escapement Alternative (Alternative 3) to the Proposed Action

Relative to the Proposed Action, Alternative 3 is predicted to result in substantially reduced levels of commercial salmon harvests and sport fishing activity. Consequently, sales, employment, and personal income generated by commercial salmon harvests and sport fishing expenditures and net economic value also are predicted be substantially smaller under Alternative 3 compared to the Proposed Action (Tables 4.6-5, 4.6-9, 4.6-13, 4.6-17 and 4.6-19). Similar to Alternative 2, the reduction in net economic value (Table 4.6-18) associated with commercial fishing is predicted to be greater than the value under baseline conditions (the Proposed Action) because of the costs to society of unemployed labor resources and the expected loss in the value of capital investments (i.e., boats and equipment).

Under Alternative 3, Scenario B, the severity of regional commercial and sport fishing effects are predicted to be similar to those previously described for Alternative 2 for all regions other than the North Puget Sound region. Within the North Puget Sound region, reductions in tribal commercial harvests and sport fishing trips are predicted to be slightly more severe than under Alternative 2 (Tables 4.6-6 and 4.6-8). Effects on regional sales, employment, and personal income under Alternative 3, Scenario B, are predicted to follow the general direction and severity of regional changes in commercial harvests and sport fishing activity (Tables 4.6-7 and 4.6-9).

For Scenarios A, C, or D, Alternative 3 is expected to result in commercial and sport fishing impacts relative to the Proposed Action similar to those described for Scenario B. For non-tribal commercial salmon fishermen, reductions in harvests are anticipated to be nearly 100 percent under each scenario (Tables 4.6-2, 4.6-10, and 4.6-14). For tribal fishermen, harvest reductions are estimated to range from 77 percent under Scenario A (Table 4.6-2), to 79 percent under Scenarios C or D (Tables 4.6-10 and 4.6-14). Overall reductions in sport angler trips are predicted to range from 88 percent under Scenario A (Table 4.6-4), to 91 percent under Scenario D (Table 4.6-16).

In conclusion, the local economic effects of Alternative 3 under all scenarios are anticipated to be substantial and adverse relative to conditions under the Proposed Action for all three regions of the Puget Sound Action Area (Table 4.6-1). These effects would be most severe in communities dependent upon commercial fishing and sport fishing activities, and, potentially, in communities with seafood processing facilities. While substantially adverse in local areas, the adverse economic effects of Alternative 3 are anticipated to be low when viewed in the context of the overall economy of each region, because the estimated reductions in sales, employment, and personal income under the alternatives would be minor compared to total levels for each region. For example, total reductions in commercial and sport fishing-related employment under the worst case scenario (i.e., Scenario D) would be an estimated 645 full-time equivalent jobs in the North Puget Sound region, 370 jobs in the Strait of Juan de Fuca/North Hood Canal region, and 200 jobs in the South Puget Sound/South Hood Canal region (Table 4.6-17). Based on regional employment levels in 2000 (see Table 3.6-4), these job losses would represent 0.1 percent of the total jobs in the North Puget Sound region, 0.8 percent of the jobs in the Strait of Juan de Fuca/North Hood Canal region, and less than 0.1 percent of the jobs in the South Puget Sound/South Hood Canal region.

4.6.4 Alternative 4 – No Action/No Authorized Take

Alternative 4, the no authorized take alternative, would substantially limit commercial and sport fishing activities, resulting in activity levels substantially below conditions in the past or under Alternative 2 or Alternative 3.

4.6.4.1 Summary of Scenario Differences

Under Alternative 4, effects on commercial and sport fishing activity are predicted to be virtually the same across all four scenarios, with commercial salmon harvests of about 429,000 pounds and sport fishing activity of 4,300 trips.

4.6.4.2 Comparison of the No Action/No Authorized Take Alternative (Alternative 4) to the Proposed Action

Relative to the Proposed Action, Alternative 4 is predicted to eliminate almost all levels of commercial salmon harvests and sport fishing activity in the Puget Sound area. Consequently, sales, employment, and personal income generated by commercial salmon harvests and sport fishing expenditures and net economic value also are predicted be virtually eliminated (Tables 4.6-5, 4.6-9, 4.6-13, 4.6-17 and 4.6-19). Similar to Alternative 2 or Alternative 3, the reduction in net economic value (Table 4.6-18) associated with commercial fishing is predicted to be greater than the value under baseline conditions (the Proposed Action) because of the costs to society of unemployed labor resources and the expected loss in the value of capital investments (i.e., boats and equipment).

Under Alternative 4, Scenario B (high abundance with maximum Canadian/Alaskan fisheries), commercial salmon harvests are predicted to be reduced by 100 percent for non-tribal fishers and by 96 percent for tribal fishers (Table 4.6-6). Commercial salmon fishing is predicted to be virtually eliminated in the North Puget Sound and Strait of Juan de Fuca/North Hood Canal regions (Table 4.6-6). Within the South Puget Sound/South Hood Canal Region, tribal harvest is expected to be reduced by 91 percent compared to harvest levels under the Proposed Action. For sport fishing under Alternative 4 (Scenario B), total angler trips and net economic value would be reduced by more than 99 percent (Tables 4.6-8 and 4.6-19). Within all regions, sport fishing is predicted to be limited to a very small number of freshwater sport fishing trips (Table 4.6-8). Adverse effects on regional sales, employment, and personal income generated by changes in commercial harvests and sport fishing activity are predicted to be substantial in all regions (Table 4.6-9).

For Scenarios A (high abundance and Canadian/Alaskan fisheries similar to those in 2003); C (30% reduction in abundance with Canadian and Alaskan fisheries similar to 2003); or D (30% reduction in abundance with maximum Canadian and Alaskan fisheries), Alternative 4 is expected to result in commercial and sport fishing impacts relative to the Proposed Action virtually the same as those described for Scenario B, with commercial harvests and sport fishing trips virtually eliminated in all regions within the Puget Sound Action Area (Tables 4.6-2, 4.6-4, 4.6-10, 4.6-12, 4.6-14, and 4.6-16).

In conclusion, the local economic effects of Alternative 4 under all scenarios are anticipated to be substantial and adverse relative to conditions under the Proposed Action for all three regions of the Puget Sound Action Area (Table 4.6-1). These effects would be most severe in communities dependent upon commercial fishing and sport fishing activities, and, potentially, in communities with seafood processing facilities. While substantially adverse in local areas, the adverse economic effects of Alternative 4 are anticipated to be low when viewed in the context of the overall economy of each region, because the estimated reductions in sales, employment, and personal income under the alternatives would be minor compared to total levels for each region. For example, total reductions in commercial and sport fishing-related employment under the worst case scenario (i.e., Scenario D) would be an estimated 660 full-time equivalent jobs in the North Puget Sound region, 373 jobs in the Strait of Juan de Fuca/North Hood Canal region, and 276 jobs in the South Puget Sound/South Hood Canal region (Table 4.6-17). Based on regional employment levels in 2000 (see Table 3.6-4), these job losses would represent 0.1 percent of the total jobs in the North Puget Sound region, 0.8 percent of the jobs in the Strait of Juan de Fuca/North Hood Canal region, and less than 0.1 percent of the jobs in the South Puget Sound/South Hood Canal region.

4.6.5 Summary

In summary, compared to the Proposed Action, Alternative 4 is predicted to have the most severe effect on the commercial and sport harvest of salmon and on regional economic activity, followed by Alternatives 3 and 2.

Under Alternatives 2, 3, or 4 for all scenarios, the virtual elimination of marine fishing and substantial restrictions on freshwater fishing would be expected to greatly reduce statewide and regional economic activity associated with Puget Sound commercial and sport fisheries. Under Scenario B (high abundance with maximum Canadian/Alaskan fisheries), total statewide salmon harvester and processor sales generated by the Puget Sound fishery are predicted to fall from $26.9 million under the Proposed Action to $4.3 million under Alternative 2, $3.6 million under Alternative 3, and $438,000 under Alternative 4 (Table 4.6-9). For Scenario B, similar reductions, ranging from 85 percent under Alternative 2 to 98 percent under Alternative 4, are predicted to occur in total employment and personal income generated by commercial salmon fishing and processing (Table 4.6-9). Statewide economic effects resulting from reductions in sport fishing activity are predicted to be much less severe than effects resulting from reduced commercial harvests because, on a statewide level, net sport fishing-related effects would be generated only by reductions in trip-related spending by persons residing outside of Washington, who account for a small portion of total trips. Reductions in angler trips and trip-related expenditures by Washington residents would have little effect because changes in spending by residents would merely redirect money already in the state economy, resulting in no net economic effects. As a result, sales, employment, and personal income in Washington related to sport fishing in Puget Sound are predicted to decline by only about 6 percent for all alternatives under Scenario B compared to levels under the Proposed Action (Table 4.6-9).

Among the three economic regions surrounding Puget Sound, all but the South Puget Sound/South Hood Canal region are predicted to lose more than 94 percent of the local and regional sales, employment, and personal income generated by commercial salmon fishing in the Puget Sound fishery under Scenario B of the three alternatives (Table 4.6-9). Reductions in commercial salmon fishing-related economic activity in the South Puget Sound/South Hood Canal region are predicted to range from 65 percent under Alternatives 2 or 3, to 95 percent under Alternative 4.

As with statewide effects, regional economic impacts resulting from reductions in sport fishing activity associated with the Puget Sound fishery are anticipated to be less severe than commercial fishing impacts. This is because economic effects in each region would result only from reductions in fishing trips and expenditures associated with out-of-region anglers who account for a relatively small percentage of angler activity. Under Scenario B, reductions in sport fishing-related economic activity (i.e., sales, employment, and personal income) are predicted to be largest in the Strait of Juan de Fuca/North Hood Canal region, ranging between 69 and 72 percent (Table 4.6-9). In the North Puget Sound region, reductions in sport fishing-related economic activity are predicted to range from about 21 percent under Alternative 2 to about 27 percent under Alternative 4. Reductions in economic activity in the South Puget Sound/South Hood Canal region are predicted to range from about 12 percent under Alternative 2 to about 15 percent under Alternative 4 (Table 4.6-9).

For Scenarios A (high abundance and Canadian/Alaskan fisheries similar to those in 2003); C (30% reduction in abundance with Canadian and Alaskan fisheries similar to 2003); or D (30% reduction in abundance with maximum Canadian and Alaskan fisheries), Alternatives 2, 3, or 4 are predicted to result in regional economic impacts relative to the Proposed Action similar to those described for Scenario B although effects are generally predicted to be greatest under Scenario D. For Scenarios A, C, or D, total statewide salmon harvester and processor sales generated by the Puget Sound fishery are predicted to fall from 84 to 87 percent with Alternative 2; 87 to 88 percent with Alternative 3; and 98 percent with Alternative 4 (Tables 4.6-5, 4.6-13, 4.6-17). Similar reductions, ranging from 84 to 87 percent with Alternative 2, to 98 percent with Alternative 4, are predicted to occur in total employment and personal income generated by commercial salmon fishing and processing (Tables 4.6-5, 4.6-13, and 4.6-17). Under Scenarios A, C, or D, sales, employment, and personal income in Washington related to sport fishing in Puget Sound are predicted to decline by only about 6 to 7 percent for all alternatives compared to levels under the Proposed Action (Tables 4.6-5, 4.6-13, and 4.6-17).

In conclusion, the local economic effects of Alternatives 2, 3, or 4 are predicted to be substantial and adverse relative to conditions under the Proposed Action for all three regions of the Puget Sound Action Area (Table 4.6-1). These effects would be most severe in communities dependent upon commercial fishing and sport fishing activities, and, potentially, in communities with seafood processing facilities. While substantially adverse in local areas, the adverse economic effects of the three alternatives would be low when viewed in the context of the overall economy of each region, because the estimated reductions in sales, employment, and personal income under the alternatives would be minor compared to total levels for each region. For example, total reductions in commercial and sport fishing-related employment under the worst case alternative and scenario (i.e., Alternative 4, Scenario D) would be an estimated 660 full-time equivalent jobs in the North Puget Sound region, 373 jobs in the Strait of Juan de Fuca/North Hood Canal region, and 276 jobs in the South Puget Sound/South Hood Canal region (Table 4.6-17). Based on regional employment levels in 2000 (see Table 3.6-4), these job losses would represent 0.1 percent of total jobs in the North Puget Sound region, 0.8 percent of jobs in the Strait of Juan de Fuca/North Hood Canal region, and less than 0.1 percent of jobs in the South Puget Sound/South Hood Canal region.

Table 4.6-1. Performance of economic indicators under alternatives 1-4 relative to conservation standards under scenarios 1-4.

	Alternative 2 Compared to Alternative 1								**Alternative 3 Compared to Alternative 1**								**Alternative 4 Compared to Alternative 1**							
	Scenario A		Scenario B		Scenario C		Scenario D		Scenario A		Scenario B		Scenario C		Scenario D		Scenario A		Scenario B		Scenario C		Scenario D	
	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent
North Puget Sound:																								
Sales by commercial salmon harvesters & processors	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Net economic value of commercial salmon fishing	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Sales by businesses to sport fishing anglers	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Sport fishing angler days	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Net economic value to sport fishing anglers	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Regional employment	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Regional personal income	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
South Puget Sound/South Hood Canal:																								
Sales by commercial salmon harvesters & processors	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Net economic value of commercial salmon fishing	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Sales by businesses to sport fishing anglers	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Sport fishing angler days	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Net economic value to sport fishing anglers	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Regional employment	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Regional personal income	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Strait of Juan de Fuca/North Hood Canal:																								
Sales by commercial salmon harvesters & processors	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Net economic value of commercial salmon fishing	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Sales by businesses to sport fishing anglers	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Sport fishing angler days	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Net economic value to sport fishing anglers	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Regional employment	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Regional personal income	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S

Impact type:		Impact extent:	
Beneficial	B	No impact (0%)	O
Adverse	A	Low (<2%)	L
No impact	NI	Moderate (2%-10%)	M
		Substantial (>10%)	S

Table 4.6-2. Impacts to commercial harvest, commercial harvest value, and processing value.
Scenario A: 2003 Abundance and 2003 Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Management Unit Level			Alternative 3 - Escapement Goal Management at the Population Level			Alternative 4 - No Fishing		
		Number	Change from Alternative 1	Percent Change	Number	Change from Alternative 1	Percent Change	Number	Change from Alternative 1	Percent Change
Puget Sound North:										
Non-Tribal										
Harvest (pounds)	5,567,330	3,032	-5,564,298	-99.9%	3,032	-5,564,298	-99.9%	0	-5,567,330	-100.0%
Harvest Value	$2,665,002	$1,434	-$2,663,568	-99.9%	$1,434	-$2,663,568	-99.9%	$0	-$2,665,002	-100.0%
Tribal										
Harvest (pounds)	6,725,730	643,255	-6,082,476	-90.4%	14,081	-6,711,649	-99.8%	13,312	-6,712,418	-99.8%
Harvest Value	$3,136,631	$218,197	-$2,918,434	-93.0%	$4,189	-$3,132,442	-99.9%	$3,874	-$3,132,758	-99.9%
Processing Value	$11,521,724	$537,194	-$10,984,530	-95.3%	$13,965	-$11,507,759	-99.9%	$10,390	-$11,511,334	-99.9%
South Puget Sound/South Hood Canal:										
Non-Tribal										
Harvest (pounds)	2,516,170	0	-2,516,170	-100.0%	0	-2,516,170	-100.0%	0	-2,516,170	-100.0%
Harvest Value	$627,257	$0	-$627,257	-100.0%	$0	-$627,257	-100.0%	$0	-$627,257	-100.0%
Tribal										
Harvest (pounds)	4,805,614	2,720,759	-2,084,856	-43.4%	2,720,759	-2,084,856	-43.4%	411,387	-4,394,227	-91.4%
Harvest Value	$1,757,387	$936,614	-$820,773	-46.7%	$936,614	-$820,773	-46.7%	$100,265	-$1,657,123	-94.3%
Processing Value	$6,604,154	$2,637,459	-$3,966,695	-60.1%	$2,637,459	-$3,966,695	-60.1%	$315,147	-$6,289,007	-95.2%
Strait of Juan de Fuca/North Hood Canal:										
Non-Tribal										
Harvest (pounds)	10,920	13,340	2,420	22.2%	13,340	2,420	22.2%	0	-10,920	-100.0%
Harvest Value	$5,132	$6,270	$1,138	22.2%	$6,270	$1,138	22.2%	$0	-$5,132	-100.0%
Tribal										
Harvest (pounds)	420,792	13,559	-407,233	-96.8%	13,559	-407,233	-96.8%	4,255	-416,537	-99.0%
Harvest Value	$292,912	$6,658	-$286,254	-97.7%	$6,658	-$286,254	-97.7%	$2,841	-$290,071	-99.0%
Processing Value	$513,111	$28,214	-$484,897	-94.5%	$28,214	-$484,897	-94.5%	$5,567	-$507,544	-98.9%
Statewide Total:										
[1] Marine trips include all local resident, non-local resident, and non-resident of the state sport fishing in the marine waters of Puget Sound and originating from a marina or launch area										
Harvest (pounds)	8,094,420	16,372	-8,078,048	-99.8%	16,372	-8,078,048	-99.8%	0	-8,094,420	-100.0%
ithin the region identified	$3,297,391	$7,704	-$3,289,688	-99.8%	$7,704	-$3,289,688	-99.8%	$0	-$3,297,391	-100.0%
[3] Expenditure effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assumed that										
Harvest (pounds)	11,952,137	3,377,573	-8,574,564	-71.7%	2,748,399	-9,203,737	-77.0%	428,954	-11,523,183	-96.4%
Harvest Value	$5,186,931	$1,161,469	-$4,025,462	-77.6%	$947,461	-$4,239,470	-81.7%	$106,979	-$5,079,952	-97.9%
Processing Value	$18,638,990	$3,202,867	-$15,436,123	-82.8%	$2,679,638	-$15,959,351	-85.6%	$331,105	-$18,307,885	-98.2%

Note: All dollar values are expressed in 2002 dollars.

Table 4.6-3. Direct economic impacts to the commercial fishing and salmon processing industries.
Scenario A: 2003 Abundance and 2003 Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Management Unit Level: Number	Change from Alternative 1	Percent Change	Alternative 3 - Escapement Goal Management at the Population Level: Number	Change from Alternative 1	Percent Change	Alternative 4 - No Fishing: Number	Change from Alternative 1	Percent Change
Puget Sound North										
Harvesting Sector:										
Non-Tribal:										
Jobs[1]	972.7	0.5	-972.2	-99.9%	0.5	-972.2	-99.9%	0.0	-972.7	-100.0%
Employment[2]	67.2	0.0	-67.1	-100.0%	0.0	-67.1	-100.0%	0.0	-67.2	-100.0%
Personal Income[3]	$1,725,198	$648	-$1,724,549	-100.0%	$648	-$1,724,549	-100.0%	$0	-$1,725,198	-100.0%
Tribal:										
Jobs[1]	1,590.3	110.6	-1,479.6	-93.0%	2.1	-1,588.1	-99.9%	2.0	-1,588.3	-99.9%
Employment[2]	76.1	7.8	-68.3	-89.7%	0.1	-76.0	-99.9%	0.1	-76.1	-99.9%
Personal Income[3]	$1,955,153	$179,310	-$1,775,843	-90.8%	$1,467	-$1,953,687	-99.9%	$1,304	-$1,953,850	-99.9%
Processing Sector:										
Employment[2]	181.5	9.6	-172.0	-94.7%	0.3	-181.3	-99.9%	0.2	-181.3	-99.9%
Personal Income[3]	$4,569,379	$241,311	-$4,328,068	-94.7%	$6,365	-$4,563,014	-99.9%	$4,922	-$4,564,457	-99.9%
South Puget Sound/South Hood Canal:										
Harvesting Sector:										
Non-Tribal:										
Jobs[1]	228.9	0.0	-228.9	-100.0%	0.0	-228.9	-100.0%	0.0	-228.9	-100.0%
Employment[2]	7.4	0.0	-7.4	-100.0%	0.0	-7.4	-100.0%	0.0	-7.4	-100.0%
Personal Income[3]	$185,657	$0	-$185,657	-100.0%	$0	-$185,657	-100.0%	$0	-$185,657	-100.0%
Tribal:										
Jobs[1]	891.0	474.9	-416.1	-46.7%	474.9	-416.1	-46.7%	50.8	-840.2	-94.3%
Employment[2]	30.3	19.4	-10.9	-36.0%	19.4	-10.9	-36.0%	1.3	-29.0	-95.8%
Personal Income[3]	$761,987	$433,255	-$328,732	-43.1%	$433,255	-$328,732	-43.1%	$28,289	-$733,698	-96.3%
Processing Sector:										
Employment[2]	94.4	35.1	-59.3	-62.8%	35.1	-59.3	-62.8%	5.3	-89.1	-94.4%
a marina or launch area	$2,442,028	$908,621	-$1,533,406	-62.8%	$908,621	-$1,533,406	-62.8%	$136,498	-$2,305,529	-94.4%
Strait of Juan de Fuca/North Hood Canal:										
[2] Freshwater trips include all local resident, non-local resident, and non-resident of the state sport fishing trips to fresh waters within the region identified.										
cause it is assumed that										
Jobs[1]	1.9	2.3	0.4	22.2%	2.3	0.4	22.2%	0.0	-1.9	-100.0%
Employment[2]	0.1	0.1	0.0	37.9%	0.1	0.0	37.9%	0.0	-0.1	-100.0%
Personal Income[3]	$2,180	$2,664	$483	22.2%	$2,664	$483	22.2%	$0	-$2,180	-100.0%
Tribal:										
Jobs[1]	148.5	3.4	-145.1	-97.7%	3.4	-145.1	-97.7%	1.4	-147.1	-99.0%
Employment[2]	5.0	0.1	-4.9	-97.3%	0.1	-4.9	-97.3%	0.1	-5.0	-99.0%
Personal Income[3]	$128,362	$3,008	-$125,354	-97.7%	$3,008	-$125,354	-97.7%	$1,150	-$127,212	-99.1%
Note: Sport fishing-related effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state										
Employment[2]	6.3	0.4	-5.9	-93.7%	0.4	-5.9	-93.7%	0.1	-6.2	-99.0%
Personal Income[3]	$159,926	$10,032	-$149,894	-93.7%	$10,032	-$149,894	-93.7%	$1,568	-$158,357	-99.0%
State:										
Harvesting Sector:										
Non-Tribal:										
Jobs[1]	1,203.5	2.8	-1,200.7	-99.8%	2.8	-1,200.7	-99.8%	0.0	-1,203.5	-100.0%
Employment[2]	71.0	0.1	-70.9	-99.8%	0.1	-70.9	-99.8%	0.0	-71.0	-100.0%
esidents of Washington.	$1,807,511	$3,167	-$1,804,344	-99.8%	$3,167	-$1,804,344	-99.8%	$0	-$1,807,511	-100.0%
Tribal:										
Jobs[1]	2,629.8	588.9	-2,040.9	-77.6%	480.4	-2,149.4	-81.7%	54.2	-2,575.5	-97.9%
Employment[2]	107.8	27.2	-80.6	-74.8%	19.8	-88.0	-81.6%	1.3	-106.5	-98.8%
Personal Income[3]	$2,740,275	$617,253	-$2,123,022	-77.5%	$450,798	-$2,289,477	-83.5%	$30,700	-$2,709,575	-98.9%
Processing Sector:										
Employment[2]	280.9	47.5	-233.4	-83.1%	38.6	-242.3	-86.3%	5.9	-274.9	-97.9%
Personal Income[3]	$7,137,841	$1,207,994	-$5,929,847	-83.1%	$981,271	-$6,156,570	-86.3%	$151,154	-$6,986,687	-97.9%

Note: Regional totals may not sum up to statewide totals because of differences in regional and statewide employment and personal income coefficients generated by the FEAM model.

[1] Represents full- and part-time jobs.

[2] Represents full-time equivalent jobs.

[3] Personal income, expressed in 2002 dollars, includes employee compensation, proprietor income, and other property income.

Table 4.6-4. Impacts to sport fishing trips and expenditures by region.
Scenario A: 2003 Abundance and 2003 Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Unit Level		Alternative 3 - Escapement Goal Management at the Population Level		Alternative 4 - No Fishing	
		Change from Alternative 1	Percent Change	Change from Alternative 1	Percent Change	Change from Alternative 1	Percent Change
North Puget Sound:							
Marine trips originating from the region[1]	125,372	-125,372	-100.0%	-125,372	-100.0%	-125,372	-100.0%
Freshwater trips occurring in the region[2]	371,857	-251,911	-67.7%	-300,883	-80.9%	-369,806	-99.4%
Total trips	497,229	-377,283	-75.9%	-426,255	-85.7%	-495,178	-99.6%
Expenditures in the region[3]	$31,974,199	-$6,208,411	-19.4%	-$7,114,001	-22.2%	-$8,388,511	-26.2%
South Puget Sound/South Hood Canal:							
Marine trips originating from the region[1]	238,655	-238,655	-100.0%	-238,655	-100.0%	-238,655	-100.0%
Freshwater trips occurring in the region[2]	288,616	-185,801	-64.4%	-185,799	-64.4%	-286,497	-99.3%
Total trips	527,271	-424,456	-80.5%	-424,454	-80.5%	-525,152	-99.6%
Expenditures in the region[3]	$33,074,640	-$3,740,707	-11.3%	-$3,740,642	-11.3%	-$4,736,183	-14.3%
Strait of Juan de Fuca/North Hood Canal:							
Marine trips originating from the region[1]	359,534	-359,534	-100.0%	-359,534	-100.0%	-359,534	-100.0%
Freshwater trips occurring in the region[2]	58,578	-49,398	-84.3%	-54,840	-93.6%	-58,438	-99.8%
Total trips	418,112	-408,932	-97.8%	-414,374	-99.1%	-417,972	-100.0%
Expenditures in the region[3]	$24,456,744	-$16,765,658	-68.6%	-$16,973,950	-69.4%	-$17,111,689	-70.0%
Regional Total:							
Marine trips originating from the region[1]	723,561	-723,561	-100.0%	-723,561	-100.0%	-723,561	-100.0%
Freshwater trips occurring in the region[2]	719,051	-487,110	-67.7%	-541,522	-75.3%	-714,741	-99.4%
Total trips	1,442,612	-1,210,671	-83.9%	-1,265,083	-87.7%	-1,438,302	-99.7%
Expenditures in the region[3]	$89,505,583	-$26,714,777	-29.8%	-$27,828,594	-31.1%	-$30,236,383	-33.8%

Note: Detailed information for angler types in included in the Economics Technical Appendix (Appendix D).

[1] Marine trips include all local resident, non-local resident, and non-resident of the state sport fishing in the marine waters of Puget Sound and originating from a marina or launch are originating from a marina or launch area in the region identified.

[2] Freshwater trips include all local resident, non-local resident, and non-resident of the state sport fishing trips to fresh waters within the region identifiec

[3] Expenditure effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assumed tha because it is assumed that spending by local resident anglers would continue in the region regardless of changes in local resident sport fishing activity under the alternatives.

Table 4.6-5. Regional economic impacts of the alternatives.
Scenario A: 2003 Abundance and 2003 Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Unit Level		Alternative 3 - Escapement Goal Management at the Population Level		Alternative 4 - No Fishing	
		Change from Alternative 1	Percent Change	Change from Alternative 1	Percent Change	Change from Alternative 1	Percent Change
North Puget Sound:							
Commercial Fishing Effects							
Sales[1]	$17,323,358	-$16,566,533	-95.6%	-$17,303,770	-99.9%	-$17,309,094	-99.9%
Employment[2]	522.5	-495.8	-94.9%	-521.9	-99.9%	-522.1	-99.9%
Personal Income[3]	$16,727,041	-$15,874,356	-94.9%	-$16,709,879	-99.9%	-$16,714,413	-99.9%
Sport Fishing Effects							
Sales[4]	$31,974,199	-$6,208,411	-19.4%	-$7,114,001	-22.2%	-$8,388,511	-26.2%
Employment[2]	567.7	-118.2	-20.8%	-135.2	-23.8%	-159.0	-28.0%
Personal Income[3]	$21,520,877	-$4,216,375	-19.6%	-$4,835,613	-22.5%	-$5,707,116	-26.5%
South Puget Sound/South Hood Canal:							
Commercial Fishing Effects							
Sales[1]	$8,988,798	-$5,414,725	-60.2%	-$5,414,725	-60.2%	-$8,573,387	-95.4%
Employment[2]	223.1	-134.9	-60.4%	-134.9	-60.4%	-212.3	-95.1%
Personal Income[3]	$8,061,452	-$4,870,679	-60.4%	-$4,870,679	-60.4%	-$7,669,101	-95.1%
Sport Fishing Effects							
Sales[4]	$33,074,640	-$3,740,707	-11.3%	-$3,740,642	-11.3%	-$4,736,183	-14.3%
Employment[2]	518.5	-65.0	-12.5%	-65.0	-12.5%	-81.7	-15.8%
Personal Income[3]	$24,679,752	-$2,819,364	-11.4%	-$2,819,314	-11.4%	-$3,578,165	-14.5%
Strait of Juan de Fuca/North Hood Canal:							
Commercial Fishing Effects							
Sales[1]	$811,156	-$770,014	-94.9%	-$770,014	-94.9%	-$802,748	-99.0%
Employment[2]	19.2	-18.2	-94.6%	-18.2	-94.6%	-19.0	-99.1%
Personal Income[3]	$567,455	-$536,783	-94.6%	-$536,783	-94.6%	-$562,146	-99.1%
Sport Fishing Effects							
Sales[4]	$24,456,744	-$16,765,658	-68.6%	-$16,973,950	-69.4%	-$17,111,689	-70.0%
g from a marina or launch are	500.5	-355.1	-70.9%	-359.2	-71.8%	-361.8	-72.3%
Personal Income[3]	$14,563,148	-$9,931,028	-68.2%	-$10,057,788	-69.1%	-$10,141,612	-69.6%
[2] Freshwater trips include all local resident, non-local resident, and non-resident of the state sport fishing trips to fresh waters within the region identified							
[3] Expenditure effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assumed tha							
Sales[1]	$27,123,312	-$22,751,272	-83.9%	-$23,488,509	-86.6%	-$26,685,228	-98.4%
Employment[2]	748.6	-631.4	-84.4%	-656.7	-87.7%	-737.0	-98.5%
Personal Income[3]	$26,023,282	-$21,953,163	-84.4%	-$22,828,837	-87.7%	-$25,620,136	-98.5%
Sport Fishing Effects[5]							
Sales[4]	$90,085,979	-$5,218,618	-5.8%	-$5,355,919	-5.9%	-$5,743,798	-6.4%
Employment[2]	1,569.5	-97.1	-6.2%	-99.8	-6.4%	-107.5	-6.8%
Personal Income[3]	$68,627,051	-$3,947,656	-5.8%	-$4,055,622	-5.9%	-$4,360,625	-6.4%

Note: Sport fishing-related effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assumed that spending by local resident anglers would continue in the region regardless of changes in local resident sport fishing activity under the alternatives.

[1] Represents direct commercial salmon harvester and processing sales in 2002 dollars.
[2] Represents total (direct and secondary) full-time equivalent jobs.
[3] Represents total (direct and secondary) personal income in 2002 dollars. Personal income includes employee compensation, proprietor income, and other property income.
[4] Represents direct sales to sport fishing anglers in 2002 dollars.
[5] Under alternatives to the Proposed Action, statewide effects for sportfishing include only those generated by changes in spending by non-residents of Washington.

Table 4.6-6. Impacts to commercial harvest, commercial harvest value, and processing value.
Scenario B: 2003 Abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

	Alternative 1	Alternative 2 - Escapement Goal Management at the Management Unit Level			Alternative 3 - Escapement Goal Management at the Population Level			Alternative 4 - No Fishing		
Region	Proposed Action/ Status Quo	Number	Change from Alternative 1	Percent Change	Number	Change from Alternative 1	Percent Change	Number	Change from Alternative 1	Percent Change
Puget Sound North:										
Non-Tribal										
Harvest (pounds)	5,533,374	3,032	-5,530,343	-99.9%	3,032	-5,530,343	-99.9%	0	-5,533,374	-100.0%
Harvest Value	$2,637,498	$1,434	-$2,636,064	-99.9%	$1,434	-$2,636,064	-99.9%	$0	-$2,637,498	-100.0%
Tribal										
Harvest (pounds)	6,691,701	640,844	-6,050,857	-90.4%	14,081	-6,677,620	-99.8%	13,310	-6,678,390	-99.8%
Harvest Value	$3,109,566	$216,272	-$2,893,294	-93.0%	$4,189	-$3,105,377	-99.9%	$3,873	-$3,105,693	-99.9%
Processing Value	$11,452,379	$534,735	-$10,917,644	-95.3%	$13,965	-$11,438,414	-99.9%	$10,389	-$11,441,990	-99.9%
South Puget Sound/South Hood Canal:										
Non-Tribal										
Harvest (pounds)	2,516,170	0	-2,516,170	-100.0%	0	-2,516,170	-100.0%	0	-2,516,170	-100.0%
Harvest Value	$627,257	$0	-$627,257	-100.0%	$0	-$627,257	-100.0%	$0	-$627,257	-100.0%
Tribal										
Harvest (pounds)	4,762,847	2,685,646	-2,077,200	-43.6%	2,685,646	-2,077,200	-43.6%	411,384	-4,351,463	-91.4%
Harvest Value	$1,730,353	$914,493	-$815,860	-47.1%	$914,493	-$815,860	-47.1%	$100,262	-$1,630,091	-94.2%
Processing Value	$6,546,846	$2,590,409	-$3,956,437	-60.4%	$2,590,409	-$3,956,437	-60.4%	$315,142	-$6,231,703	-95.2%
Strait of Juan de Fuca/North Hood Canal:										
Non-Tribal										
Harvest (pounds)	10,920	13,340	2,420	22.2%	13,340	2,420	22.2%	0	-10,920	-100.0%
Harvest Value	$5,132	$6,270	$1,138	22.2%	$6,270	$1,138	22.2%	$0	-$5,132	-100.0%
Tribal										
Harvest (pounds)	420,792	13,559	-407,232	-96.8%	13,559	-407,232	-96.8%	4,255	-416,537	-99.0%
Harvest Value	$292,912	$6,658	-$286,254	-97.7%	$6,658	-$286,254	-97.7%	$2,841	-$290,071	-99.0%
Processing Value	$513,111	$28,214	-$484,897	-94.5%	$28,214	-$484,897	-94.5%	$5,567	-$507,544	-98.9%
Statewide Total:										
[1] Marine trips include all local resident, non-local resident, and non-resident of the state sport fishing in the marine waters of Puget Sound and originating from a marina or launch area										
Harvest (pounds)	8,060,464	16,372	-8,044,092	-99.8%	16,372	-8,044,092	-99.8%	0	-8,060,464	-100.0%
thin the region identified	$3,269,887	$7,704	-$3,262,183	-99.8%	$7,704	-$3,262,183	-99.8%	$0	-$3,269,887	-100.0%
[3] Expenditure effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assumed that										
Harvest (pounds)	11,875,339	3,340,050	-8,535,289	-71.9%	2,713,287	-9,162,052	-77.2%	428,949	-11,446,390	-96.4%
Harvest Value	$5,132,831	$1,137,423	-$3,995,408	-77.8%	$925,340	-$4,207,491	-82.0%	$106,976	-$5,025,855	-97.9%
Processing Value	$18,512,335	$3,153,358	-$15,358,978	-83.0%	$2,632,588	-$15,879,747	-85.8%	$331,098	-$18,181,237	-98.2%

Note: All dollar values are expressed in 2002 dollars.

Table 4.6-7. Direct economic impacts to the commercial fishing and salmon processing industries.
Scenario B: 2003 Abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Management Unit Level Number	Change from Alternative 1	Percent Change	Alternative 3 - Escapement Goal Management at the Population Level Number	Change from Alternative 1	Percent Change	Alternative 4 - No Fishing Number	Change from Alternative 1	Percent Change
Puget Sound North										
Harvesting Sector:										
Non-Tribal:										
Jobs[1]	962.7	0.5	-962.2	-99.9%	0.5	-962.2	-99.9%	0.0	-962.7	-100.0%
Employment[2]	66.6	0.0	-66.6	-100.0%	0.0	-66.6	-100.0%	0.0	-66.6	-100.0%
Personal Income[3]	$1,710,634	$648	-$1,709,985	-100.0%	$648	-$1,709,985	-100.0%	$0	-$1,710,634	-100.0%
Tribal:										
Jobs[1]	1,576.6	109.6	-1,466.9	-93.0%	2.1	-1,574.4	-99.9%	2.0	-1,574.6	-99.9%
Employment[2]	75.5	7.8	-67.8	-89.7%	0.1	-75.5	-99.9%	0.1	-75.5	-99.9%
Personal Income[3]	$1,940,557	$178,276	-$1,762,282	-90.8%	$1,467	-$1,939,091	-99.9%	$1,303	-$1,939,254	-99.9%
Processing Sector:										
Employment[2]	180.5	9.5	-171.0	-94.7%	0.3	-180.3	-99.9%	0.2	-180.3	-99.9%
Personal Income[3]	$4,543,906	$240,408	-$4,303,498	-94.7%	$6,365	-$4,537,541	-99.9%	$4,922	-$4,538,985	-99.9%
South Puget Sound/South Hood Canal:										
Harvesting Sector:										
Non-Tribal:										
Jobs[1]	228.9	0.0	-228.9	-100.0%	0.0	-228.9	-100.0%	0.0	-228.9	-100.0%
Employment[2]	7.4	0.0	-7.4	-100.0%	0.0	-7.4	-100.0%	0.0	-7.4	-100.0%
Personal Income[3]	$185,657	$0	-$185,657	-100.0%	$0	-$185,657	-100.0%	$0	-$185,657	-100.0%
Tribal:										
Jobs[1]	877.3	463.6	-413.6	-47.1%	463.6	-413.6	-47.1%	50.8	-826.5	-94.2%
Employment[2]	29.6	18.8	-10.9	-36.7%	18.8	-10.9	-36.7%	1.3	-28.4	-95.7%
Personal Income[3]	$745,461	$419,688	-$325,774	-43.7%	$419,688	-$325,774	-43.7%	$28,288	-$717,174	-96.2%
Processing Sector:										
Employment[2]	93.9	34.7	-59.2	-63.1%	34.7	-59.2	-63.1%	5.3	-88.6	-94.4%
from a marina or launch a	$2,427,658	$896,824	-$1,530,834	-63.1%	$896,824	-$1,530,834	-63.1%	$136,497	-$2,291,161	-94.4%
Strait of Juan de Fuca/North Hood Canal:										
[2] Freshwater trips include all local resident, non-local resident, and non-resident of the state sport fishing trips to fresh waters within the region identified.										
g because it is assumed t										
Jobs[1]	1.9	2.3	0.4	22.2%	2.3	0.4	22.2%	0.0	-1.9	-100.0%
Employment[2]	0.1	0.1	0.0	37.9%	0.1	0.0	37.9%	0.0	-0.1	-100.0%
Personal Income[3]	$2,180	$2,664	$483	22.2%	$2,664	$483	22.2%	$0	-$2,180	-100.0%
Tribal:										
Jobs[1]	148.5	3.4	-145.1	-97.7%	3.4	-145.1	-97.7%	1.4	-147.1	-99.0%
Employment[2]	5.0	0.1	-4.9	-97.3%	0.1	-4.9	-97.3%	0.1	-5.0	-99.0%
Personal Income[3]	$128,362	$3,008	-$125,353	-97.7%	$3,008	-$125,353	-97.7%	$1,150	-$127,212	-99.1%
Note: Sport fishing-related effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state										
Employment[2]	6.3	0.4	-5.9	-93.7%	0.4	-5.9	-93.7%	0.1	-6.2	-99.0%
Personal Income[3]	$159,926	$10,032	-$149,894	-93.7%	$10,032	-$149,894	-93.7%	$1,568	-$158,357	-99.0%
State:										
Harvesting Sector:										
Non-Tribal:										
Jobs[1]	1,193.5	2.8	-1,190.7	-99.8%	2.8	-1,190.7	-99.8%	0.0	-1,193.5	-100.0%
Employment[2]	70.5	0.1	-70.4	-99.8%	0.1	-70.4	-99.8%	0.0	-70.5	-100.0%
on-residents of Washingto	$1,793,789	$3,167	-$1,790,623	-99.8%	$3,167	-$1,790,623	-99.8%	$0	-$1,793,789	-100.0%
Tribal:										
Jobs[1]	2,602.3	576.7	-2,025.7	-77.8%	469.1	-2,133.2	-82.0%	54.2	-2,548.1	-97.9%
Employment[2]	106.6	26.5	-80.0	-75.1%	19.2	-87.4	-82.0%	1.3	-105.3	-98.8%
Personal Income[3]	$2,709,241	$602,090	-$2,107,151	-77.8%	$436,609	-$2,272,632	-83.9%	$30,698	-$2,678,543	-98.9%
Processing Sector:										
Employment[2]	279.3	47.0	-232.3	-83.2%	38.1	-241.2	-86.4%	5.9	-273.4	-97.9%
Personal Income[3]	$7,098,058	$1,194,516	-$5,903,543	-83.2%	$968,659	-$6,129,400	-86.4%	$151,152	-$6,946,907	-97.9%

Note: Regional totals may not sum up to statewide totals because of differences in regional and statewide employment and personal income coefficients generated by the FEAM model

[1] Represents full- and part-time jobs.

[2] Represents full-time equivalent jobs.

[3] Personal income, expressed in 2002 dollars, includes employee compensation, proprietor income, and other property income.

Table 4.6-8. Impacts to sport fishing trips and expenditures by region.
Scenario B: 2003 Abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Unit Level		Alternative 3 - Escapement Goal Management at the Population Level		Alternative 4 - No Fishing	
		Change from Alternative 1	Percent Change	Change from Alternative 1	Percent Change	Change from Alternative 1	Percent Change
North Puget Sound:							
Marine trips originating from the region[1]	125,121	-125,121	-100.0%	-125,121	-100.0%	-125,121	-100.0%
Freshwater trips occurring in the region[2]	371,435	-258,296	-69.5%	-307,335	-82.7%	-369,384	-99.4%
Total trips	496,556	-383,417	-77.2%	-432,456	-87.1%	-494,505	-99.6%
Expenditures in the region[3]	$31,931,283	-$6,323,085	-19.8%	-$7,229,930	-22.6%	-$8,377,306	-26.2%
South Puget Sound/South Hood Canal:							
Marine trips originating from the region[1]	234,995	-234,995	-100.0%	-234,995	-100.0%	-234,995	-100.0%
Freshwater trips occurring in the region[2]	284,800	-183,525	-64.4%	-183,523	-64.4%	-282,681	-99.3%
Total trips	519,795	-418,520	-80.5%	-418,518	-80.5%	-517,676	-99.6%
Expenditures in the region[3]	$32,607,684	-$3,686,620	-11.3%	-$3,686,620	-11.3%	-$4,666,871	-14.3%
Strait of Juan de Fuca/North Hood Canal:							
Marine trips originating from the region[1]	359,259	-359,259	-100.0%	-359,259	-100.0%	-359,259	-100.0%
Freshwater trips occurring in the region[2]	58,492	-49,425	-84.5%	-54,874	-93.8%	-58,352	-99.8%
Total trips	417,751	-408,684	-97.8%	-414,133	-99.1%	-417,611	-100.0%
Expenditures in the region[3]	$24,435,112	-$16,757,867	-68.6%	-$16,966,489	-69.4%	-$17,099,608	-70.0%
Regional Total:							
Marine trips originating from the region[1]	719,375	-719,375	-100.0%	-719,375	-100.0%	-719,375	-100.0%
Freshwater trips occurring in the region[2]	714,727	-491,246	-68.7%	-545,732	-76.4%	-710,417	-99.4%
Total trips	1,434,102	-1,210,621	-84.4%	-1,265,107	-88.2%	-1,429,792	-99.7%
Expenditures in the region[3]	$88,974,079	-$26,767,573	-30.1%	-$27,883,039	-31.3%	-$30,143,785	-33.9%

Note: Detailed information for angler types in included in the Economics Technical Appendix (Appendix D).

[1] Marine trips include all local resident, non-local resident, and non-resident of the state sport fishing in the marine waters of Puget Sound and originating from a marina or launch are
or launch area in the region identified.

[2] Freshwater trips include all local resident, non-local resident, and non-resident of the state sport fishing trips to fresh waters within the region identifiec

[3] Expenditure effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assumed tha
that spending by local resident anglers would continue in the region regardless of changes in local resident sport fishing activity under the alternatives.

Table 4.6-9. Regional economic impacts of the alternatives.
Scenario B: 2003 Abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Unit Level		Alternative 3 - Escapement Goal Management at the Population Level		Alternative 4 - No Fishing	
		Change from Alternative 1	Percent Change	Change from Alternative 1	Percent Change	Change from Alternative 1	Percent Change
North Puget Sound:							
Commercial Fishing Effects							
Sales[1]	$17,199,443	-$16,447,002	-95.6%	-$17,179,855	-99.9%	-$17,185,181	-99.9%
Employment[2]	519.0	-492.5	-94.9%	-518.5	-99.9%	-518.6	-99.9%
Personal Income[3]	$16,616,225	-$15,767,469	-94.9%	-$16,599,062	-99.9%	-$16,603,598	-99.9%
Sport Fishing Effects							
Sales[4]	$31,931,283	-$6,323,085	-19.8%	-$7,229,930	-22.6%	-$8,377,306	-26.2%
Employment[2]	567.0	-120.3	-21.2%	-137.3	-24.2%	-158.8	-28.0%
Personal Income[3]	$21,492,002	-$4,294,853	-20.0%	-$4,914,949	-22.9%	-$5,699,519	-26.5%
South Puget Sound/South Hood Canal:							
Commercial Fishing Effects							
Sales[1]	$8,904,456	-$5,399,554	-60.6%	-$5,399,554	-60.6%	-$8,489,051	-95.3%
Employment[2]	221.1	-134.5	-60.8%	-134.5	-60.8%	-210.3	-95.1%
Personal Income[3]	$7,987,892	-$4,857,512	-60.8%	-$4,857,512	-60.8%	-$7,595,547	-95.1%
Sport Fishing Effects							
Sales[4]	$32,607,684	-$3,686,620	-11.3%	-$3,686,620	-11.3%	-$4,666,871	-14.3%
Employment[2]	511.2	-64.1	-12.5%	-64.1	-12.5%	-80.5	-15.8%
Personal Income[3]	$24,331,289	-$2,778,665	-11.4%	-$2,778,665	-11.4%	-$3,525,860	-14.5%
Strait of Juan de Fuca/North Hood Canal:							
Commercial Fishing Effects							
Sales[1]	$811,155	-$770,013	-94.9%	-$770,013	-94.9%	-$802,747	-99.0%
Employment[2]	19.2	-18.2	-94.6%	-18.2	-94.6%	-19.0	-99.1%
Personal Income[3]	$567,454	-$536,782	-94.6%	-$536,782	-94.6%	-$562,145	-99.1%
Sport Fishing Effects							
Sales[4]	$24,435,112	-$16,757,867	-68.6%	-$16,966,489	-69.4%	-$17,099,608	-70.0%
from a marina or launch area	500.1	-354.9	-71.0%	-359.0	-71.8%	-361.6	-72.3%
Personal Income[3]	$14,550,212	-$9,926,446	-68.2%	-$10,053,407	-69.1%	-$10,134,420	-69.7%
[2] Freshwater trips include all local resident, non-local resident, and non-resident of the state sport fishing trips to fresh waters within the region identified.							
[3] Expenditure effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assume							
Sales[1]	$26,915,053	-$22,616,569	-84.0%	-$23,349,422	-86.8%	-$26,476,979	-98.4%
Employment[2]	743.1	-627.9	-84.5%	-653.0	-87.9%	-731.6	-98.4%
Personal Income[3]	$25,835,001	-$21,828,671	-84.5%	-$22,700,247	-87.9%	-$25,431,863	-98.4%
Sport Fishing Effects[5]							
Sales[4]	$89,552,061	-$5,213,429	-5.8%	-$5,351,019	-6.0%	-$5,719,922	-6.4%
Employment[2]	1,560.4	-97.0	-6.2%	-99.7	-6.4%	-107.0	-6.9%
Personal Income[3]	$68,220,788	-$3,944,122	-5.8%	-$4,052,314	-5.9%	-$4,342,396	-6.4%

Note: Sport fishing-related effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state the state spending because it is assumed that spending by local resident anglers would continue in the region regardless of changes in local resident sport fishing activity under the alternatives.

[1] Represents direct commercial salmon harvester and processing sales in 2002 dollars.

[2] Represents total (direct and secondary) full-time equivalent jobs.

[3] Represents total (direct and secondary) personal income in 2002 dollars. Personal income includes employee compensation, proprietor income, and other property income.

[4] Represents direct sales to sport fishing anglers in 2002 dollars.

[5] Under alternatives to the Proposed Action, statewide effects for sportfishing include only those generated by changes in spending by non-residents of Washington. Changes in spending by Washington residents would merely redirect money already in the state economy and would result in no net economic effects.

Table 4.6-10. Impacts to commercial harvest, commercial harvest value, and processing value.
Scenario C: 30% Reduction in abundance and 2003 Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Management Unit Level			Alternative 3 - Escapement Goal Management at the Population Level			Alternative 4 - No Fishing		
		Number	Change from Alternative 1	Percent Change	Number	Change from Alternative 1	Percent Change	Number	Change from Alternative 1	Percent Change
Puget Sound North:										
Non-Tribal										
Harvest (pounds)	5,474,785	0	-5,474,785	-100.0%	0	-5,474,785	-100.0%	0	-5,474,785	-100.0%
Harvest Value	$2,589,993	$0	-$2,589,993	-100.0%	$0	-$2,589,993	-100.0%	$0	-$2,589,993	-100.0%
Tribal										
Harvest (pounds)	6,604,161	370,510	-6,233,651	-94.4%	14,081	-6,590,080	-99.8%	13,310	-6,590,850	-99.8%
Harvest Value	$3,039,344	$64,176	-$2,975,169	-97.9%	$4,189	-$3,035,156	-99.9%	$3,873	-$3,035,472	-99.9%
Processing Value	$11,303,131	$269,359	-$11,033,773	-97.6%	$11,113	-$11,292,018	-99.9%	$10,389	-$11,292,742	-99.9%
South Puget Sound/South Hood Canal:										
Non-Tribal										
Harvest (pounds)	2,516,383	0	-2,516,383	-100.0%	0	-2,516,383	-100.0%	0	-2,516,383	-100.0%
Harvest Value	$627,357	$0	-$627,357	-100.0%	$0	-$627,357	-100.0%	$0	-$627,357	-100.0%
Tribal										
Harvest (pounds)	4,605,362	2,458,337	-2,147,025	-46.6%	2,458,337	-2,147,025	-46.6%	411,384	-4,193,979	-91.1%
Harvest Value	$1,629,120	$771,288	-$857,831	-52.7%	$771,288	-$857,831	-52.7%	$100,262	-$1,528,858	-93.8%
Processing Value	$6,334,627	$2,285,814	-$4,048,813	-63.9%	$2,285,814	-$4,048,813	-63.9%	$315,142	-$6,019,485	-95.0%
Strait of Juan de Fuca/North Hood Canal:										
Non-Tribal										
Harvest (pounds)	10,932	13,340	2,409	22.0%	13,340	2,409	22.0%	0	-10,932	-100.0%
Harvest Value	$5,138	$6,270	$1,132	22.0%	$6,270	$1,132	22.0%	$0	-$5,138	-100.0%
Tribal										
Harvest (pounds)	420,806	13,559	-407,247	-96.8%	13,559	-407,247	-96.8%	4,255	-416,551	-99.0%
Harvest Value	$292,918	$6,658	-$286,260	-97.7%	$6,658	-$286,260	-97.7%	$2,841	-$290,077	-99.0%
Processing Value	$513,136	$28,214	-$484,922	-94.5%	$28,214	-$484,922	-94.5%	$5,567	-$507,569	-98.9%
Statewide Total:										
[1] Marine trips include all local resident, non-local resident, and non-resident of the state sport fishing in the marine waters of Puget Sound and originating from a marina or launch area										
Harvest (pounds)	8,002,099	13,340	-7,988,759	-99.8%	13,340	-7,988,759	-99.8%	0	-8,002,099	-100.0%
thin the region identified	$3,222,488	$6,270	-$3,216,218	-99.8%	$6,270	-$3,216,218	-99.8%	$0	-$3,222,488	-100.0%
[3] Expenditure effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assumed that										
Harvest (pounds)	11,630,329	2,842,406	-8,787,923	-75.6%	2,485,978	-9,144,351	-78.6%	428,949	-11,201,380	-96.3%
Harvest Value	$4,961,382	$842,122	-$4,119,260	-83.0%	$782,135	-$4,179,247	-84.2%	$106,976	-$4,854,406	-97.8%
Processing Value	$18,150,894	$2,583,387	-$15,567,508	-85.8%	$2,325,142	-$15,825,753	-87.2%	$331,098	-$17,819,796	-98.2%

Note: All dollar values are expressed in 2002 dollars.

Table 4.6-11. Direct economic impacts to the commercial fishing and salmon processing industries.
Scenario C: 30% Reduction in abundance and 2003 Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Management Unit Level			Alternative 3 - Escapement Goal Management at the Population Level			Alternative 4 - No Fishing		
		Number	Change from Alternative 1	Percent Change	Number	Change from Alternative 1	Percent Change	Number	Change from Alternative 1	Percent Change
Puget Sound North										
Harvesting Sector:										
Non-Tribal:										
Jobs[1]	945.3	0.0	-945.3	-100.0%	0.0	-945.3	-100.0%	0.0	-945.3	-100.0%
Employment[2]	65.6	0.0	-65.6	-100.0%	0.0	-65.6	-100.0%	0.0	-65.6	-100.0%
Personal Income[3]	$1,685,474	$0	-$1,685,474	-100.0%	$0	-$1,685,474	-100.0%	$0	-$1,685,474	-100.0%
Tribal:										
Jobs[1]	1,540.9	32.5	-1,508.4	-97.9%	2.1	-1,538.8	-99.9%	2.0	-1,539.0	-99.9%
Employment[2]	74.1	4.3	-69.8	-94.2%	0.1	-74.0	-99.9%	0.1	-74.0	-99.9%
Personal Income[3]	$1,902,511	$98,163	-$1,804,348	-94.8%	$1,467	-$1,901,044	-99.9%	$1,303	-$1,901,207	-99.9%
Processing Sector:										
Employment[2]	178.4	5.5	-172.9	-96.9%	0.2	-178.1	-99.9%	0.2	-178.2	-99.9%
Personal Income[3]	$4,489,166	$137,154	-$4,352,012	-96.9%	$5,214	-$4,483,952	-99.9%	$4,922	-$4,484,245	-99.9%
South Puget Sound/South Hood Canal:										
Harvesting Sector:										
Non-Tribal:										
Jobs[1]	229.0	0.0	-229.0	-100.0%	0.0	-229.0	-100.0%	0.0	-229.0	-100.0%
Employment[2]	7.4	0.0	-7.4	-100.0%	0.0	-7.4	-100.0%	0.0	-7.4	-100.0%
Personal Income[3]	$185,698	$0	-$185,698	-100.0%	$0	-$185,698	-100.0%	$0	-$185,698	-100.0%
Tribal:										
Jobs[1]	826.0	391.0	-434.9	-52.7%	391.0	-434.9	-52.7%	50.8	-775.1	-93.8%
Employment[2]	27.2	14.9	-12.3	-45.3%	14.9	-12.3	-45.3%	1.3	-25.9	-95.3%
Personal Income[3]	$683,033	$331,855	-$351,178	-51.4%	$331,855	-$351,178	-51.4%	$28,288	-$654,745	-95.9%
Processing Sector:										
Employment[2]	91.8	31.7	-60.1	-65.5%	31.7	-60.1	-65.5%	5.3	-86.5	-94.2%
rom a marina or launch a	$2,374,849	$820,448	-$1,554,401	-65.5%	$820,448	-$1,554,401	-65.5%	$136,497	-$2,238,352	-94.3%
Strait of Juan de Fuca/North Hood Canal:										
[2] Freshwater trips include all local resident, non-local resident, and non-resident of the state sport fishing trips to fresh waters within the region identified.										
g because it is assumed tl										
Jobs[1]	1.9	2.3	0.4	22.0%	2.3	0.4	22.0%	0.0	-1.9	-100.0%
Employment[2]	0.1	0.1	0.0	37.8%	0.1	0.0	37.8%	0.0	-0.1	-100.0%
Personal Income[3]	$2,183	$2,664	$481	22.0%	$2,664	$481	22.0%	$0	-$2,183	-100.0%
Tribal:										
Jobs[1]	148.5	3.4	-145.1	-97.7%	3.4	-145.1	-97.7%	1.4	-147.1	-99.0%
Employment[2]	5.0	0.1	-4.9	-97.3%	0.1	-4.9	-97.3%	0.1	-5.0	-99.0%
Personal Income[3]	$128,364	$3,008	-$125,356	-97.7%	$3,008	-$125,356	-97.7%	$1,150	-$127,214	-99.1%
Note: Sport fishing-related effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state										
Employment[2]	6.3	0.4	-5.9	-93.7%	0.4	-5.9	-93.7%	0.1	-6.2	-99.0%
Personal Income[3]	$159,935	$10,032	-$149,903	-93.7%	$10,032	-$149,903	-93.7%	$1,568	-$158,367	-99.0%
State:										
Harvesting Sector:										
Non-Tribal:										
Jobs[1]	1,176.2	2.3	-1,173.9	-99.8%	2.3	-1,173.9	-99.8%	0.0	-1,176.2	-100.0%
Employment[2]	69.6	0.1	-69.5	-99.8%	0.1	-69.5	-99.8%	0.0	-69.6	-100.0%
on-residents of Washingto	$1,770,127	$2,576	-$1,767,552	-99.9%	$2,576	-$1,767,552	-99.9%	$0	-$1,770,127	-100.0%
Tribal:										
Jobs[1]	2,515.4	427.0	-2,088.5	-83.0%	396.5	-2,118.9	-84.2%	54.2	-2,461.2	-97.8%
Employment[2]	102.6	19.2	-83.4	-81.3%	15.1	-87.5	-85.3%	1.3	-101.3	-98.7%
Personal Income[3]	$2,608,057	$435,855	-$2,172,202	-83.3%	$344,754	-$2,263,304	-86.8%	$30,698	-$2,577,359	-98.8%
Processing Sector:										
Employment[2]	275.0	39.9	-235.1	-85.5%	34.8	-240.2	-87.3%	5.9	-269.1	-97.8%
Personal Income[3]	$6,989,134	$1,013,918	-$5,975,216	-85.5%	$885,907	-$6,103,227	-87.3%	$151,152	-$6,837,983	-97.8%

Note: Regional totals may not sum up to statewide totals because of differences in regional and statewide employment and personal income coefficients generated by the FEAM model

[1] Represents full- and part-time jobs.

[2] Represents full-time equivalent jobs.

[3] Personal income, expressed in 2002 dollars, includes employee compensation, proprietor income, and other property income.

Table 4.6-12. Impacts to sport fishing trips and expenditures by region.
Scenario C: 30% Reduction in abundance and 2003 Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Unit Level		Alternative 3 - Escapement Goal Management at the Population Level		Alternative 4 - No Fishing	
		Change from Alternative 1	Percent Change	Change from Alternative 1	Percent Change	Change from Alternative 1	Percent Change
North Puget Sound:							
Marine trips originating from the region[1]	118,554	-118,554	-100.0%	-118,554	-100.0%	-118,554	-100.0%
Freshwater trips occurring in the region[2]	351,609	-274,166	-78.0%	-300,306	-85.4%	-349,558	-99.4%
Total trips	470,163	-392,720	-83.5%	-418,860	-89.1%	-468,112	-99.6%
Expenditures in the region[3]	$30,233,716	-$6,535,617	-21.6%	-$7,018,991	-23.2%	-$7,929,732	-26.2%
South Puget Sound/South Hood Canal:							
Marine trips originating from the region[1]	215,562	-215,562	-100.0%	-215,562	-100.0%	-215,562	-100.0%
Freshwater trips occurring in the region[2]	263,094	-182,513	-69.4%	-182,513	-69.4%	-260,975	-99.2%
Total trips	478,656	-398,075	-83.2%	-398,075	-83.2%	-476,537	-99.6%
Expenditures in the region[3]	$30,032,910	-$3,514,752	-11.7%	-$3,514,752	-11.7%	-$4,290,425	-14.3%
Strait of Juan de Fuca/North Hood Canal:							
Marine trips originating from the region[1]	343,428	-343,428	-100.0%	-343,428	-100.0%	-343,428	-100.0%
Freshwater trips occurring in the region[2]	55,492	-49,941	-90.0%	-52,844	-95.2%	-55,352	-99.7%
Total trips	398,920	-393,369	-98.6%	-396,272	-99.3%	-398,780	-100.0%
Expenditures in the region[3]	$23,334,015	-$16,121,151	-69.1%	-$16,232,293	-69.6%	-$16,328,320	-70.0%
Regional Total:							
Marine trips originating from the region[1]	677,544	-677,544	-100.0%	-677,544	-100.0%	-677,544	-100.0%
Freshwater trips occurring in the region[2]	670,195	-506,620	-75.6%	-535,663	-79.9%	-665,885	-99.4%
Total trips	1,347,739	-1,184,164	-87.9%	-1,213,207	-90.0%	-1,343,429	-99.7%
Expenditures in the region[3]	$83,600,641	-$26,171,521	-31.3%	-$26,766,036	-32.0%	-$28,548,477	-34.1%

Note: Detailed information for angler types in included in the Economics Technical Appendix (Appendix D).

[1] Marine trips include all local resident, non-local resident, and non-resident of the state sport fishing in the marine waters of Puget Sound and originating from a marina or launch are area in the region identified.

[2] Freshwater trips include all local resident, non-local resident, and non-resident of the state sport fishing trips to fresh waters within the region identifiec

[3] Expenditure effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assumed tha assumed that spending by local resident anglers would continue in the region regardless of changes in local resident sport fishing activity under the alternatives.

Table 4.6-13. Regional economic impacts of the alternatives.

Scenario C: 30% Reduction in abundance and 2003 Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Unit Level: Change from Alternative 1	Alternative 2: Percent Change	Alternative 3 - Escapement Goal Management at the Population Level: Change from Alternative 1	Alternative 3: Percent Change	Alternative 4 - No Fishing: Change from Alternative 1	Alternative 4: Percent Change
North Puget Sound:							
Commercial Fishing Effects							
Sales[1]	$16,932,469	-$16,598,935	-98.0%	-$16,917,166	-99.9%	-$16,918,207	-99.9%
Employment[2]	511.5	-496.6	-97.1%	-511.1	-99.9%	-511.1	-99.9%
Personal Income[3]	$16,376,958	-$15,899,777	-97.1%	-$16,363,414	-99.9%	-$16,364,332	-99.9%
Sport Fishing Effects							
Sales[4]	$30,233,716	-$6,535,617	-21.6%	-$7,018,991	-23.2%	-$7,929,732	-26.2%
Employment[2]	536.8	-124.2	-23.1%	-133.3	-24.8%	-150.4	-28.0%
Personal Income[3]	$20,349,409	-$4,441,685	-21.8%	-$4,772,213	-23.5%	-$5,394,974	-26.5%
South Puget Sound/South Hood Canal:							
Commercial Fishing Effects							
Sales[1]	$8,591,104	-$5,534,001	-64.4%	-$5,534,001	-64.4%	-$8,175,700	-95.2%
Employment[2]	213.5	-137.7	-64.5%	-137.7	-64.5%	-202.7	-94.9%
Personal Income[3]	$7,713,533	-$4,974,125	-64.5%	-$4,974,125	-64.5%	-$7,321,188	-94.9%
Sport Fishing Effects							
Sales[4]	$30,032,910	-$3,514,752	-11.7%	-$3,514,752	-11.7%	-$4,290,425	-14.3%
Employment[2]	470.7	-61.0	-13.0%	-61.0	-13.0%	-74.0	-15.7%
Personal Income[3]	$22,409,940	-$2,650,376	-11.8%	-$2,650,376	-11.8%	-$3,241,632	-14.5%
Strait of Juan de Fuca/North Hood Canal:							
Commercial Fishing Effects							
Sales[1]	$811,192	-$770,050	-94.9%	-$770,050	-94.9%	-$802,784	-99.0%
Employment[2]	19.2	-18.2	-94.6%	-18.2	-94.6%	-19.0	-99.1%
Personal Income[3]	$567,483	-$536,810	-94.6%	-$536,810	-94.6%	-$562,173	-99.1%
Sport Fishing Effects							
Sales[4]	$23,334,015	-$16,121,151	-69.1%	-$16,232,293	-69.6%	-$16,328,320	-70.0%
g from a marina or launch are	477.6	-341.3	-71.5%	-343.4	-71.9%	-345.3	-72.3%
Personal Income[3]	$13,894,215	-$9,550,833	-68.7%	-$9,618,471	-69.2%	-$9,676,911	-69.6%
[2] Freshwater trips include all local resident, non-local resident, and non-resident of the state sport fishing trips to fresh waters within the region identified							
[3] Expenditure effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assumed							
Sales[1]	$26,334,765	-$22,902,986	-87.0%	-$23,221,218	-88.2%	-$25,896,691	-98.3%
Employment[2]	728.2	-635.2	-87.2%	-649.2	-89.2%	-716.6	-98.4%
Personal Income[3]	$25,314,356	-$22,081,797	-87.2%	-$22,569,799	-89.2%	-$24,911,218	-98.4%
Sport Fishing Effects[5]							
Sales[4]	$84,147,737	-$5,049,946	-6.0%	-$5,123,251	-6.1%	-$5,414,087	-6.4%
Employment[2]	1,466.8	-94.1	-6.4%	-95.5	-6.5%	-101.3	-6.9%
Personal Income[3]	$64,104,502	-$3,823,344	-6.0%	-$3,880,986	-6.1%	-$4,109,682	-6.4%

Note: Sport fishing-related effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assumed that spending by local resident anglers would continue in the region regardless of changes in local resident sport fishing activity under the alternatives.

[1] Represents direct commercial salmon harvester and processing sales in 2002 dollars.

[2] Represents total (direct and secondary) full-time equivalent jobs.

[3] Represents total (direct and secondary) personal income in 2002 dollars. Personal income includes employee compensation, proprietor income, and other property income.

[4] Represents direct sales to sport fishing anglers in 2002 dollars.

[5] Under alternatives to the Proposed Action, statewide effects for sportfishing include only those generated by changes in spending by non-residents of Washington. Changes in spending by Washington residents would merely redirect money already in the state economy and would result in no net economic effects.

Table 4.6-14. Impacts to commercial harvest, commercial harvest value, and processing value.
Scenario D: 30% Reduction in abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Management Unit Level: Number	Alternative 2: Change from Alternative 1	Alternative 2: Percent Change	Alternative 3 - Escapement Goal Management at the Population Level: Number	Alternative 3: Change from Alternative 1	Alternative 3: Percent Change	Alternative 4 - No Fishing: Number	Alternative 4: Change from Alternative 1	Alternative 4: Percent Change
Puget Sound North:										
Non-Tribal										
Harvest (pounds)	5,446,432	0	-5,446,432	-100.0%	0	-5,446,432	-100.0%	0	-5,446,432	-100.0%
Harvest Value	$2,567,061	$0	-$2,567,061	-100.0%	$0	-$2,567,061	-100.0%	$0	-$2,567,061	-100.0%
Tribal										
Harvest (pounds)	6,574,849	370,212	-6,204,637	-94.4%	14,081	-6,560,768	-99.8%	13,310	-6,561,539	-99.8%
Harvest Value	$3,016,306	$63,988	-$2,952,318	-97.9%	$4,189	-$3,012,117	-99.9%	$3,873	-$3,012,433	-99.9%
Processing Value	$11,244,390	$269,055	-$10,975,335	-97.6%	$11,113	-$11,233,276	-99.9%	$10,389	-$11,234,001	-99.9%
South Puget Sound/South Hood Canal:										
Non-Tribal										
Harvest (pounds)	2,516,308	0	-2,516,308	-100.0%	0	-2,516,308	-100.0%	0	-2,516,308	-100.0%
Harvest Value	$627,322	$0	-$627,322	-100.0%	$0	-$627,322	-100.0%	$0	-$627,322	-100.0%
Tribal										
Harvest (pounds)	4,577,736	2,431,935	-2,145,801	-46.9%	2,431,935	-2,145,801	-46.9%	411,384	-4,166,352	-91.0%
Harvest Value	$1,612,233	$754,655	-$857,578	-53.2%	$754,655	-$857,578	-53.2%	$100,262	-$1,511,971	-93.8%
Processing Value	$6,298,089	$2,250,435	-$4,047,653	-64.3%	$2,250,435	-$4,047,653	-64.3%	$315,142	-$5,982,946	-95.0%
Strait of Juan de Fuca/North Hood Canal:										
Non-Tribal										
Harvest (pounds)	10,920	13,340	2,420	22.2%	13,340	2,420	22.2%	0	-10,920	-100.0%
Harvest Value	$5,132	$6,270	$1,138	22.2%	$6,270	$1,138	22.2%	$0	-$5,132	-100.0%
Tribal										
Harvest (pounds)	420,800	13,559	-407,241	-96.8%	13,559	-407,241	-96.8%	4,255	-416,545	-99.0%
Harvest Value	$292,915	$6,658	-$286,257	-97.7%	$6,658	-$286,257	-97.7%	$2,841	-$290,074	-99.0%
Processing Value	$513,118	$28,214	-$484,904	-94.5%	$28,214	-$484,904	-94.5%	$5,567	-$507,551	-98.9%
Statewide Total:										
[1] Marine trips include all local resident, non-local resident, and non-resident of the state sport fishing in the marine waters of Puget Sound and originating from a marina or launch area										
Harvest (pounds)	7,973,660	13,340	-7,960,319	-99.8%	13,340	-7,960,319	-99.8%	0	-7,973,660	-100.0%
thin the region identified.	$3,199,515	$6,270	-$3,193,245	-99.8%	$6,270	-$3,193,245	-99.8%	$0	-$3,199,515	-100.0%
[3] Expenditure effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assumed that										
Harvest (pounds)	11,573,385	2,815,707	-8,757,679	-75.7%	2,459,576	-9,113,810	-78.7%	428,949	-11,144,437	-96.3%
Harvest Value	$4,921,455	$825,301	-$4,096,154	-83.2%	$765,502	-$4,155,953	-84.4%	$106,976	-$4,814,479	-97.8%
Processing Value	$18,055,597	$2,547,704	-$15,507,892	-85.9%	$2,289,763	-$15,765,834	-87.3%	$331,098	-$17,724,499	-98.2%

Note: All dollar values are expressed in 2002 dollars.

Table 4.6-15. Direct economic impacts to the commercial fishing and salmon processing industries.
Scenario D: 30% Reduction in abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Management Unit Level			Alternative 3 - Escapement Goal Management at the Population Level			Alternative 4 - No Fishing		
		Number	Change from Alternative 1	Percent Change	Number	Change from Alternative 1	Percent Change	Number	Change from Alternative 1	Percent Change
Puget Sound North										
Harvesting Sector:										
Non-Tribal:										
Jobs[1]	937.0	0.0	-937.0	-100.0%	0.0	-937.0	-100.0%	0.0	-937.0	-100.0%
Employment[2]	65.2	0.0	-65.2	-100.0%	0.0	-65.2	-100.0%	0.0	-65.2	-100.0%
Personal Income[3]	$1,673,335	$0	-$1,673,335	-100.0%	$0	-$1,673,335	-100.0%	$0	-$1,673,335	-100.0%
Tribal:										
Jobs[1]	1,529.3	32.4	-1,496.8	-97.9%	2.1	-1,527.1	-99.9%	2.0	-1,527.3	-99.9%
Employment[2]	73.6	4.3	-69.3	-94.2%	0.1	-73.5	-99.9%	0.1	-73.5	-99.9%
Personal Income[3]	$1,890,123	$98,035	-$1,792,088	-94.8%	$1,467	-$1,888,656	-99.9%	$1,303	-$1,888,819	-99.9%
Processing Sector:										
Employment[2]	177.5	5.4	-172.1	-96.9%	0.2	-177.3	-99.9%	0.2	-177.3	-99.9%
Personal Income[3]	$4,467,556	$137,042	-$4,330,514	-96.9%	$5,214	-$4,462,342	-99.9%	$4,922	-$4,462,634	-99.9%
South Puget Sound/South Hood Canal:										
Harvesting Sector:										
Non-Tribal:										
Jobs[1]	229.0	0.0	-229.0	-100.0%	0.0	-229.0	-100.0%	0.0	-229.0	-100.0%
Employment[2]	7.4	0.0	-7.4	-100.0%	0.0	-7.4	-100.0%	0.0	-7.4	-100.0%
Personal Income[3]	$185,683	$0	-$185,683	-100.0%	$0	-$185,683	-100.0%	$0	-$185,683	-100.0%
Tribal:										
Jobs[1]	817.4	382.6	-434.8	-53.2%	382.6	-434.8	-53.2%	50.8	-766.6	-93.8%
Employment[2]	26.8	14.4	-12.4	-46.2%	14.4	-12.4	-46.2%	1.3	-25.5	-95.2%
Personal Income[3]	$672,982	$321,654	-$351,328	-52.2%	$321,654	-$351,328	-52.2%	$28,288	-$644,694	-95.8%
Processing Sector:										
Employment[2]	91.5	31.4	-60.1	-65.7%	31.4	-60.1	-65.7%	5.3	-86.2	-94.2%
from a marina or launch a	$2,365,528	$811,577	-$1,553,951	-65.7%	$811,577	-$1,553,951	-65.7%	$136,497	-$2,229,031	-94.2%
Strait of Juan de Fuca/North Hood Canal:										
[2] Freshwater trips include all local resident, non-local resident, and non-resident of the state sport fishing trips to fresh waters within the region identified.										
g because it is assumed t										
Jobs[1]	1.9	2.3	0.4	22.2%	2.3	0.4	22.2%	0.0	-1.9	-100.0%
Employment[2]	0.1	0.1	0.0	37.9%	0.1	0.0	37.9%	0.0	-0.1	-100.0%
Personal Income[3]	$2,180	$2,664	$483	22.2%	$2,664	$483	22.2%	$0	-$2,180	-100.0%
Tribal:										
Jobs[1]	148.5	3.4	-145.1	-97.7%	3.4	-145.1	-97.7%	1.4	-147.1	-99.0%
Employment[2]	5.0	0.1	-4.9	-97.3%	0.1	-4.9	-97.3%	0.1	-5.0	-99.0%
Personal Income[3]	$128,363	$3,008	-$125,354	-97.7%	$3,008	-$125,354	-97.7%	$1,150	-$127,213	-99.1%
Note: Sport fishing-related effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state										
Employment[2]	6.3	0.4	-5.9	-93.7%	0.4	-5.9	-93.7%	0.1	-6.2	-99.0%
Personal Income[3]	$159,929	$10,032	-$149,897	-93.7%	$10,032	-$149,897	-93.7%	$1,568	-$158,360	-99.0%
State:										
Harvesting Sector:										
Non-Tribal:										
Jobs[1]	1,167.8	2.3	-1,165.5	-99.8%	2.3	-1,165.5	-99.8%	0.0	-1,167.8	-100.0%
Employment[2]	69.1	0.1	-69.0	-99.8%	0.1	-69.0	-99.8%	0.0	-69.1	-100.0%
on-residents of Washingto	$1,758,674	$2,576	-$1,756,098	-99.9%	$2,576	-$1,756,098	-99.9%	$0	-$1,758,674	-100.0%
Tribal:										
Jobs[1]	2,495.2	418.4	-2,076.7	-83.2%	388.1	-2,107.1	-84.4%	54.2	-2,440.9	-97.8%
Employment[2]	101.7	18.7	-83.0	-81.6%	14.7	-87.1	-85.6%	1.3	-100.4	-98.7%
Personal Income[3]	$2,585,893	$425,066	-$2,160,827	-83.6%	$334,084	-$2,251,809	-87.1%	$30,698	-$2,555,194	-98.8%
Processing Sector:										
Employment[2]	273.8	39.5	-234.3	-85.6%	34.5	-239.3	-87.4%	5.9	-267.9	-97.8%
Personal Income[3]	$6,958,446	$1,004,327	-$5,954,118	-85.6%	$876,423	-$6,082,023	-87.4%	$151,152	-$6,807,294	-97.8%

Note: Regional totals may not sum up to statewide totals because of differences in regional and statewide employment and personal income coefficients generated by the FEAM model

[1] Represents full- and part-time jobs.

[2] Represents full-time equivalent jobs.

[3] Personal income, expressed in 2002 dollars, includes employee compensation, proprietor income, and other property income.

Table 4.6-16. Impacts to sport fishing trips and expenditures by region.
Scenario D: 30% Reduction in abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Unit Level: Change from Alternative 1	Alternative 2: Percent Change	Alternative 3 - Escapement Goal Management at the Population Level: Change from Alternative 1	Alternative 3: Percent Change	Alternative 4 - No Fishing: Change from Alternative 1	Alternative 4: Percent Change
North Puget Sound:							
Marine trips originating from the region[1]	119,653	-119,653	-100.0%	-119,653	-100.0%	-119,653	-100.0%
Freshwater trips occurring in the region[2]	354,535	-282,791	-79.8%	-308,851	-87.1%	-352,484	-99.4%
Total trips	474,188	-402,444	-84.9%	-428,504	-90.4%	-472,137	-99.6%
Expenditures in the region[3]	$30,491,871	-$6,709,000	-22.0%	-$7,190,855	-23.6%	-$7,997,710	-26.2%
South Puget Sound/South Hood Canal:							
Marine trips originating from the region[1]	217,544	-217,544	-100.0%	-217,544	-100.0%	-217,544	-100.0%
Freshwater trips occurring in the region[2]	267,415	-189,746	-71.0%	-189,746	-71.0%	-265,296	-99.2%
Total trips	484,959	-407,290	-84.0%	-407,290	-84.0%	-482,840	-99.6%
Expenditures in the region[3]	$30,434,487	-$3,594,729	-11.8%	-$3,594,729	-11.8%	-$4,341,599	-14.3%
Strait of Juan de Fuca/North Hood Canal:							
Marine trips originating from the region[1]	352,411	-352,411	-100.0%	-352,411	-100.0%	-352,411	-100.0%
Freshwater trips occurring in the region[2]	56,352	-50,990	-90.5%	-53,885	-95.6%	-56,212	-99.8%
Total trips	408,763	-403,401	-98.7%	-406,296	-99.4%	-408,623	-100.0%
Expenditures in the region[3]	$23,911,897	-$16,523,168	-69.1%	-$16,633,979	-69.6%	-$16,723,078	-69.9%
Regional Total:							
Marine trips originating from the region[1]	689,608	-689,608	-100.0%	-689,608	-100.0%	-689,608	-100.0%
Freshwater trips occurring in the region[2]	678,302	-523,527	-77.2%	-552,482	-81.5%	-673,992	-99.4%
Total trips	1,367,910	-1,213,135	-88.7%	-1,242,090	-90.8%	-1,363,600	-99.7%
Expenditures in the region[3]	$84,838,256	-$26,826,897	-31.6%	-$27,419,563	-32.3%	-$29,062,386	-34.3%

Note: Detailed information for angler types in included in the Economics Technical Appendix (Appendix D).

[1] Marine trips include all local resident, non-local resident, and non-resident of the state sport fishing in the marine waters of Puget Sound and originating from a marina or launch area in the region identified.

[2] Freshwater trips include all local resident, non-local resident, and non-resident of the state sport fishing trips to fresh waters within the region identified

[3] Expenditure effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assumed that spending by local resident anglers would continue in the region regardless of changes in local resident sport fishing activity under the alternatives.

Table 4.6-17. Regional economic impacts of the alternatives.
Scenario D: 30% Reduction in abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Unit Level: Change from Alternative 1	Alternative 2: Percent Change	Alternative 3 - Escapement Goal Management at the Population Level: Change from Alternative 1	Alternative 3: Percent Change	Alternative 4 - No Fishing: Change from Alternative 1	Alternative 4: Percent Change
North Puget Sound:							
Commercial Fishing Effects							
Sales[1]	$16,827,756	-$16,494,713	-98.0%	-$16,812,454	-99.9%	-$16,813,494	-99.9%
Employment[2]	508.6	-493.7	-97.1%	-508.2	-99.9%	-508.2	-99.9%
Personal Income[3]	$16,283,382	-$15,806,686	-97.1%	-$16,269,838	-99.9%	-$16,270,755	-99.9%
Sport Fishing Effects							
Sales[4]	$30,491,871	-$6,709,000	-22.0%	-$7,190,855	-23.6%	-$7,997,710	-26.2%
Employment[2]	541.4	-127.5	-23.5%	-136.5	-25.2%	-151.6	-28.0%
Personal Income[3]	$20,523,138	-$4,559,981	-22.2%	-$4,889,470	-23.8%	-$5,441,193	-26.5%
South Puget Sound/South Hood Canal:							
Commercial Fishing Effects							
Sales[1]	$8,537,644	-$5,532,554	-64.8%	-$5,532,554	-64.8%	-$8,122,240	-95.1%
Employment[2]	212.3	-137.7	-64.9%	-137.7	-64.9%	-201.4	-94.9%
Personal Income[3]	$7,667,405	-$4,973,409	-64.9%	-$4,973,409	-64.9%	-$7,275,061	-94.9%
Sport Fishing Effects							
Sales[4]	$30,434,487	-$3,594,729	-11.8%	-$3,594,729	-11.8%	-$4,341,599	-14.3%
Employment[2]	477.0	-62.3	-13.1%	-62.3	-13.1%	-74.9	-15.7%
Personal Income[3]	$22,709,494	-$2,711,198	-11.9%	-$2,711,198	-11.9%	-$3,280,499	-14.4%
Strait of Juan de Fuca/North Hood Canal:							
Commercial Fishing Effects							
Sales[1]	$811,166	-$770,024	-94.9%	-$770,024	-94.9%	-$802,758	-99.0%
Employment[2]	19.2	-18.2	-94.6%	-18.2	-94.6%	-19.0	-99.1%
Personal Income[3]	$567,463	-$536,790	-94.6%	-$536,790	-94.6%	-$562,153	-99.1%
Sport Fishing Effects							
Sales[4]	$23,911,897	-$16,523,168	-69.1%	-$16,633,979	-69.6%	-$16,723,078	-69.9%
om a marina or launch area	489.5	-349.8	-71.5%	-351.9	-71.9%	-353.7	-72.3%
Personal Income[3]	$14,237,944	-$9,788,652	-68.8%	-$9,856,089	-69.2%	-$9,910,311	-69.6%
[2] Freshwater trips include all local resident, non-local resident, and non-resident of the state sport fishing trips to fresh waters within the region identified.							
[3] Expenditure effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assun							
Sales[1]	$26,176,566	-$22,797,291	-87.1%	-$23,115,032	-88.3%	-$25,738,492	-98.3%
Employment[2]	724.0	-632.3	-87.3%	-646.4	-89.3%	-712.5	-98.4%
Personal Income[3]	$25,171,134	-$21,983,966	-87.3%	-$22,471,461	-89.3%	-$24,767,996	-98.4%
Sport Fishing Effects[5]							
Sales[4]	$85,396,400	-$5,179,514	-6.1%	-$5,252,602	-6.2%	-$5,523,958	-6.5%
Employment[2]	1,488.8	-96.5	-6.5%	-97.9	-6.6%	-103.3	-6.9%
Personal Income[3]	$65,055,332	-$3,921,734	-6.0%	-$3,979,205	-6.1%	-$4,192,583	-6.4%

Note: Sport fishing-related effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assumed that spending by local resident anglers would continue in the region regardless of changes in local resident sport fishing activity under the alternatives.

[1] Represents direct commercial salmon harvester and processing sales in 2002 dollars.

[2] Represents total (direct and secondary) full-time equivalent jobs.

[3] Represents total (direct and secondary) personal income in 2002 dollars. Personal income includes employee compensation, proprietor income, and other property income.

[4] Represents direct sales to sport fishing anglers in 2002 dollars.

[5] Under alternatives to the Proposed Action, statewide effects for sportfishing include only those generated by changes in spending by non-residents of Washington. Changes in spending by Washington residents would merely redirect money already in the state economy and would result in no net economic effects.

Table 4.6-18. Baseline and change in net economic values of commercial salmon fishing (in millions of 2002 dollars).

Scenario	Baseline Conditions (Proposed Action/Status Quo)	Change from Baseline Conditions		
		Alternative 2: Management Unit Escapement Goal Management	Alternative 3: Population Unit Escapement Goal Management	Alternative 4: No Fishing
Scenario A: 2003 Abundance and 2003 Canadian/ Alaskan PST Fisheries	$8.4 M	-$9.7 M	-$10.0 M	-$11.2 M
Scenario B: 2003 Abundance and Maximum Canadian/ Alaskan PST Fisheries	$8.3 M	-$9.7 M	-$9.9 M	-$11.2 M
Scenario C: 30% Reduction in Abundance and 2003 Canadian/ Alaskan PST Fisheries	$8.2 M	-$9.8 M	-$9.9 M	-$10.9 M
Scenario D: 30% Reduction in Abundance and Maximum Canadian/ Alaskan PST Fisheries	$8.1 M	-$9.7 M	-$9.8 M	-$10.9 M

Note: The reductions in net economic values associated with Alternatives 2 through 4 are larger than baseline conditions because these values include the costs to society associated with unemployed labor resources and expected losses in capital investment value.

Table 4.6-19. Baseline and changes in angler days and net economic value (NEV) of salmon sport fishing in the Puget Sound area.

Scenario	Baseline Conditions (Proposed Action/ Status Quo)		Alternative 2: Management Unit Escapement Goal Management		Alternative 3: Population Unit Escapement Goal Management		Alternative 4: No Fishing	
	Angler Days	NEV	Change in Angler Days	Change in NEV	Change in Angler Days	Change in NEV	Change in Angler Days	Change in NEV
Scenario A: 2003 Abundance and 2003 Canadian/Alaskan PST Fisheries	1,443,600	$98.2 M	-1,211,660	-$82.4 M	-1,266,070	-$86.1 M	-1,439,290	-$97.9 M
Scenario B: 2003 Abundance and Maximum Canadian/ Alaskan PST Fisheries	1,434,100	$97.5 M	-1,210,620	-$82.3 M	-1,265,100	-$86.0 M	-1,429,790	-$97.2 M
Scenario C: 30% Reduction in Abundance and 2003 Canadian/ Alaskan PST Fisheries	1,347,700	$91.6 M	-1,184,120	-$80.5 M	-1,213,170	-$82.5 M	-1,363,590	-$92.7 M
Scenario D: 30% Reduction in Abundance and Maximum Canadian/ Alaskan PST Fisheries	1,367,900	$93.0 M	-1,212,920	-$82.5 M	-1,242,080	-$84.5 M	-1,363,590	-$92.7 M

Note: Monetary values are expressed in millions of 2002 dollars.

4.6.6 Cumulative Effects

NEPA defines cumulative effects as “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such other actions” (40 CFR1508.7). For the purposes of this discussion, the terms “effects” and “impacts” will be considered synonymously with “consequences,” and consequences may be negative or beneficial. This section presents an analysis of the cumulative effects (negative or beneficial) of the Proposed Action in the context of other local, state, tribal, and federal management activities in the Puget Sound region on fish resources and related economic conditions.

The geographic scope of the cumulative effects analysis area includes the entire Puget Sound region. The analysis area covers both inland and marine environments that are managed under laws, policies, regulations, and plans having a direct or indirect impact on fish. The substantive scope of the cumulative analysis is predicated on a review of all laws, policies, regulations, and plans that specifically pertain to fish-related management activities or that have an indirect negative or beneficial effect on fish resources and related economic conditions. These laws, policies, regulations, and plans are described in Section 1 and Appendix F. Because of the geographic scope of the analysis area, it is not feasible to analyze all habitat-specific activities that are occurring, have occurred in the past, or that will occur in the future in a quantitative manner. By reviewing all laws, policies, regulations, and plans, the analysis captures the objectives of any management activity that is occurring or planned to occur that may interface with fish resources within the Puget Sound region. It is assumed that no management activity is occurring or would occur outside of an implemented law, policy, regulation, or sanctioned plan at the federal, tribal, state, or local level. Although the analysis is necessarily qualitative, it provides a thorough review of all other activities within the region that, when combined with the Proposed Action, could have a negative or beneficial affect on fish resources and related economic conditions.

Table 4.3.8.2-1 summarizes the potential cumulative effects to fish resources of implementing the Proposed Action with the effects of these existing laws, policies, regulations, and plans. Table 4.6-20 below summarizes the potential cumulative effects on economic conditions of other plans, policies and programs in the Puget Sound region.

The Proposed Action is implementation of the Puget Sound Chinook Harvest Resource Management Plan (RMP), jointly prepared by the Washington Department of Fish and Wildlife (WDFW) and the

Puget Sound Treaty Tribes (co-managers). Factors common to the relationship between the RMP and the various existing plans, policies and programs include: 1) the Resource Management Plan would provide protection to Puget Sound chinook salmon by conserving the productivity, abundance, and diversity of populations within the Puget Sound Chinook Evolutionarily Significant Unit (ESU), while managing harvest of strong salmon stocks; and 2) conserving productivity requires biological integrity in the freshwater systems in which salmon spawn and rear.

1 Table 4.6-20. Federal, Tribal, Washington State, and local plans, policies, and programs that influence economic condition within the Puget
2 Sound Action Area (2004).

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of the earliest to the most recent)	Description and Intent	Cumulative Effect when Combined with the Proposed Action
State of Washington, Chapter 36.70A RCW Growth Management – Planning by Selected Counties and Cities. Commonly referred to as the Growth Management Act (GMA). Adopted by the state in 1990.	The GMA guides development and adoption of comprehensive land use plans and development regulations of counties and cities within the state of Washington. The goals of the GMA include: "[m]aintain and enhance natural resource-based industries, including productive timber, agricultural, and fisheries industries" and "[p]rotect the environment and enhance the state's high quality of life, including air and water quality, and the availability of water."	Under the Proposed Action, commercial fishing and sport fishing activities would occur at levels similar to the recent past. Employment and economic growth levels supported by these activities would have little effect on local and regional land use plans, and would not conflict with growth objectives of the GMA. Consequently, the Proposed Action, when considered in conjunction with the GMA, is predicted to result in no cumulative impact to economic resource conditions, because the Proposed Action would not change current or expected future economic conditions.
Puget Sound Regional Council VISION 2020 Strategy, 1995.	VISION 2020 is the long-range growth management, economic, and transportation strategy for the central Puget Sound region encompassing King, Kitsap, Pierce, and Snohomish counties. The strategy combines a public commitment to a growth management vision with the transportation investments and programs and economic strategy necessary to support that vision. VISION 2020 identifies the policies and key actions necessary to implement the overall strategy. The vision is for "diverse, economically and environmentally healthy communities framed by open space and connected by a high-quality multimodal transportation system that provides effective mobility for people and goods. The VISION 2020 strategy for managing growth, the economy, and transportation contains the following eight parts: urban growth areas; contiguous and orderly development; regional capital facilities; housing; rural areas; open space, resource protection, and critical areas; economics; and transportation. Together, these eight parts constitute the Multi-county Policies for King, Kitsap, Pierce, and Snohomish counties and meet the multi-county planning requirements of Washington's Growth Management Act.	From a growth and economic development perspective, the Proposed Action would maintain the status quo in regards to employment and personal income growth related to Puget Sound's commercial and sport fisheries. Consequently, the Proposed Action, when considered in conjunction with the VISION strategy, is predicted to result in no cumulative impact to economic resource conditions, because the Proposed Action would not change current or expected future economic conditions.

Table 4.6-20. Federal, Tribal, Washington State, and local plans, policies, and programs that influence economic condition within the Puget Sound Action Area (2004). *continued*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of the earliest to the most recent)	Description and Intent	Cumulative Effect when Combined with the Proposed Action
Economic Development Agency Plans and Programs	Several economic development councils and agencies operate in the counties surrounding Puget Sound. Economic development agencies normally include private, non-profit agencies that seek to encourage economic growth through the provision of various services to businesses and governments. Agencies in the Puget Sound region include, but are not limited to, the Economic Development Council of Thurston County, the Bellingham/Whatcom County Economic Development Council, the Kitsap Regional Economic Development Council, the Economic Development Council of Tacoma-Pierce County, the Economic Development Council of Seattle/King County, the Mason County Economic Development Council, and the Clallam County Economic Development Council. Economic development councils can affect regional economic growth and conditions in several ways, including through the development of economic development plans and business enhancement programs, and through business relocation assistance and planning, business promotion, coordination with local government economic development planning, and through the provision of socioeconomic data to the public and business community.	From a growth and economic development perspective, the Proposed Action would maintain the status quo in regards to employment and personal income growth related to Puget Sound's commercial and sport fisheries. Consequently, the Proposed Action, when considered in conjunction with economic development plans and programs in the Puget Sound region, is predicted to result in no cumulative impact to economic resource conditions because the Proposed Action would not change current or expected future economic conditions.
Local Plans, Policies, and Programs	Local activities that influence cumulative effects to economic conditions include, but are not limited to, capital improvement projects, growth and development plans, and economic and redevelopment plans.	The fisheries that would be allowed by the Proposed Action are predicted to have minimal to negligible effect on local economic conditions. Recent levels of local employment and growth supported by Puget Sound's commercial and sport salmon fisheries would be maintained by the Proposed Action. Consequently, the Proposed Action, when considered in conjunction with local plans, policies, and programs, is predicted to result in no cumulative impact to economic resource conditions because the Proposed Action would not change current or expected future economic conditions.

4.7 Environmental Justice

In consultation with the U.S. Environmental Protection Agency's (EPA) Office of Civil Rights and Environmental Justice, the National Marine Fisheries Service determined that Native American tribes were the only racial or socio-economic minorities identified as potentially affected Environmental Justice communities within the Puget Sound Action Area. EPA's Office of Civil Rights and Environmental Justice concurred that the focus of the Environmental Justice analysis should be on these tribes (personal communication with Mike Letourneau, U.S. Environmental Protection Agency, December 10, 2002). To guide the framework of Environmental Justice analysis, the EPA Office of Civil Rights and Environmental Justice has provided guidance to be used by all federal agencies conducting Environmental Justice analyses. NMFS has utilized this guidance for the Environmental Justice analysis herein. The EPA Environmental Justice guidelines offer a range of categories that might be utilized to indicate the presence or absence of Environmental Justice effects (U.S. Environmental Protection Agency 1998b). The Northwest Power Planning Council (2000) has also utilized a range of indicators to analyze human effects in a multi-cultural framework.

> Selection of indicators to appropriately represent potential impacts on tribal peoples . . . is necessarily cross-cultural. For example, while economic issues are of keen interest to Tribes due to their critical needs for jobs and improved incomes, the Tribes consider spiritual, cultural and life-style values associated with fish and wildlife of paramount importance – and these cannot be accurately represented by contemporary economic measures.
>
> Northwest Power Planning Council 2000.

Consequently, this indicator-based assessment draws topically from the range of indicator categories outlined by the US Environmental Protection Agency (1998b), from information provided in cultural and economic sections of Section 3 of this Environmental Impact Statement, and from other information relevant to the circumstances of the subject tribes. A brief discussion of each selected indicator follows.

Number of Salmon Harvested as an Indicator of Tribal Perspective of Value

Tribal spokespersons remind us that, in their culture, " . . . tribal peoples live as one with the land, the waters, and the fish and wildlife of their areas." From a tribal perspective, the value of the salmon is self-evident – and can be articulated by tribes in their own words, and on their own terms (Northwest Power Planning Council 2000). Some of this broad perspective is captured in Section 3.5 of this Environmental Impact Statement. Other tribal statements are found throughout tribal literature. The following examples are typical, but not exhaustive.

> Shellfish, all species of salmon and steelhead are what we depend on for our survival. This was a long time resource the Klallam people depended on for food. We still depend on it. . . . The water has long been a key religious asset for the Klallam people – a sacred thing, to get our strength from the food we have taken from the Sea water and the fresh water. It still is to this day.
>
> David Charles, Klallam Elder, in U.S. Minerals Management Service 1991.

> The Lummi people have historically been major producers of seafood products. Native to the cold, productive waters of Puget Sound and the North Pacific, Lummi fishermen have harvested, processed and marketed fish to others for thousands of years.
>
> Lummi Business Council, *in* U.S. Minerals Management Service 1991.

> The people acquired guardian spirits, many of whom were salt water spirits. The Salmon Spirit was particularly powerful and was the basis for many ceremonial rituals involving death and rebirth. It was felt that the Salmon's power should be recognized, and that the Salmon should be treated properly and not abused. . . . We know what the Earth and the Creator have given us to survive. We still have the same resources – and they are still providing us with a livelihood today.
>
> Ray Fryberg, Tulalip Councillor, *in* U.S. Minerals Management Service 1991.

Numbers of salmon harvested provide an indicator of the health of stocks, and represent an appropriate measure of relative harvest abundance and of tribal value. They are incorporated in this section as a value indicator that, from tribal perspective, "speaks for itself."

Cultural Viability

The U.S. Environmental Protection Agency (EPA) incorporates cultural impacts in its Exhibit 2 menu of factors that may be considered in any Environmental Justice analysis (U.S. Environmental Protection Agency 1998b). Where the "number of salmon" indicator facilitates tribal assertion of value and potential impact "in their own words," the "cultural viability" indicator is anthropologically based – and following analysis of Section 3.5 in this Environmental Impact Statement, will focus on impacts potentially affecting *cultural sustainability*, *passing on tribal knowledge to future tribal generations*, and *preservation of tribal identity*. These issues are interrelated – but taken together, are designed to carry the framework constructed in Section 3.5 through to this Environmental Justice assessment.

The information provided in Section 3.5, together with the tribal statements provided herein, identify that while salmon available to the tribes are diminished from Treaty times, the tribes continue to actively pursue salmon, depend on salmon as a key element of their present well-being, and value salmon highly for future generations. It is this contemporary relationship between the tribes and salmon that provides the baseline for the present analysis with respect to both the "number of salmon" and the "cultural viability" indicators.

Tribal Fishing Revenue

This tribal fishing indicator directly addresses economic revenue obtained by the tribes from sale of commercially-caught salmon and/or salmon eggs. Tribes also receive economic revenue from processing salmon, and from service activity associated with commercial and sport fishing. Such additional revenues are significant for some tribes, less so for others. However, in this assessment, comparison of direct revenues from sale of tribal catch serves as an accurate and sufficient measure to identify revenue-based Environmental Justice concerns associated with the four chinook salmon management alternatives.

Actual tribal revenues from salmon harvests vary from year to year due to changes in abundance and price. Table 4.7-1 provides information on recent revenues within the Puget Sound Action Area for the 17 fishing tribes included in this Environmental Impact Statement.

Table 4.7-1. Tribal salmon fishing revenue for the action area – 17 fishing tribes (estimates in thousands of dollars).

Species	1999 Revenue	2000 Revenue	2001 Revenue
Chinook	716	636	663
Chum	325	388	248
Pink	28	1	126
Coho	350	1,031	577
Sockeye	146	2,033	133
Steelhead	10	15	2
Salmon Egg Sales	303	746	1,807
Total – All Salmon	1,878	4,849	3,556

Source: Northwest Indian Fisheries Commission, February 2003.

Finally, this section addresses three indicators common to both tribal and non-tribal assessment of human effects: per capita income, level of poverty, and relative health/mortality. Available data will not necessarily sustain a quantitative calculation of precise effects linkages between salmon harvest under each alternative and impacts on these three indicators. However, information is sufficient to apply an ordinal measure of change to each indicator, where differences in tribal access/harvest between alternatives are deemed to be significant.

Annual Per Capita Income

This indicator is based on U.S. Bureau of the Census data published from Census 2000 for *American Indians and Alaska Natives* resident *on or near* each designated reservation. U.S. Census data is commonly relied on as a “best available” objective data source. (The data reported here include some

Native Americans resident on or near designated reservations who are not members of the 17 treaty fishing tribes.)

Percent Below Poverty Level

Data for this indicator come from the same U.S. Census 2000 source as per capita income. The data indicate the percentage of *American Indians and Alaska Natives* resident *on or near* each designated reservation with annual income below the federal poverty level.

Present populations and selected circumstances for the subject fishing tribes, as reported in the Census 2000 report, are presented in Table 4.7-2. Figures for all residents of the State of Washington are included for comparative purposes. Per capita and poverty data are for 1999. Data for the Jamestown S'Klallam Tribe are based on a sample size of 5 persons, and have not been relied upon. Actual circumstances at Jamestown S'Klallam have been reported to be within the range indicated for other tribes (Meyer 1993).

Table 4.7-2. Selected data for potentially affected tribes.

Tribe/State	Native Population	Per Capita Income	% below Poverty
Makah	1,076	$9,835	31
Lower Elwha	256	8,082	33
Jamestown	5	–	–
Port Gamble	461	8,539	18
Suquamish	503	13,613	13
Skokomish	518	8,500	32
Squaxin Island	325	8,698	33
Nisqually	314	11,072	18
Puyallup	1,386	12,439	26
Muckleshoot	1,029	9,914	29
Tulalip	1,875	10,623	29
Stillaguamish	78	7,609	13
Swinomish	611	8,712	36
Upper Skagit	139	5,523	60
Sauk Suiattle	41	8,127	5
Lummi	2,208	10,142	28
Nooksack	348	9,695	29
Washington State		$22,973	11

Source: U.S. Bureau of the Census. Census 2000, Summary File 3, Tables P6, P82, P157C and P159C.

Health and Mortality

The general health status of tribal peoples in Washington State, including within the Puget Sound Action Area considered here, were described in two 1992–1993 publications as "very poor" (Washington State Department of Health 1992), and "alarmingly poor" (American Indian Health Care Association 1993). The 1999 update to the *American Indian Health Care Delivery Plan* in Washington State confirms the conclusions from these earlier studies.

> AI/AN (American Indians/Alaska Natives) have a higher burden of serious disease, premature death, and poor birth outcomes than the population as a whole.
>
> American Indian Health Commission for Washington State and Washington State Department of Health (2001) (C-3).

> Since 1980, the total reported age-adjusted death rate for AI/AN in Washington State has consistently been higher than the death rate for the entire population of the State. . . . The general trend for overall AI/AN age-adjusted death rates since 1980 has been downward, but the gap between the AI/AN death rate and that for the general population has not narrowed appreciably.
>
> American Indian Health Commission for Washington State and Washington State Department of Health (2001) (C-7).

Recent work in the Pacific Northwest has identified a linkage between salmon resources and tribal health (i.e., Trafzer 1997; and Meyer Resources 1999). Commentary from a nurse from a neighbor salmon fishing tribe offers insight into relationships between salmon and tribal health.

> My specialty is psychosocial nursing. From my perspective, everything is tied together. Nothing is separate. The health of the kids is impacted every day. We see kids come in who are grossly overweight, and they're laying the groundwork for diabetes to come. The impact of the loss of the salmon, and the loss of the traditional grounds – the loss of the time with the elders to learn the ways and to feel as if they're part of this community, instead of feeling alienated not only from their neighbors and their families but also from the bigger community of humans – has a devastating effect on the kids. I have moms come in here eighteen years old who have been pregnant two or three times, who use substances and who don't teach their children the old ways because they don't know them. They don't feed their kids the old foods because they don't have any idea what they were. So the loss of the food and the salmon is monumental – and it is all tied together. . . . If you lose your foods, you lose part of your culture – and it has a devastating effect on the psyche. You also lose the social interaction. When we can fish, we spend time together – you share all the things that impact your life – and you plan together for the next year. Salmon is more important than just food.
>
> In sum, there's a huge connection between salmon and tribal health. Restoring salmon becomes a way of life. It restores physical activity. It restores mental health. It improves nutrition and thus restores physical health. It restores a traditional food source. It allows families to share time together and build connections between family members. It passes on traditions that are being lost.
>
> Chris Walsh, Yakama psycho-social nurse, *in* Meyer Resources 1999 (page 141).

While precise cause and effect quantification remains unspecified, it can be concluded that for the fish-eating tribes that are the subject of this analysis, salmon has played, and continues to play an important role in the health of tribal peoples – and consequently, is also a likely explanatory variable respecting observable differences in age-adjusted mortality between tribal peoples and residents of the State of Washington in general (Table 4.7-3).

Table 4.7-3. Relative mortality for tribal peoples compared to residents of Washington State.

Tribal Health Service, by Counties	Ratio of Tribal Mortality to Mortality for Residents of Washington State
Clallam	1.7
Skagit, Whatcom	1.7
King, Kitsap, Mason, Snohomish, Thurston	1.3
Pierce	0.7
Jefferson, Grays Harbor, Pacific	1.0

Source: Portland Area Indian Health Care Service 1994.

These data compare number of deaths per 100,000 population for American Indians/Alaska Natives against similar data for Washington State residents as a whole. Age-adjustment eliminates the impact of differences in age structure between the two populations, and allows for comparisons of death rates as though there were no age differences between populations (Portland Area Indian Health Care Service 1994).

As discussed in Subsection 4.2, four different scenarios of abundance and Canadian/Alaskan fisheries harvest were considered in this Environmental Impact Statement (Scenarios A through D). Considering the likelihood attributed to various assumptions by the Interdisciplinary Team, Scenario B (high abundance and maximum Canadian/Alaskan fisheries) is considered most likely, followed by Scenario A (high abundance and Canadian/Alaskan fisheries similar to those in 2003). Scenarios C (30% reduction in abundance and fisheries similar to those in 2003), and D (30% reduction in abundance and maximum Canadian/Alaskan fisheries) provide a basis for lower-bound sensitivity adjustments related to adverse exogenous events. In this section, discussion focuses on comparison of estimated tribal harvests for the four alternatives under Scenario B. Results from employing Scenarios A, C, or D are discussed following the discussion of Scenario B for each alternative. Although the catch and revenue results differ among scenarios, comparison of alternatives illustrated by Scenario B as well as the Environmental Justice conclusions reached in Table 4.7-13, are the same across scenarios.

4.7.1. Alternative 1 – Proposed Action/Status Quo

Alternative 1 would maintain present harvest opportunities and distribute catch broadly between areas and dependent tribes – supporting the existing array of economic, material, and cultural activities and values discussed here and in other report sections. Of the four alternative management regimes evaluated under Scenario B, Alternative 1 is estimated to provide approximately 4.5 times more salmon to the tribes than Alternative 2 (following), 6.5 times more salmon than Alternative 3, and 49 times more salmon than Alternative 4. Alternative 1 is projected to leave present tribal circumstance essentially unchanged – and consequently, is not estimated to generate either positive or adverse cultural, material, or health impacts for the tribes, measured from the present baseline.

Scenario B (High Abundance and Maximum Canadian/Alaskan Fisheries)

Integrating information on average fish size and prices developed from Washington Department of Fish and Wildlife (2002) with projected harvest impact under Scenario B (Appendix B), estimated tribal harvest and associated fishermen revenues under Alternative 1 are identified in Tables 4.7-4 and 4.7-5.

Table 4.7-4. Estimated tribal salmon harvested annually under Alternative 1, Scenario B.

Areas	Chinook	Coho	Sockeye	Pink	Chum	Steelhead
Juan de Fuca Strait	2,363	23,879	26,419	1,374	10,450	739
North Puget Sound	29,238	101,652	255,859	731,587	152,189	532
South Puget Sound	33,241	140,279	47,700	316	196,350	663
Hood Canal	15,311	17,015	0	28,602	107,433	0
Full Action Area	80,153	282,825	329,978	761,879	466,422	1,934
Full Action Area – All Species						1,923,191

Under Alternative 1, Scenario B, an estimated 80,000 chinook, 283,000 coho, 330,000 sockeye, 762,000 pink salmon, 466,000 chum salmon, and almost 2,000 steelhead would be taken by the tribes annually. Applying average fish size and prices developed by the Washington Department of Fish and Wildlife (2002) to these numbers, Alternative 1, Scenario B, would generate an estimated $5.1 million in annual direct revenue for tribal fishermen.

Table 4.7-5. Estimated annual tribal salmon revenue, by species – Alternative 1, Scenario B.

Species	Estimated Annual Revenue (dollars)
Chinook	750,883
Coho	716,548
Sockeye	2,083,397
Pinks	494,615
Chums	1,076,968
Steelhead	9,516
All Species	$5,131,930

Commercial revenue estimates in Table 4.7-5 and for other alternatives may be underestimated to the extent that chum catch is diverted to higher-value egg sales.

These estimates maintain present harvest opportunities and distribute catch broadly between areas and dependent tribes – supporting the existing array of economic, material and cultural activities and values discussed here and in other EIS sections.

Of the four alternative management regimes evaluated under Scenario B, Alternative 1 is estimated to provide approximately 4.5 times more salmon to the tribes than Alternative 2 (discussed below), 6.5 times more salmon than Alternative 3, and 49 times more salmon than Alternative 4. Alternative 1 is projected to leave present tribal circumstance essentially unchanged – and consequently, is not estimated to generate either positive or adverse cultural, material, or health impacts for the tribes, measured from the present baseline.

Anticipated Environmental Justice effects are summarized in Table 4.7-13, following discussion of tribal impacts associated with each alternative.

<u>Summary of Results for Alternative 1, Scenarios A, C, or D</u>

Predicted tribal harvests of chinook salmon under Alternative 1, Scenarios A, C, or D are presented in Table 4.7-6.

Table 4.7.6. Predicted tribal harvests of chinook salmon under Alternative 1, Scenarios A, C, or D.

Area/Element	Scenario A	Scenario C	Scenario D
Juan de Fuca Harvest (#)	2,363	2,363	2,363
North Puget Sound (#)	31,813	22,434	20,281
South Puget Sound (#)	35,027	25,099	23,961
Hood Canal (#)	16,962	10,166	9,340
Chinook Harvest – All Areas (#)	86,165	60,062	55,945
Chinook Revenue ($)	$805,977	$575,902	$537,757
Chinook salmon: Difference from Scenario B.	+6,012 chinook +$55,094	-20,091 chinook -$174,981	-24,209 chinook -$213,126

Predicted tribal harvests for Puget Sound coho, sockeye, pink, chum, and steelhead would remain unchanged between Scenarios A, C, or D, and Scenario B (Table 4.7-6). Scenario A (high abundance and Canadian/Alaskan fisheries similar to 2003) would increase predicted tribal harvest under preferred Alternative 1 by 6,012 chinook compared with Scenario B. This represents a 7.5 percent increase in chinook harvest – and a 0.3 percent increase in tribal harvest of all species taken together. Tribal fishing revenue under Alternative 1 is predicted to increase by $55,094 (1.1 percent) – or $6 per capita. Predictably, assumption of 30 percent less harvest would decrease projected tribal harvest under Scenarios C or D significantly. Tribal harvest is predicted to decline by 25 to 30 percent and revenue by 3.4 to 4.1 percent under Scenarios C or D.

4.7.2 Alternative 2 – Escapement Goal Management at the Management Unit Level

Scenario B

Under Alternative 2, Scenario B, overall tribal chinook harvest is predicted to decline by an estimated 29,265 fish (78%), compared to Alternative 1 (Table 4.7-7). Losses would be most prevalent in North and South Puget Sound. Catch in the Strait of Juan de Fuca would be eliminated. Harvest in Hood Canal is predicted to increase by more than 4,000 chinook.

Table 4.7-7. Number of tribal salmon caught annually under Alternative 2, Scenario B.

	Chinook	Coho	Sockeye	Pink	Chum	Steelhead
Strait of Juan de Fuca	0	1,725	0	0	2	610
North Puget Sound	8,349	33,142	0	83,400	1,808	227
South Puget Sound	22,738	72,889	0	316	81,163	653
Hood Canal	19,802	4,493	0	25,792	65,813	0
Full Action Area	50,888	112,249	0	109,508	148,786	1,490
Full Action Area – All species	422,921					

Tribal coho catches are estimated to decline from an Alternative 1 catch of 24,000 fish to less than 2,000 fish in the Strait of Juan de Fuca under Alternative 2. Coho catches in North Puget Sound are predicted to decline from 102,000 to 33,000 fish. Tribal coho harvest in South Puget Sound is predicted to decline by an estimated 67,000 salmon. Estimated catches in Hood Canal are predicted to decline by 12,500 coho. Over all areas, tribal harvesters are estimated to lose 170,000 coho under Alternative 2, Scenario B, compared to Alternative 1, Scenario B.

Under Alternative 2, Scenario B, no tribal harvest of sockeye salmon would occur. Compared to Alternative 1, this would represent an estimated loss of 282,000 sockeye to North Puget Sound and Strait of Juan de Fuca tribal fishers, and a lost tribal catch of approximately 48,000 sockeye salmon in South Puget Sound.

Tribal catch of pink salmon is expected to decline by an estimated 652,000 fish under Alternative 2, Scenario B. Lost catch in the Strait of Juan de Fuca is estimated to exceed 1,000 pink salmon. In North Puget Sound, the loss of pink salmon to tribal fisherman is estimated to be 649,000. In Hood Canal, catch of pink salmon is predicted to decline by about 3,000. The South Puget Sound pink salmon fisheries would remain about the same as with Alternative 1.

Starting from the Alternative 1 baseline, tribal chum salmon harvest is predicted to decline by an estimated 318,000 fish under Alternative 2. In the Strait of Juan de Fuca and North Puget Sound, the estimated loss of chum salmon to tribal fishermen would be approximately 160,000 fish. An estimated 157,000 chum salmon would be lost from the South Puget Sound and Hood Canal tribal harvest – a decline of 52 percent.

Under Scenario B, the loss of steelhead to the tribal harvest is predicted to be 400 fish with Alternative 2, compared to Alternative 1.

Overall, Alternative 2 is predicted to provide an all-species catch of approximately 423,000 salmon to the tribes. This is predicted to result in an all-species reduction in catch of 1.5 million salmon (78%) compared to the Alternative 1 baseline.

Using average fish size and prices developed by Washington Department of Fish and Wildlife (2002), Alternative 2 is predicted to provide annual commercial direct revenue to tribal fishermen of $1,137,000 – a loss of $4 million from the Alternative 1 baseline.

Under Scenario B, the estimated impacts of Alternative 2 would greatly diminish, and in some cases eliminate, the opportunity to be a fisherman – a respected lifestyle in tribal society. Many tribal fishermen would lose their investment in boats and gear, and the tribal ability to pass on fishing knowledge to their children and grandchildren would be impaired.

Other cultural opportunities to provide salmon as food, to share or trade salmon within tribal communities, and to conduct ceremonies would be eliminated or substantially reduced for the tribes. Information provided earlier in this subsection suggests that this, in turn, could be expected to have an adverse impact on the physical, spiritual, and cultural health of tribal peoples who already experience adverse circumstances relative to residents of the State of Washington in general (Tables 4.7-2 and 4.7-3).

Alternative 2 would significantly worsen the already adverse economic and health circumstances experienced by the 17 tribes addressed in this Environmental Impact Statement, relative to residents of the State of Washington in general when compared with Alternative 1, Scenario B.

Alternative 2 stands second to Alternative 3 (described below) in terms of adversity for the tribes. However, considered alone, Alternative 2 would still generate disproportionately high and adverse human impacts across tribal groups. Given the dependence of tribes on salmon, and the unique cultural linkage between salmon and tribal peoples, these adverse impacts would resonate far more strongly among the tribes than among the non-tribal population of Washington State as a whole.

Summary of Results for Alternative 2, Scenarios A, C, or D

Predicted tribal harvests of chinook salmon under Alternative 1, Scenarios A, C, or D are presented in Table 4.7-8. Predicted tribal harvests for Puget Sound coho, sockeye, pink, chum, and steelhead would remain unchanged between Scenarios A, C, or D, and Scenario B (Table 4.7-8).

Table 4.7-8. Predicted tribal harvests of chinook salmon under Alternative 2, Scenarios A, C, or D.

Area/Element	Scenario A	Scenario C	Scenario D
Juan de Fuca Harvest (#)	0	0	0
North Puget Sound (#)	8,531	415	391
South Puget Sound (#)	24,150	11,523	10,537
Hood Canal (#)	21,213	12,745	11,608
Chinook Harvest – All Areas (#)	53,893	24,683	22,536
Chinook Revenue ($)	$445,065	$193,445	$176,619
Chinook salmon: Difference from Scenario B.	+3,005 chinook +$24,049	-26,683 chinook -$227,571	-28,351 chinook -$244,397

If Scenario A were implemented, tribal harvest would be predicted to increase under Alternative 2 by 3,005 chinook salmon compared to Scenario B. This would represent a 6.0 percent increase in chinook harvest – and a 0.2 percent increase in tribal harvest of all species taken together. Tribal fishing revenue under Alternative 1 would increase by $24,049 (0.5 percent), or $3 per capita. Predictably, assumption of 30 percent less harvest would decrease projected tribal harvest under Scenarios C or D significantly. Tribal harvest is predicted to decline by 56 to 58 percent and revenue by 3.4 to 4.1 percent under Alternative 2, Scenarios C or D because of the 30 percent decline in abundance in these two scenarios.

4.7.3 Alternative 3 – Escapement Goal Management at the Population Level

Scenario B

Under Alternative 3, Scenario B, overall tribal catch of salmon is predicted to be reduced by 85 percent compared to Alternative 1 – a loss of 1.6 million salmon each year (Table 4.7-9). Associated annual loss of direct tribal revenue from fish sales is estimated at $4.2 million.

Table 4.7-9. Estimated tribal salmon numbers harvested annually under Alternative 3, Scenario B.

Areas	Chinook	Coho	Sockeye	Pink	Chum	Steelhead
Strait of Juan de Fuca	0	1,725	0	0	2	610
North Puget Sound	0	143	0	0	1,057	227
South Puget Sound	22,738	72,889	0	316	81,163	653
Hood Canal	19,802	4,493	0	25,792	65,813	0
Full Action Area	42,540	79,250	0	26,108	148,035	1,490
Full Action Area – All Species						297,421

Principal predicted losses would be to tribal harvests of chinook salmon, down from 80,000 under Alternative 1 to 42,540 pieces, chiefly in North and South Puget Sound; coho down from 283,000 to 79,000 fish, chiefly from North and South Puget Sound; sockeye with 330,000 salmon lost from North and South Puget Sound; pink salmon in North Puget Sound, down to zero from 731,000 fish; and chum, down from 466,000 to 148,000, with all subareas adversely affected.

Alternative 3, Scenario B, would be more adverse than Alternative 2, Scenario B. It would significantly worsen the already adverse economic, health, and cultural circumstances experienced by the 17 tribes within the Puget Sound Action Area.

Summary of Results for Alternative 3, Scenarios A, C, or D

Predicted tribal harvests of chinook salmon under Alternative 1, Scenarios A, C, or D are presented in Table 4.7-10.

Table 4.7-10. Predicted tribal harvests of chinook salmon under Alternative 3, Scenarios A, C, or D.

Area/Element	Scenario A	Scenario C	Scenario D
Juan de Fuca Harvest (#)	0	0	0
North Puget Sound (#)	0	0	0
South Puget Sound (#)	24,150	11,523	10,537
Hood Canal (#)	21,213	12,745	11,608
Chinook Harvest – All Areas (#)	45,363	24,267	22,145
Chinook Revenue ($)	$355,519	$190,193	$173,555
Chinook salmon: Difference from Scenario B.	+2,822 chinook +$22,125	-18,273 chinook -$143,201	-20,395 chinook -$159,839

Predicted tribal harvests for Puget Sound coho, sockeye, pink, chum, and steelhead would remain unchanged between Scenarios A, C, or D, and Scenario B (Table 4.7-10). If Scenario A were implemented, tribal harvest under Alternative 3 would be predicted to increase by 2,822 chinook when compared with Scenario B. This would represent a 6.6 percent increase in chinook harvest, and a 0.2 percent increase in tribal harvest of all species taken together. Tribal fishing revenue under Alternative 1 would increase by $22,125 (0.4%), or $3 per capita. Predictably, assumption of 30 percent less harvest would decrease projected tribal harvest under Scenarios C or D significantly. Tribal harvest is predicted to decline by 43 to 48 percent, and revenue by 2.8 to 3.1 percent under Alternative 3, Scenarios C or D.

4.7.4 Alternative 4 – No Action/No Authorized Take, Scenario B.

Under Alternative 4, Scenario B, potential tribal harvests of four salmon species – chinook, coho, sockeye, and pink – are predicted to cease throughout the Puget Sound Action Area (Table 4.7-11). Potential tribal harvest of chum salmon is predicted to occur only in freshwater areas, principally in South Puget Sound, with small predicted catches in North Puget Sound and Hood Canal, and miniscule amounts predicted from Strait of Juan de Fuca streams. Total tribal chum salmon harvests are projected to decline by 92 percent under Alternative 4, from an estimated 466,000 fish under the Proposed Action (Alternative 1), to 37,800 fish.

Table 4.7-11. Estimated tribal salmon numbers harvested annually under Alternative 4, Scenario B.

Areas	Chinook	Coho	Sockeye	Pink	Chum	Steelhead
Juan de Fuca Strait	0	0	0	0	2	609
North Sound	0	0	0	0	1,057	227
South Sound	0	0	0	0	36,389	512
Hood Canal	0	0	0	0	352	0
Full Action Area	0	0	0	0	37,800	1,348
Full Action Area – All Species						39,148

Steelhead harvests by the tribes are predicted to decline by an estimated 30 percent, from 1,934 fish under Alternative 1, to 1,348 fish under Alternative 4. These catches would occur only in fresh water.

Summing lost tribal harvests for all salmonid species compared to baseline (Alternative 1) conditions, it is predicted that the tribes would lose almost 1.9 million salmon under Alternative 4, virtually eliminating access to the salmon resources reserved to them in the Stevens treaties. These impacts would, in turn, greatly diminish or eliminate the opportunity to pursue the occupation of tribal fisherman.

Other cultural opportunities to provide salmon as food, share or trade salmon within tribal communities, and conduct ceremonies would be eliminated or greatly reduced, and the physical and spiritual health of tribal peoples would be expected to decline.

The tribal peoples within the Puget Sound Action Area are already impoverished relative to residents of the State as a whole (Table 4.7-2). Using average fish size and prices for each species developed by Washington Department of Fish and Wildlife (2002), it is predicted that the subject tribes would receive approximately $107,000 from salmon sales under Alternative 4 – 2 percent of the revenues predicted with Alternative 1. Additionally, tribal fishermen, with no marine areas to fish, would lose their investments in boats, gear, and – over time – their fishing knowledge, should these losses occur.

The projected adverse impacts identified here show that Alternative 4 is predicted to have the most disproportionately high and adverse human and/or environmental effects on the tribes of any alternative being considered, and would exacerbate existing adverse differences in economic well-being and health between the tribes and Washington State residents as a whole. The unique linkage between salmon and tribal culture/values renders these adverse differences between the well-being of the tribes and residents of the State of Washington in general more pronounced under Alternative 4 than the other alternatives under consideration.

<u>Summary of Results for Alternative 4, Scenarios A, C, or D</u>

Predicted tribal harvests of chinook salmon under Alternative 4, Scenarios A, C, or D are presented in Table 4.7-12. Chinook catch under all scenarios would be zero, since Alternative 4 is defined as no take of listed chinook salmon.

Table 4.7-12. Predicted tribal harvests of chinook salmon under Alternative 4, Scenarios A, C, or D.

Area/Element	Scenario A	Scenario C	Scenario D
Juan de Fuca Harvest (#)	0	0	0
North Puget Sound (#)	0	0	0
South Puget Sound (#)	0	0	0
Hood Canal (#)	0	0	0
Chinook Harvest – All Areas (#)	0	0	0
Chinook Revenue ($)	0	0	0
Chinook salmon: Difference from Scenario B.	--- ---	--- ---	--- ---

Predicted tribal harvests for Puget Sound coho, sockeye, pink, chum, and steelhead would remain unchanged between Scenarios A, C, or D, and Scenario B.

4.7.5 Comparison of the Effects of Management Alternatives on the Tribes

Table 4.7-13 summarizes the findings of this section – arrayed by Environmental Justice indicator. The comparison uses the results of Scenario B, but the results follow the same pattern regardless of which scenario is used.

Table 4.7-13. Summary of environmental justice indicators associated with potential impacts from alternative management plans under Scenario B. [1]

Tribal Indicator	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Number of Salmon Harvested	1,923,191	422,921	297,421	39,148
Cultural Viability	Maintains status quo. Not predicted to have high disproportionate or adverse impact.	Disproportionate and substantial adverse impact to: *Cultural sustainability. *Tribal identity. *Passing on tribal knowledge.	Disproportionate and substantial adverse impact to: *Cultural sustainability. *Tribal identity. *Passing on tribal knowledge.	Disproportionate and substantial adverse impact to: *Cultural sustainability. *Tribal identity. *Passing on tribal knowledge.
Catch Revenue	$5,131,930	$1,137,426	$925,339	$106,976
Per Capita Income*	No change	Minus $358 /person.	Minus $376 /person.	Minus $450/person.
Poverty	No change	Substantial and disproportionate increase.	Substantial and disproportionate increase.	Substantial and disproportionate increase.
Health/Mortality	Maintains status quo. Not predicted to have high disproportionate or adverse impact.	Disproportionately adverse to health.	Disproportionately adverse to health.	Disproportionate and substantial threat to health.

[1] Based on tribal population estimates in Table 4.7-2.

The alternatives considered in this Environmental Impact Statement balance issues of salmon harvest and non-harvest, each of which involves its own affected constituencies, among tribes, and within the Washington State population as a whole. The tribes considered here retained guaranteed access to salmon in their treaties – in order to allow them to sustain themselves and prosper. In treaty times, and today, salmon play a unique role for the tribes. The loss of salmon as a viable resource upon which the fishing tribes depend economically and culturally would be an irretrievable loss to tribal culture.

Notwithstanding treaty guarantees, the life of the tribal peoples subject to this impact analysis remains difficult, compared to non-tribal residents of the State. Poverty is unacceptably high. Incomes and health circumstances are adverse. Cultural viability is often threatened.

Salmon remain critically important as the tribes struggle to survive – providing food and badly needed economic returns, a continuing basis for culture and lifestyle, and hope of improvement for children and grandchildren in the future. Comparatively, on the non-tribal side, salmon are important to non-tribal commercial and sport fishermen – but within a context that is characterized by far more diversity of economic opportunity, higher levels of material well-being, superior health and less direct cultural linkage with salmon for the majority of non-tribal citizens of Washington State.

Given this context, Table 4.7-13 and the preceding discussion identify that Alternatives 2, 3, or 4 would pose disproportionately-high and substantial adverse impacts to tribal culture, health and material well-being, differing only in degree. It is concluded that the severe potential impacts associated with any of these three alternatives render them unjust to the tribes when balanced against impacts to the people of Washington State as a whole. No mitigation measures have been identified that could effectively offset or reduce predicted Environmental Justice impacts to the tribes that would result from Alternative 2, Alternative 3, or Alternative 4.

4.7.6 Indirect and Cumulative Effects

4.7.6.1. Indirect Effects

Alternative 3 or 4 would specifically preclude fishing in marine areas. Alternative 2 would provide for only a modest marine chinook salmon fishery in North Puget Sound. In addition to direct harvest effects, these options could lead to increased crowding and/or competition between tribal fishers in some freshwater areas, and increased pressure on those freshwater stocks and on tribal fishing efficiencies.

The Samish and the Snoqualmie Tribes are afforded federal recognition, and demonstrate an historic fishing tradition. They are not presently recognized by the federal government to have status as treaty fishing tribes. Tribal spokespersons/experts report that a small number of their members have taken out non-tribal commercial salmon fishing licenses, but most of their salmon for ceremonies are currently obtained from one or more of the fishing tribes discussed in this Environmental Impact Statement. Consequently, Alternatives 2, 3, or 4 would not pose a present substantial threat with respect to material well-being or health for these tribes, but would make it more difficult for them to obtain salmon for ceremonial purposes and to continue cultural practices. As with other tribes, Alternative 1 would maintain current linkages between salmon and Samish and Snoqualmie peoples.

4.7.6.2 Cumulative Effects

NEPA defines cumulative effects as " . . . the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR1508.7). For purposes of this discussion, the terms "effects" and "impacts" will be considered synonymously with “consequences,” and consequences may be negative or beneficial. This subsection presents an analysis of the cumulative effects (negative or beneficial) of the Proposed Action in the context of other local, state, tribal, and federal management activities in the Puget Sound region on fish resources and related economic conditions.

The geographic scope of the cumulative effects analysis area includes the entire Puget Sound region. The analysis area covers both inland and marine environments that are managed under laws, policies, regulations, and plans having a direct or indirect impact on fish. The substantive scope of the cumulative effects analysis is predicated on a review of applicable laws, policies, regulations, and plans that specifically pertain to fish-related management activities, or that have an indirect negative or beneficial effect on fish resources and related economic conditions. These laws, policies, regulations, and plans are described in section 1 and Appendix F. Because of the geographic scope of the analysis area, it is not feasible to analyze all habitat-specific activities that are occurring, have occurred in the past, or will occur in the future in a quantitative manner. By reviewing applicable laws, policies, regulations, and plans, the analysis captures the objectives of management activities that are occurring or planned to occur that may interface with fish resources within the Puget Sound region. It is assumed that no management activity is occurring or would occur outside of an implemented law, policy, regulation, or sanctioned plan at the federal, tribal, state, or local level. Although the analysis is necessarily qualitative, it provides a thorough review of other activities within the region that, when combined with the Proposed Action, could have a negative or beneficial affect on environmental justice communities. Table 4.7-14 below summarizes the potential cumulative effects on environmental justice communities of other plans, policies and programs in the Puget Sound region in addition to the Proposed Action.

The Proposed Action (Alternative 1) is implementation of the Puget Sound Chinook Harvest Resource Management Plan (RMP), jointly prepared by the Washington Department of Fish and Wildlife (WDFW) and the Puget Sound Treaty Tribes (co-managers). Factors common to the relationship between the RMP and the various existing plans, policies and programs include: 1) the Resource Management Plan would provide protection to Puget Sound chinook salmon by conserving the productivity, abundance, and diversity of populations within the Puget Sound Chinook Evolutionarily Significant Unit (ESU), while managing harvest of strong salmon stocks; and 2) conserving productivity requires biological integrity in the freshwater systems in which salmon spawn and rear. Alternative 1 would maintain present-day distributions of salmon to the tribes, and is preferred. Due to alterations in habitat, stream water quality and other factors, the amount of salmon available to the subject tribes is substantially less than at treaty times. Consequently, management of salmon harvests as described in Alternative 1 is necessary, but may not be sufficient, to deal with cumulative Environmental Justice concerns arising from other sources. Alternatives 2, 3, or 4 would substantially reduce tribal access to salmon fisheries, and therefore would significantly worsen tribal material and cultural circumstance.

Table 4.7-14. Federal, Tribal, Washington State, and local plans, policies, and programs predicted to have a cumulative impact on environmental justice communities within the Puget Sound Action Area (2004).

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of the earliest to the most recent)	Description and Intent	Cumulative Effect when Combined with the Proposed Action
U.S. v. Washington (Boldt Decision)	The Boldt Decision reaffirmed the rights of Washington Indian tribes to fish in accustomed places, and allocated 50 percent of the annual catch to treaty tribes. Judge Boldt held that the government's promise to secure the fisheries for the tribes was central to the treaty-making process, and that the tribes had an original right to the fish, which they extended to white settlers. Judge Boldt ordered the state to take action to limit fishing by non-Indians. The court decision recognized that "assuring proper spawning escapement is the basic element of conservation involved in restricting the harvest of salmon and Steelhead." The decision further defined adequate production escapement as "… that level of escapement from each fishery which will produce viable offspring in numbers to fully utilize all natural spawning grounds and propagation facilities reasonable and necessary for conservation of the resource…"	For treaty tribes considered as Environmental Justice communities, the legal mandates prescribed in U.S. v. Washington in conjunction with the Proposed Action would be predicted to result in a beneficial impact to Tribes considered to be Environmental Justice communities. Both the Proposed Action and U.S.v. Washington require that Tribes have access to fishery resources.
EPA Environmental Justice Policy under Executive Order 12898	The Executive Order requires that EPA maintain oversight responsibility on ensuring that federal agencies assess whether their actions may result in a disproportionate impact on environmental justice communities. Also, EPA oversees that other federal agencies strive to avoid disproportionate impacts when they are predicted to occur	In keeping with the intent of the Executive Order, it is predicted that the Proposed Action would not result in a cumulative or disproportionate impact to Environmental Justice communities.

4.8 Wildlife

This section assesses the potential impacts of the Proposed Action or alternatives on marine birds, mammals, and invertebrates, including threatened and endangered wildlife species. Effects are described by fishery gear type and location (i.e., marine and freshwater terminal areas).

4.8.1 Marine Birds

The susceptibility of marine birds as a bycatch of Puget Sound salmon fishing depends largely on three factors: the type of fishing gear, the occurrence of birds during the fishing seasons, and bird diving behavior. The following discussion considers the effects of five fishing methods: sport, purse seine, beach seine, reef net, and gillnet.

Noviello (1999) studied seabird interaction with the Strait of Juan de Fuca and Puget Sound "hook and line" sport fishery (Marine Catch Areas 4, 5, 8-2, and 10) in 1997 and 1998, and observed no bird mortalities in 1,090 observed "hook-ups." (The only birds hooked were four immature gulls, all released alive.)

Purse seine nets are usually built of heavy nylon twine, with a small mesh (3.5 to 4 inches) that is probably visible to diving seabirds. Such nets, therefore, are probably easily avoided, or easily escaped from, by most seabirds. Anderson (1993) found that of 179 seabirds (mainly rhinoceros auklets, common murres, pigeon guillemots, and western grebes) observed encircled by seine nets in the 1990 to 1992 Puget Sound coho and chum salmon fisheries, 74 percent escaped, 21 percent were entangled but released unharmed, and only 5 percent were killed or injured. The mortality rate for this fishery was a very low 0.026 seabirds killed per net set. Further, the Washington Department of Fish & Wildlife (WDFW) now requires that purse seines have at least four 12-inch cork-line bird openings to facilitate escape by captured seabirds. The small tribal and non-tribal beach seine fisheries are similar. Because they operate in shallow, nearshore water with constant human presence, few, if any, seabirds are captured in this fishery. Consequently, neither purse seine nor beach seine fisheries are substantial sources of seabird mortality.

Reef net fishing is practiced by non-tribal fishers in Marine Catch Areas 7 and 7A. Reef nets are highly selective fishing gear with a design that prevents bycatch mortality. The mesh size is sufficiently small (3.5 inches) to avoid entanglement as the net is lifted out of the water and the contents spilled into a holding pen. Non-target species are then released from the holding pen unharmed.

Gillnet fisheries have been shown to entangle seabirds throughout the world (e.g., Christensen and Lear 1977; Piatt and Nettleship 1987; DeGange et al. 1993; and Julian and Beeson 1998), including Puget

Sound (Pierce et al. 1995; and Melvin et al. 1999). Gill nets have mesh openings large enough (5 to 7 inches) to entangle seabirds, and are made of monofilament nylon line, which is virtually invisible to pursuit diving seabirds.

However, not all marine birds are susceptible to the Puget Sound gillnet fishery. Gulls, kittiwakes, jaegers, terns, phalaropes, and dabbling ducks generally do not face a risk of bycatch because they forage at the surface, rather than diving to depths where nets are used. Fulmars and shearwaters are pelagic seabirds that do not enter very far into the Strait of Juan de Fuca and, therefore, do not often encounter net fisheries. Other species of ducks do not arrive in Puget Sound in great numbers until the fisheries are nearly complete. Using fish landings as a basis of effort, 90 percent of the commercial salmon fishery in the Strait of Juan de Fuca and North Puget Sound is complete by October, and November fishing in all catch areas is generally 80 to 85 percent completed by November 15. Subsection 3.8.2, Marine Birds – Affected Environment, describes marine bird migration through the Puget Sound Action area. Further, sea ducks and diving ducks are generally not fast-pursuit predators, feeding instead on more sedentary benthic prey such as mussels, clams, crabs, and algae. Entanglement in gillnets may require birds striking the net at a fast speed.

Large numbers of western grebe overlap with the late-season chum fisheries (Courtney et al. 1997) and, because they are pursuit divers, would be expected show up in the bycatch. Currently-available data, however, do not indicate that western grebes are susceptible to the gillnet fishery. This apparent immunity may be due to the bird's nocturnal foraging behavior (Clowater 1998), but further research may be required to substantiate this explanation.

What remain are diurnal foraging pursuit predators such as cormorants, loons, and alcids like rhinoceros auklets, common murres, pigeon guillemots, and marbled murrelets (the latter are addressed further in Subsection 4.8.4, below). Loons and cormorants have been identified as bycatch in gillnet fisheries in Newfoundland (Piatt and Nettleship 1987), and California (Julian and Beeson 1998), but in small numbers. Although cormorants are found year-around in Puget Sound and the Strait of Juan de Fuca, they, along with loons, do not reach their seasonal peak until December, after almost all salmon fishing is complete. Pierce et al. (1996) and Melvin et al. (1999) observed no loon or cormorant entanglements during the seabird interaction studies of sockeye fisheries within Marine Catch Areas 7 and 7A.

All types of fishing gear can become lost as a result of entanglement with bottom structures, logs and debris, or because of storms, flood events and other occurrences. Of the gears used to harvest salmon, monofilament gillnet and angling gears are the most common gear types lost. Submerged gillnets typically drift until they become entangled on submerged features or structures, where they may impact bottom-dwelling organisms. Seabirds, mammals, fish and other animals become entangled in derelict nets or entangle in or ingest monofilament fishing line. Nets and pots lying on the seabed continue to entangle fish and wildlife species for years after they are lost or abandoned.

In 2004, the Greystone Foundation provided funding to the Northwest Straits Foundation (NWSF), who contracted with Natural Resource Consultants to conduct derelict fishing gear removal in the Strait of Juan de Fuca and the San Juan Islands. In the 46 nets encountered in this project, 43 dead seabirds were recovered, and bone evidence below the nets suggests that hundreds and perhaps over one thousand other birds may have been killed. These results are too recent (April 5, 2004) for rigorous estimates of cumulative impacts to populations of seabirds, marine mammals and other wildlife to be available. Such estimates will allow managers to determine what relative impact this environmental problem is exerting on seabird and mammal populations.

Worldwide, alcids are the most common seabird caught in coastal gillnet fisheries, with common murres the most commonly caught species (Melvin et al. 1999). These birds are most susceptible because 1) they swim very rapidly in dive-pursuit of prey and, therefore, likely hit gillnets with enough force to cause entanglement; 2) they tend to form large aggregations; and 3) they tend to pursue a common prey with salmon (e.g., herring). Collectively, then, large numbers of these fast diving birds may be found in association with salmon, which are targeted by gillnet fishers, resulting in bycatch of the alcids. Recognizing that alcid mortality due to gillnet fishing is the only potentially substantial seabird fishery interaction issue, only pigeon guillemots, rhinoceros auklets, and common murres are addressed further in this subsection. Marbled murrelets are addressed in the Threatened and Endangered Species subsection (4.8.4 below).

Pigeon Guillemot

Guillemots have shown susceptibility to gillnet fisheries in some regions. Piatt and Nettleship (1987) estimated that the Newfoundland cod and salmon gillnet fishery killed approximately 2,000 black guillemots annually between 1981 and 1984. In contrast, Pierce et al. (1996) did not report the presence of pigeon guillemots during the 1994 sockeye fishery Marine Catch Areas 7 and 7A, and in a 1996 sockeye test fishery in Marine Catch Area 7, only one pigeon guillemot was caught in 642 gillnet sets (Melvin et al. 1999). Also, Julian and Beeson (1998) recorded no entanglements of pigeon guillemots during 1990 to 1994 gillnet fishing in central California that was killing up to 2,300 common murres annually (Forney et al. 2001). Guillemots in Washington are probably not susceptible to the Puget Sound gillnet fishery because they forage on gunnels, pricklebacks, and sculpins (Drent 1965; and

Koelink 1972), generally in shallow, nearshore waters. Gunnels, pricklebacks, and sculpins are more sedentary than schooling fish such as herring, and therefore probably do not require fast pursuit to capture.

Rhinoceros Auklet

Thompson et al. (1998) estimated that the 1994 sockeye fishery in Marine Catch Areas 7 and 7A killed less than 0.8 percent of the Washington breeding auklet population (36,800), well below the 6 percent mortality level where population stability concerns occur. Further, Thompson et al. (1998) observed no adults during the fall chum salmon fishery, confirming that most auklets winter outside Washington's inner marine waters (Angell and Balcomb 1982). Consequently, while the sockeye fishery in Marine Catch Areas 7 and 7A killed relatively large numbers of rhinoceros auklets in the 1990s, this mortality does not appear to exceed biological thresholds of concern.

Common Murre

WDFW estimated that the 1994 sockeye fishery in Marine Catch Areas 7 and 7A alone killed approximately 2,700 common murres (Pierce et al. 1996). If a constant rate of entanglement of murres is assumed throughout all Puget Sound fisheries (which is not realistic), and the Marine Catch Area 7 and 7A sockeye fisheries are assumed to represent about 45 percent of all fishing effort (based on number of landings during the period 1996 through 2001), then a maximum of about 6,100 murres may have been killed in 1994. If, following Thompson et al. (1998), 70 percent of the murres killed were adults, then the 1994 adult mortality may have been approximately 4,300. This represents 73 percent of the estimated 1994 Washington breeding population of 5,900 (Carter et al. 2001), well beyond the 6 to 12 percent mortality at which maintenance of a stable breeding population becomes difficult, if not impossible (Piatt et al. 1984). However, it is known that this degree of mortality was not the case. If the 1994 mortality exacted such a toll on the Washington breeding murre population, a dramatic decline would have been observed in the 1995 breeding population, rather than the observed doubling from 5,900 to 9,600 (Carter et al. 2001) or 13,600 murres (*TENYO MARU* Oil Spill Natural Resources Trustees 2000).

Based on the studies conducted by Thompson et al. (1998), a considerable, but unknown, proportion of the murres killed in the sockeye salmon fishery originated from Oregon, where the breeding population exceeds 700,000 (personal communication with Roy Lowe, U.S. Fish and Wildlife Service, Refuge Biologist, February 25, 2003). Thompson et al. contend that during the peak of the sockeye fishing season, Washington murres are still attending colonies, while Oregon murres, which complete their breeding cycle a month or more earlier, have already dispersed from breeding sites and then dominate the waters of Puget Sound during the sockeye fishery. The exact ratio of Oregon versus Washington birds in the Puget Sound salmon fishery bycatch is currently unknown, however (Thompson et al. 1998), numbers of common murres found in Washington waters in late summer far exceed the Washington breeding population (Manuwal and Carter 2001). The maximum adult mortality of 4,300 murres is less than 1 percent of the combined Oregon and Washington breeding population, which is not a substantial proportion of the two-state population. Further, the Washington and Oregon birds are all part of a single subspecies (*Uria aalge californica*) that includes birds from California (approximately 350,000 adults), and British Columbia (approximately 10,000 adults) (Carter et al. 2001). Finally, given that fishing effort is now substantially lower than in the 1990s when the Pierce et al. (1996) and Thompson et al. (1998) studies were conducted (personal communication with Will Beattie, Northwest Indian Fisheries Commission, December 19, 2003), the significance of gillnet entanglement mortality in Puget Sound is likely further reduced. Nevertheless, current radio-telemetry studies by Hamel and Parrish are aimed at determining the presence of Washington-bred murres coincident with the salmon gillnet fisheries to verify whether this breeding population is at risk from Puget Sound fisheries (personal communication with Julia Parrish, University of Washington, Associate Professor, February 13, 2003).

4.8.1.1 Alternative 1 – Proposed Action/Status Quo

The Proposed Action would involve a fishery effort similar to (or substantially less than) the fishing that occurred in Puget Sound and the Strait of Juan de Fuca during the 1990s, except seabird bycatch would likely be greatly reduced during the Marine Catch Area 7 and 7A sockeye and pink salmon gillnet fishery, through the implementation of the "bird web" net design and dawn hours fishing restrictions originally proposed by Melvin et al. (1999). Net modification designs for purse seines and gillnets, and area and time closures are required by the Washington Department of Fish (WDFW) and Wildlife in areas frequented by marbled murrelets. WDFW requires that 1) gillnets fishing in Marine Catch Areas 7 and 7A use "bird webs" (a 20-mesh panel of small diameter, highly-visible white nylon across the top of the net); 2) purse seines in all areas have a 12-inch space between corks; 3) shoreline areas in Marine Catch Areas 7 and 12 close to gillnet fishing; and 4) gillnet fisheries remain closed during early morning hours. These requirements, estimated to reduce the seabird bycatch by approximately 70 to 75 percent (based on research results from Melvin et al. 1999), may ensure that the annual gillnet mortality of Washington common murres does not exceed the maximum mortality to sustain a stable population, although continued research is needed to ensure this is the case. Bycatch mortality of rhinoceros auklets and pigeon guillemots was considered to be well below significance levels prior to implementation of the bird bycatch reduction requirements (Pierce et al. 1996;

Thompson et al. 1998; and Melvin et al. 1999). These requirements should safely ensure the annual bycatch stays sufficiently low. Finally, the overall fishing effort in Marine Catch Areas 7 and 7A is considerably lower than that compared to effort in previous years which were the basis of the estimates in the Environmental Impact Statement evaluation.

4.8.1.2 Alternative 2 – Escapement Goal Management at the Management Unit Level

Under Alternative 2, no net fisheries would occur in marine areas with the exception of small-scale, nearshore, set gillnet, and beach seine fisheries in Dungeness Bay (Marine Catch Area 6D), Tulalip Harbor (Marine Catch Area 8D), and adjacent to the Hoodsport Hatchery in Hood Canal (Marine Catch Area 12H). Consequently, there would be no bycatch of alcids, or any marine birds for that matter. Therefore, fisheries under Alternative 2 are predicted to have no impact to marine bird populations. This alternative would entirely eliminate the small bycatch predicted to occur with the Proposed Action (Alternative 1). Because marine bird bycatch would not occur under Alternative 2, it would be considered to have a beneficial impact when compared to Alternative 1; however, the magnitude of the beneficial impact is considered low.

4.8.1.3 Alternative 3 – Escapement Goal Management at the Population Level with Terminal Fisheries Only

The scale and distribution of marine net fisheries for salmon under Alternative 3 would be similar to those under Alternative 2, except that all potential salmon harvest would be limited to freshwater terminal areas (major rivers) only. No salmon fishing of any kind would occur in the Strait of Juan de Fuca or Puget Sound marine waters. The small fisheries occurring in Dungeness Bay, Tulalip Harbor and adjacent to the Hoodsport Hatchery under Alternative 2 would not occur under Alternative 3. Consequently, there would be no bycatch of alcids, or any marine birds. As with Alternative 2, Alternative 3 would entirely eliminate the small bycatch predicted to occur with the Proposed Action (Alternative 1). Because marine bird bycatch would not occur with Alternative 3, it would be considered to have a beneficial impact when compared with Alternative 1; however, the magnitude of the beneficial impact is considered low.

4.8.1.4 Alternative 4 – No Action/No Authorized Take

Like Alternative 2 or 3, Alternative 4 would preclude all marine-area fisheries. No fishing would occur in any habitat, including habitats occupied by alcids or other seabirds susceptible to gillnet mortality. Therefore, Alternative 4 would have no impact to regional marine bird populations. Like Alternative 2 or 3, this alternative would completely eliminate the small marine bird bycatch that would occur under Alternative 1. Because this bycatch would not occur under Alternative 4, it would be considered to have a beneficial impact when compared with Alternative 1; however, the magnitude of the beneficial impact is considered low.

4.8.2 Marine Mammals

The National Marine Fisheries Service (NMFS) is required under the Marine Mammal Protection Act to periodically reassess each stock of marine mammal species, determine a minimum population estimate, then calculate a Potential Biological Removal (PBR) value. The PBR, unique to each species, is the estimated number of marine mammals that could be killed or seriously injured by human activities without depleting the stock (Barlow et al. 1995). Generally, stock PBRs are 6 percent of the minimum estimated stock size. NMFS is further mandated to regulate fisheries in a manner towards achieving a goal of zero mortality or serious injury to marine mammals. NMFS has proposed ~~considers~~ that fisheries are achieving this goal when the annual mortality of a given marine mammal species is less than 10 percent of the PBR (69 FR 23477). NMFS also annually publishes in the Federal Register a list of all fisheries (Annual List of Fisheries) classifying each as to its potential impact to individual stocks. In the 2003 List of Fisheries (NOAA 2003), Washington beach seine, salmon purse seine, and salmon reef net fisheries were all classified as Category III – no documented marine mammal mortality with potential mortality less than 1 percent of PBR. The Washington Puget Sound Region salmon drift gillnet fishery (excluding treaty fishing) was classified in 1995 as Category II (60 FR 67063) with documented mortality of harbor porpoise, Dall's porpoise, and harbor seal between 1 and 50 percent of PBR. However, ~~NMFS (2000a)~~Carretta et al. (2004) used Laake et al.'s (1997) estimate of 3,509 animals to calculate a minimum population estimate of 2,545 and a PBR of 20 animals for the Washington Inland Waters stock of harbor porpoise. In the 1995 evaluation, NMFS noted that the estimated take of harbor porpoises at the time (15) exceeded 10% of PBR (2.7) and therefore could not be considered insignificant. However, NMFS further reported that the take estimate was derived from observations in the sockeye salmon fishery and included treaty fishing effort, which constitutes about one half of the effort in Puget Sound, but is exempted under the Marine Mammal Protection Act. Therefore the estimated take of harbor porpoise for the non-tribal salmon drift gillnet fishery would be about one half of the total estimated take (7.5), which is greater than one percent but less than 50 percent of the calculated PBR for the stock. Since that time the effort in the fishery has been reduced through license buy back programs and the number of active participants in the non-tribal fishery declined from 1,044 in 1995 to 210 in 2003 (69 FR]. Further, gear modifications and changes to daylight fishing periods for the benefit of endangered seabirds are likely also beneficial for reducing interactions with harbor porpoises. Commercial fishers are required, by regulation, to report incidental marine mammal injuries or deaths to NMFS ~~Then, using Pierce et al.'s (1996) estimate of 15 harbor~~

~~porpoise killed in the 1994 sockeye gillnet fishery, NMFS (2000a) concluded that although the estimated annual mortality (15) did not exceed PBR (20), at 75 percent PBR it was not insignificant nor approaching zero mortality and serious injury rate. Fishermen are currently required by NMFS to provide reports of lethal encounters with Category II marine mammals~~ (personal communication with Brent Norberg, NOAA Fisheries Northwest Region, April 4, 2003). This allows NMFS to monitor the impacts to harbor porpoise in the Puget Sound salmon drift gillnet fishery. If patterns of interactions emerge, this information could be used to shape fisheries to further reduce harbor porpoise-fishing gear interactions.

NMFS (~~NMFS 2000b~~Carretta et al. 2004) has not calculated an annual mortality rate for Dall's porpoise as a result of the Puget Sound salmon fishery. However, the calculated PBR of ~~787~~ 789 for the California/Oregon/ Washington stock (minimum population estimate = 75,915) is sufficiently high that the potential annual mortality is unlikely to exceed 10 percent of the PBR and, therefore, should be approaching a zero mortality or serious injury rate.

~~NMFS (1998)~~Carretta et al. (2004) estimated the minimum population size of the Inland Washington stock of harbor seal at ~~16,104~~ 12,844, and calculated a PBR of ~~966~~ 771 animals. Professing that no reliable estimate of annual mortality incidental to commercial fisheries was available because of a lack of sufficient observer effort, ~~NMFS (1998)~~ Carretta et al. (2004) used available data (Gearin et al. 1994; Pierce et al. 1996; and Erstad et al. 1996), and estimated the annual mortality from all Washington fisheries at ~~36~~ 30 animals, well less than 10 percent of PBR.

Although California sea lions are susceptible to gillnet entanglement, deaths from entanglement in the Puget Sound gillnet fisheries has not been reported (~~NMFS 2000c~~Carretta et al. 2004). This is partially due to the fact that peak abundances of California sea lions in Puget Sound occur in winter and spring after most salmon fisheries are complete (NMFS 1997). California sea lions do interact with tribal gillnet fisheries in terminal areas for winter run steelhead and chum salmon. In order to protect their fisheries, tribal fisherman legally harvest a number of these depredating sea lions under subsistence regulations (personal communication with Will Beattie, Northwest Indian Fisheries Commission, December 19, 2003). These removals, however, are negligible compared to the minimum population estimate of ~~110,000~~ 138,881 for this stock, and it's PBR of ~~6,143~~ 8,333 (~~NMFS 2000c~~Carretta et al. 2004).

NMFS Annual List of Fisheries only classifies commercial fisheries, not sport fisheries. However, Noviello (1999) did study the potential impact of Puget Sound sport fisheries on marine mammals during the 1997 and 1998 seasons. During this study, no marine mammal hook-ups or entanglements were observed in 1,090 hook-up observations, although NMFS and WDFW have received a substantial number of reports of seal and sea lion interations with salmon sport fisheries. These interactions include losses of fish off lines at Neah Bay, Sekiu, Point No Point, Point Defiance, and off the Nisqually River. The sport fishery probably does not represent a ~~potential~~ substantial source of mortality for marine mammals, although anglers do shoot seals and sea lions based on anecdotal reports and observed strandings with bullet wounds (personal communication with Steve Jeffries, WDFW, Research Scientist, July 30, 2004)~~.~~

4.8.2.1 Alternative 1 – Proposed Action/Status Quo

Under Alternative 1, mortality levels of marine mammals as a result of Puget Sound fisheries would likely be similar to those observed during the 1990s, or considerably less if shortened fishing seasons and declines in fishing effort continue. Gillnet fisheries would be expected to result in the incidental ~~capture~~ mortality of small numbers of harbor seals, harbor porpoise, and Dall's porpoise and the removal of California sea lions predating on entangled salmon. Mortality rates would continue to be low compared to stock population levels, however, and management concerns would therefore not be warranted. However, NMFS acknowledges that these mortality rates are based on limited data and that further data is needed for more accurate estimates of mortality rates.

4.8.2.2 Alternative 2 – Escapement Goal Management at the Management Unit Level

Under Alternative 2, no salmon fishing would occur in marine waters, only freshwater rivers except for small-scale, nearshore fisheries in Dungeness Bay (Marine Catch Area 6D), Tulalip Harbor (Marine Catch Area 8D), and adjacent to the Hoodsport Hatchery in Hood Canal (Marine Catch Area 12H); therefore, most of the marine mammals inhabiting Puget Sound would not come in contact with fisheries managed under Alternative 2. Harbor seals and California sea lions would be exceptions, as both commonly enter freshwater rivers (Stanley and Shaffer 1995; and NMFS 1997), and even lakes (Scheffer and Slipp 1948). NMFS (1997) stated that the 2,000 to 3,000 harbor seals ~~annually enter~~in the Columbia River during the winter forage on~~in pursuit of~~ eulochon runs that move upstream to spawn. California sea lions also forage on the eulachon run as it enters the Columbia River; shifting to predation on spring chinook as it becomes more abundant~~, and~~. California sea lions are also commonly observed in the Duwamish, Green, and Nisqually Rivers. Consequently, it is possible for harbor seals and~~,~~ California sea lions to encounter, and possibly become entangled in, gillnets set in terminal river locations. However, there is currently no evidence of harbor seal or sea lion entanglement mortality associated with terminal fisheries in the Strait of Juan de Fuca or Puget Sound region, although this may be due to a lack of observer data and declines in self-reporting. The level of self-reporting after

1995 dropped dramatically, such that the records are considered incomplete and estimates of mortality based on them represent minimums (Carretta et al. 2004). ~~although s~~Some animals are legally harvested in the rivers under tribal subsistence regulations. There have been only a few reported takes of harbor seals from directed tribal subsistence hunts. It is possible that very few seals have been taken in directed hunts because tribal fishers use seals caught incidentally to fishing operations for their subsistence needs before undertaking a ceremonial or subsistence hunt. From communications with the tribes, the NMFS Northwest Regional Office (personal communication with J. Scordino as cited in Carretta et al. 2004) believes that 5-10 harbor seals from this stock may be taken annually in directed subsistence harvests off the Washington coast. Therefore, the combination of harbor seals and sea lions from taken in subsistence fisheries and those potentially caught incidentally in salmon fisheries, as estimated from available data, would be low and ~~se removals do~~would not exceed biological thresholds of concern (greater than 10 percent of PBR). Further data is needed for more accurate estimates of mortality rates.

The increased in-river harvest opportunity available in some areas under Alternative 2, relative to Alternative 1, would result in higher freshwater gillnet fishing effort. The number of vessels involved would increase in some areas, and fishery openings would likely be extended in these areas, relative to Alternative 1. However, such an increase in freshwater fishing, combined with almost no marine-area fishing, would still result in overall lower mortality of harbor seals and sea lions, compared to Alternative 1. Therefore, the potential marine mammal mortality associated with Alternative 2 is likely ~~extremely~~ low for harbor seals and California sea lions, and zero for all other marine mammals. Compared to Alternative 1, Alternative 2 would eliminate any bycatch concerns with harbor porpoise and other cetaceans. Because this bycatch would not occur under Alternative 2, it would be considered to have a beneficial impact when compared with Alternative 1; however, the magnitude of the beneficial impact is considered low.

4.8.2.3 Alternative 3 – Escapement Goal Management at the Population Level with Terminal Fisheries Only

Under Alternative 3, gillnet fisheries for salmon would occur at virtually the same times and in virtually the same places as under Alternative 2, so the impacts of gillnet fisheries to marine mammals would be the same. No salmon fishing would occur in marine waters, only freshwater rivers; therefore, the potential marine mammal mortality associated with Alternative 3 is likely ~~extremely~~ low for harbor seals and California sea lions, and zero for all other marine mammals The more restrictive fisheries in Alternative 3 would slightly decrease the potential for interactions with harbor seals (and California sea lions) in particular, relative to Alternative 2. Compared to Alternative 1, Alternative 3 would eliminate any bycatch concerns with harbor porpoise and other cetaceans. Because this bycatch would not occur under Alternative 3, it would be considered to have a beneficial impact when compared with Alternative 1; however, the magnitude of the beneficial impact is considered low.

4.8.2.4 Alternative 4 – No Action/No Authorized Take

Under Alternative 4, no salmon fishing would occur in marine waters. Therefore, Alternative 4 would have no potential for impact to marine mammals, with the exception of a possible extremely low mortality rate for river-inhabiting harbor seals and California sea lions. Like Alternative 2 or 3, Alternative 4 would eliminate all potential incidental take of harbor porpoise and other cetaceans that could possibly occur under Alternative 1.

4.8.3 Marine Invertebrates

Four of the five types of salmon fishing authorized in Puget Sound and the Strait of Juan de Fuca – sport, purse seine, beach seine, reef net, or gillnet – do not actively operate in the benthic zone where marine invertebrates occur. Beach seining is an exception, where a seine net is dragged along the bottom as it is hauled ashore. However, beaching seining generally occurs over sandy or pebbly substrates to avoid snagging on exposed rocks, therefore not occurring where encounters of benthic invertebrates are most likely to occur. Further, captured marine invertebrates (e.g., crabs, sea stars) are easily released unharmed.

The sport fishing "mooching" technique involves bouncing weight and bait along the seafloor. An occasional sea pen, anemone, or sea star is snagged, but all are usually released unharmed. The only invertebrate observed by Noviello (1999) during observation of 1,090 hookups during the 1997 and 1998 Puget Sound sport fishery was a single sea star.

Set gillnets that reach to the seafloor commonly capture crabs as a bycatch, although they are generally released alive. A growing concern, however, involves ghost nets, especially gillnets that have been lost and continue to fish (High 1985). Although not yet quantified, these nets have been observed to continually capture crabs for years (personal communication with Wayne Palsson, Washington Department of Fish and Wildlife, Research Scientist, February 17, 2003). One 575-foot-long net lost in Puget Sound contained an estimated 1,000 female crabs (Breen 1990). During the removal of derelict gear by the Natural Resource Consultants (see Subsections 3.3.5 and 3.8.1), divers reported high sedimentation rates on many of the nets that had apparently suffocated sessile animals on the hard rock substrate. Adjacent areas, without derelict nets, were observed to have a relatively higher density of sessile and bottom dwelling organisms such as sea urchins and sea cucumbers. Several of the nets had rolled into long tubes of webbing and lead line that was entangled on a rock pinnacle or reef edge at one end. The tube of net was observed to sweep back and forth over the gravel seabed in an arc. The divers reported no animals or vegetation on the seabed in the arc swept by these nets. These results are too recent (April 5, 2004) for rigorous estimates of cumulative impacts to populations of fish and benthic organisms to be available.

4.8.3.1 Alternative 1 – Proposed Action/Status Quo

The Proposed Action would likely result in no or very low impacts to marine invertebrates as the five types of Puget Sound salmon fishery do not operate on the seafloor in a manner that is lethal to benthic organisms. The only concern identified that requires further investigation is the long-term lethality of derelict nets lost during gillnet fisheries.

4.8.3.2 Alternative 2 – Escapement Goal Management at the Management Unit Level

Under Alternative 2, salmon fisheries would occur primarily in rivers. Very limited nearshore, marine-area harvest would occur in Dungeness Bay (Marine Catch Area 6D), Tulalip Harbor (Marine Catch Area 8D), and adjacent to the Hoodsport Hatchery in southern Hood Canal (Marine Catch Area 12H) using beach seines and set gillnets. There would be no measurable impact to marine invertebrates. Compared to Alternative 1, Alternative 2 would eliminate ghost net concerns, except those left by previous fishing activities.

4.8.3.3 Alternative 3 – Escapement Goal Management at the Population Level with Terminal Fisheries Only

Under Alternative 3, no salmon fishing would occur in the marine waters of Puget Sound. Consequently, there would be no avenues for impact to marine invertebrates. Compared to Alternative 1, Alternative 3 would eliminate ghost net concerns, except those left by previous fishing activities.

4.8.3.4 Alternative 4 – No Action/No Authorized Take

Like Alternative 2, no salmon fishing would occur in marine waters of Puget Sound or the Strait of Juan de Fuca with Alternative 4; therefore, there would be no mechanisms to potentially impact marine invertebrates. Like Alternative 2, Alternative 4 would eliminate ghost net concerns raised under Alternative 1, except those left by previous fishing activities.

4.8.4 Threatened and Endangered Wildlife Species

Seven threatened and endangered wildlife species are at least occasionally found in the inland marine waters of Washington. These include the marbled murrelet, California brown pelican, bald eagle, Steller sea lion, humpback whale, fin whale, and Pacific leatherback turtle. All, except possibly the bald eagle, have been reported entangled in fishing nets. However, only the marbled murrelet has been reported as a bycatch in the Puget Sound salmon fishery (Pierce et al. 1996; and Melvin et al. 1998).

Further, the total numbers of pelicans, Steller sea lions, humpback whales, fin whales, and leatherback turtles that annually enter Puget Sound are sufficiently small that total mortality of these animals would not exceed 10 percent of stock PBRs.

Salmon, especially runs of fall coho and chum salmon that extend into winter (December-February), are an important food source for hundreds of bald eagles wintering in Washington. However, annual fishing harvest managed for sustainable levels and abundance of fall chum and coho salmon has increased over the last decade. In turn, this management strategy ensures that enough chum and coho salmon return annually to support a viable wintering eagle population.

Carter et al. (1995) expressed concern that marbled murrelet mortality from Puget Sound gillnet fishing was likely substantial, based on extrapolations from the 1979 to 1980 Barkley Sound, British Columbia, murrelet densities and mortality rates. However, Pierce et al. (1996) observed the 1994 sockeye gillnet fishery in Marine Catch Areas 7 and 7A to quantify seabird and marine mammal interactions, and recorded only one murrelet entanglement, in Marine Catch Area 7. This individual was released alive. The entanglement rate was estimated to be 0.00158 per set in Area 7, or 0.00045 per set for the combined Marine Catch Area 7 and 7A fishery. Wide confidence limits were associated with these estimates of entanglement rate. It was estimated based on extrapolation that the 1994 fishery killed 15 birds, and it was concluded that the occurrence of marbled murrelet entanglement in these areas was "an extremely rare event." Melvin et al (1999) conducted an experimental test of a gillnet designed to reduce seabird entanglements, during the 1996 sockeye fishery. They observed one marbled murrelet capture in 642 sets, and categorized the capture as "extremely rare." Both studies suggest that murrelet encounters with fisheries are so rare that sufficient sample sizes are difficult to generate to develop meaningful estimates of mortality. Courtney et al. (1997) surveyed for marbled murrelets in several fishing areas throughout Puget Sound, and concluded that the potential for entanglement was generally localized and unpredictable, with Hood Canal a potential location for future problems. Having observed large flocks of marbled murrelets in northern Hood Canal in the fall, Courtney et al. (1997) noted the potential there for murrelet interactions with gillnet fisheries. Finally, however, observations by Beauchamp et al. (1999) suggest that a portion of the seasonal influx of marbled murrelets into the inland waters of Washington in the fall and winter are breeding birds from British Columbia (rather than the listed U.S. population).

Conclusions from information gathered in the 1990s are that the potential for substantial marbled murrelet mortality from gillnets remains in the Puget Sound region, although actual observation of entanglement events is extremely rare. However, with the current requirements on the non-treaty gillnet fishery in Marine Catch Areas 7 and 7A to utilize nets designed to reduce alcid entanglement, and to preclude fishing during dawn hours when alcids are actively feeding, murrelet mortality rates from the 1990s may be reduced by 70 to 75 percent based on research by Melvin et al. (1999).

4.8.4.1 Alternative 1 – Proposed Action/Status Quo

The Proposed Action would result in gillnet fishing effort in the Strait of Juan de Fuca and Puget Sound similar in area but less intense than that which occurred in the mid-1990s, when studies on marbled murrelet encounters with gillnet fisheries were conducted. These studies (Pierce et al. 1996; and Melvin et al. 1999) failed to show substantial mortality to marbled murrelets from Puget Sound gillnet fisheries then. Mortality is probably greatly ameliorated by the new fishing gear and fishing schedules implemented in the non-treaty fishery, and the shorter fishing season and reduced fishing effort in Marine Catch Areas 7 and 7A typical of recent years in both tribal and non-tribal fisheries. Consequently, there is no evidence that Puget Sound gillnet fisheries as proposed under the Puget Sound Chinook Harvest Resource Management Plan (Alternative 1) would substantially impact local marbled murrelet populations. Past consultations conducted by the U.S. Fish and Wildlife Service (USFWS), pursuant the Endangered Species Act, concluded that Puget Sound fisheries do not jeopardize the continued survival and recovery of the threatened marbled murrelet population. The previous incidental take allowance for treaty tribal salmon fisheries expired in December 2003 (USFWS). The incidental take allowance for Puget Sound non-tribal commercial and sport salmon fisheries extends through 2011 (USFWS 2001). The Puget Sound treaty tribes recently completed a consultation with the USFWS on the effect of fisheries under the Proposed Action on marbled murrelets (USFWS 2004). They specify terms and conditions and conservation measures that are designed to minimize the effects on encounters with live murrelets, minimize the potential to exceed the allowable take and recommend evaluation of alternative salmon harvest methods and fishery implementation to reduce marbled murrelets entanglement and encounters. As described in Subsection 4.8.4, the current requirements to use nets designed to reduce alcid entanglement, and the preclusion of fishing during dawn hours when alcids are actively feeding are example of these types of measures that have been implemented in non-tribal salmon fisheries.

4.8.4.2 Alternative 2 – Escapement Goal Management at the Management Unit Level

Salmon fisheries would primarily be confined to rivers under Alternative 2, so there would be very low risk of entanglement of marbled murrelets, although the harvest opportunity in Tulalip Harbor (Marine Catch Area 8D) possible under Alternative 2 would involve gillnet fishing where aggregations of murrelets have been observed in the fall (Courtney et al. 1997). Alternative 2 would therefore pose a lower risk to marbled murrelets than Alternative 1, though this reduced level of risk cannot be quantified with the available data. Because marbled murrelet bycatch would not occur under Alternative 2, this alternative would be considered to have a beneficial impact when compared to Alternative 1; however, the magnitude of the beneficial impact is considered low.

4.8.4.3 Alternative 3 – Escapement Goal Management at the Population Level with Terminal Fisheries Only

Under Alternative 3, salmon harvest would be limited to freshwater rivers only. No fishing would occur in marine waters inhabited by marbled murrelets. Therefore, this alternative would have no potential to affect local marbled murrelet populations, and would eliminate the very small bycatch risk posed by Alternative 1. Because this bycatch would not occur under Alternative 3, it would be considered to have a beneficial impact when compared with Alternative 1; however, the magnitude of the beneficial impact is considered low.

4.8.4.4 Alternative 4 – No Action/No Authorized Take

Like Alternative 3, Alternative 4 would result in no harvest in marine waters where marbled murrelets are found. Consequently, this alternative would have no impact on marbled murrelets and, like Alternative 3, would eliminate the very low risk of bycatch posed by Alternative 1.

4.8.5 Wildlife Indirect Effects

Direct mortality of adult seabirds (primarily alcids) indirectly affects the abundance of subsequent breeding populations. Mortality of females could be more significant in this regard. Mortality of juvenile birds can also depress production, but the effect is discounted to the extent juveniles might otherwise die from natural causes before they reach sexual maturity or breed. The age composition (i.e., adults vs. juveniles) of seabirds entangled in Puget Sound fisheries varies among species. A greater proportion of entangled rhinoceros auklets are young-of-the-year, compared to common murres (Thompson et al. 1998), in part due to proximity of auklet colonies to fishing areas. The magnitude of fishery-related mortality of alcids, relative to other natural or human causes has not been quantified. It is known to be highly variable and unpredictable, as is natural mortality. Other known causes of significant mortality include recent oil spills; predation by eagles, gulls, and corvids; and reduction in marine productivity due to the El Nino phenomenon (Manuwal et al. 2001).

Indirect effects at a finer scale (e.g., mortality impacts on sub-populations of common murres or marbled murrelets that breed in Oregon, Washington, or British Columbia), are also possible, and could affect the diversity within species, but these effects are not quantifiable at this time. Thompson et al.

(1998) concluded that common murres from both Oregon and Washington colonies are entangled in Puget Sound fisheries.

The fishing regime envisioned under Alternative 1 would have greater indirect effects on alcid seabirds than Alternative 2, 3 or 4, under which marine-area fisheries with the potential to entangle seabirds would be closed. The currently stable status of common murres and rhinoceros auklets suggests that these species are resilient to the cumulative effects of human-caused and natural mortality. The threatened status of marbled murrelets in Washington warrants higher concern over all sources of mortality. But the best available information (Pierce et al 1994; and Melvin et al 2001) indicates that entanglement in gillnet fisheries occurs very rarely, so it is difficult to conclude that eliminating this source of mortality would have any measurable beneficial effect, given the relatively greater constraints imposed by habitat and natural predation.

Because of their indirect effect on the abundance of juvenile salmon in subsequent years, the Proposed Action or alternatives imply some potential for altering the food supply of piscivorous seabirds. The alternatives to the Proposed Action (Alternative 1), particularly Alternative 4, would result in higher spawning escapement of salmon. It is not certain, however, that substantially higher escapement will, in the long term, necessarily result in higher production of juvenile salmon. Nor is there information available to support the contention that the current abundance of juvenile salmonids constrains the survival of any seabird species, or that secondary productivity in Puget Sound constrains survival of juvenile salmonids or seabirds. So it is not possible to speculate that increasing the abundance of juvenile salmonids would have a measurable positive effect on predators, or negative effect on competition. Increasing the escapement of adult salmon to the degree projected under Alternatives 2, 3, or 4 would, for some period through the fall and winter, increase the food supply for a wide variety of vertebrate species known to utilize this resource (Cederholm et al. 1999). The accumulation of carcasses and material in the lower reaches of streams generates a seasonal pulse of nutrients to estuarine and nearshore marine areas, with potential indirect benefit to many other fish and invertebrate species. Uptake and transport of these nutrients through the food chain would occur over subsequent years. Though carcass enhancement has been experimentally shown to increase local primary and secondary production, and enable higher growth rates among juvenile salmon and other resident salmonids (discussed in Subsection 3.3.6, Marine-Derived Nutrients from Salmon Spawners – Affected Environment), information is lacking to quantify the long-term direct or indirect effects on communities or individual species.

The indirect effects of higher juvenile salmon abundance, were that to occur as a consequence of Alternatives 2, 3, or 4, on the abundance of other fish and invertebrate species, much less their avian or mammalian predators, cannot be predicted with any certainty. Intuitively, any increases in subadult or adult salmon could increase predation on forage fish species such as Pacific herring, smelt, and sandlance. This effect would be pronounced during periods when migrating salmon are at highest density in Puget Sound (i.e., as they migrate toward the outer coast and as they return to spawn); however, adult salmon feed less frequently as they approach maturity and enter fresh water. The potential for competition with other species that also utilize these species would exist during these periods. Though production of these forage species is depressed in Puget Sound, there is no information to support a conclusion that their current productivity now constrains the growth and survival of their predators, or would do so at higher predator abundance.

The reduction of net fisheries as contemplated under Alternative 2, 3, or 4 would reduce the rate of potential gear loss in Puget Sound. Some nets that are lost in Puget Sound fisheries, especially gillnets, continue to fish, entangling marine mammals, marine birds, and invertebrates such as crabs (High 1985, and Breen 1990). The influence of these ghost nets on the mortality rate of any given species, however, is presently unknown, and may not be significant. Nevertheless, there is enough concern that concerted efforts are presently being undertaken by the Northwest Straits Commission and Washington Department of Fish and Wildlife to remove tons of these derelict nets from the Puget Sound ecosystem (Derelict Fishing Gear Removal Project).

Because salmon may contribute a large proportion of the diet of southern resident killer whales (Ford et al. 1998), fisheries that reduce the abundance of adult salmon in Puget Sound may indirectly impact this species. This hypothesis is based on the as-yet-undemonstrated assumption that the current total abundance of salmon, including hatchery production, that rear or migrate through Puget Sound, is significantly lower or has declined in coincidence with the observed decline in the abundance of southern resident killer whales. In evaluating the status of killer whales, Krahn et al. (2002) did not conclude that prey availability affected southern resident killer whales. However, in the absence of marine-area fisheries, particularly as envisioned under Alternatives 2, 3, or 4, the increase in availability of salmon could have beneficial effects on killer whales by increasing local prey availability.

Cederholm et al. (2001) identified nine wildlife species with strong consistent links to salmon. Mergansers and harlequin ducks feed on drift eggs, Caspian terns and osprey on freshwater juveniles, bald eagles on saltwater subadults and carcasses, killer whales on saltwater adults, and bears and river otters on spawning adults and carcasses. Cederholm et al. (1989) found black bears on the Olympic Peninsula to forage heavily on salmon carcasses, much like black bears in western Canada and Alaska. However, most bear diet studies in Washington show a consistent lack of black bear use of salmon (Cederholm et al. 2001). Stable isotope studies by Hildebrand et al. (1996) suggested that grizzly bears inhabiting the Columbia Basin prior to European settlement foraged heavily on the large salmon runs that occurred then. Only about 5-20 grizzly bears now occur in Washington (North Cascades) and the importance of salmon to their diet is unknown. Nevertheless, all nine species strongly linked to salmon could potentially benefit from increased salmon production in the river tributaries of Puget Sound, although the benefit is not quantifiable.

4.8.6 Cumulative Effects on Wildlife

NEPA defines cumulative effects as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR1508.7)." For the purposes of this discussion, the terms "effects" and "impacts" will be considered synonymously with "consequences," and consequences may be negative or beneficial. This section presents an analysis of the cumulative effects (negative or beneficial) of the Proposed Action in the context of other local, state, tribal, and federal management activities in the Puget Sound region on fish resources and related economic conditions.

The geographic scope of the cumulative effects analysis area includes the entire Puget Sound region. The analysis area covers both inland and marine environments that are managed under laws, policies, regulations, and plans having a direct or indirect impact on fish. The substantive scope of the cumulative analysis is predicated on a review of laws, policies, regulations, and plans that specifically pertain to fish-related management activities or that have an indirect negative or beneficial effect on fish resources and related economic conditions. These laws, policies, regulations, and plans are described in Section 1 and Appendix F. Because of the geographic scope of the analysis area, it is not feasible to analyze all habitat-specific activities that are occurring, have occurred in the past, or that will occur in the future in a quantitative manner. By reviewing laws, policies, regulations, and plans, the analysis will capture the objectives of any management activity that is occurring or planned to occur that may interface with fish resources within the Puget Sound region. It is assumed that no management activity is occurring or would occur outside of an implemented law, policy, regulation, or sanctioned plan at the federal, tribal, state, or local level. Although the analysis is necessarily qualitative, it provides a thorough review of all other activities within the region that, when combined with the Proposed Action, could have a negative or beneficial affect on fish resources and related economic conditions.

Table 4.3.8.2-1 summarizes the potential cumulative effects on fish resources of implementing the Proposed Action with the effects of these existing laws, policies, regulations, and plans. The table below summarizes the potential cumulative effects on wildlife of the Proposed Action and other plans, policies and programs in the Puget Sound region.

The Proposed Action is implementation of the Puget Sound Chinook Harvest Resource Management Plan (RMP), jointly prepared by the Washington Department of Fish and Wildlife (WDFW) and the Puget Sound Treaty Tribes (co-managers). Factors common to the relationship between the RMP and the various existing plans, policies and programs include: 1) the Resource Management Plan would provide protection to Puget Sound chinook salmon by conserving the productivity, abundance, and diversity of populations within the Puget Sound Chinook Evolutionarily Significant Unit (ESU), while managing harvest of strong salmon stocks; and 2) conserving productivity requires biological integrity in the freshwater systems in which salmon spawn and rear.

Table 4.8.6-1 Cumulative effects on wildlife of the Proposed Action in combination with various plans, policies and laws.

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of the earliest to the most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
Fish and Wildlife Coordination Act, 1956, as amended in 1964 (FWCA).	The FWCA recognizes "the vital contribution of our wildlife resources to the Nation, the increasing public interest and significance thereof due to expansion of our national economy and other factors, and to provide that wildlife conservation shall receive equal consideration and be coordinated with other features of water-resource development programs through the effectual and harmonious planning, development, maintenance, and coordination of wildlife conservation and rehabilitation."	The Puget Sound Chinook Salmon Resource Management Plan would allow the harvest of salmon in coordination with ongoing conservation and rehabilitation efforts for chinook salmon. With an estimated value of $35 million ($16.2 million commercial plus $18.8 million recreational), the Puget Sound fishing industries are important to the Nation's economy. The Proposed Action would be consistent with the FWCA by recognizing the vital contribution of Puget Sound chinook salmon and local wildlife populations to the Nation and our national economy. It is predicted that implementation of the Resource Management Plan, in combination with the FWCA, would strive to balance considerations of the national economy, while also providing for fish and wildlife conservation.
Washington State Shoreline Management Act of 1971 (SMA).	The SMA was adopted in Washington in 1972 with the goal of "prevent[ing] the inherent harm in an uncoordinated and piecemeal development of the state's shorelines." The provisions of this law are designed to guide the development of the shoreline lands in a manner that will promote and enhance the public interest. The law expresses the public concern for protection against adverse effects to public health, the land and its vegetation and wildlife, and the aquatic life of the waters.	Rearing habitat within shoreline areas of Washington State is essential to conserving the productivity of Puget Sound chinook salmon. Consequently, the Proposed Action would be consistent with the SMA by ensuring that harvest works in concert with habitat protection efforts under the SMA. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the SMA, would protect fish from adverse effects associated with uncoordinated and piecemeal development of the state's shorelines. Puget Sound marine shorelines are also critical nesting and foraging habitat for bald eagles, and nearshore shallow-water areas are used by a variety of seabirds, including marbled murrelets. As with fish, implementation of the Resource Management Plan in combination with the SMA is predicted to aid in the protection of wildlife (e.g., reduced entanglement risk) and their nearshore breeding and foraging habitat.

Table 4.8.6-1 Cumulative effects on wildlife of the Proposed Action in combination with various plans, policies and laws. *continued*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of the earliest to the most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
The National Marine Sanctuaries Act. Also known as Title III of the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA).	The MPRSA authorizes the Secretary of Commerce to designate and manage areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or a aesthetic qualities as National Marine Sanctuaries. One of the purposes and policies of the MPRSA is "to maintain the natural biological communities in the national marine sanctuaries, and to protect, and, where appropriate, restore and enhance natural habitats, populations, and ecological processes."	Protecting the marine environment where chinook salmon mature is important to conserving the productivity of Puget Sound chinook salmon. Consequently, the Proposed Action would be consistent with the MPRSA by maintaining chinook salmon populations of the natural biological communities in the marine environment. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the MPRSA, would strive to restore and enhance natural habitats, populations, and ecological processes of fish. Marine Sanctuaries also provide protection for many species of marine mammals and seabirds that seasonally use Puget Sound. Those that forage on salmon, or are susceptible to net entanglement, are predicted to further benefit from implementation of the Resource Management Plan.
Coastal Zone Management Act of 1972 (CZMA), as amended through The Coastal Zone Protection Act of 1996.	The CZMA declares a national policy "to preserve, protect, develop, and where possible, to restore or enhance, the resources of the Nation's coastal zone for this and succeeding generations by "the protection of natural resources, including wetlands, floodplains, estuaries, beaches, dunes, barrier islands, coral reefs, and fish and wildlife and their habitat, within the coastal zone."	Chinook salmon are one of the Nation's resources within the coastal zone regulated by the CZMA. The Proposed Action would be consistent with the CZMA by encouraging preservation and protection of Puget Sound chinook salmon and their habitat within the coastal zone for existing and succeeding generations, and by ensuring that harvest is consistent with the production and capacity of the habitat. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the CZMA, would preserve, protect, restore or enhance the fish resources of the Nation's coastal zone. The coastal zone is also important to many species of marine wildlife, including marbled murrelets and bald eagles. The CZMA in combination with the Proposed Action is predicted to benefit marbled murrelets and other seabirds through habitat protection and reduced net entanglement risk, and increased fish prey in the case of bald eagles and other fish-eating predators/scavengers.

Table 4.8.6-1 Cumulative effects on wildlife of the Proposed Action in combination with various plans, policies and laws. *continued*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of the earliest to the most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
Marine Mammal Protection Act of 1972, as amended through 1996 (MMPA).	The MMPA establishes a Federal responsibility to conserve marine mammals, with management vested in the Department of Commerce, National Oceanic and Atmospheric Administration (NOAA) for cetaceans and pinnipeds other than walrus. The MMPA states that the "Secretary must undertake a program of research and development for improving fishing methods and gear to reduce to the maximum extent practical the incidental taking of marine mammals in commercial fishing." To meet this requirement, the "Secretary must issue regulations to reduce to the lowest practical level the taking of marine mammals incidental to commercial fishing operations." The Secretary of Commerce has issued regulations that prohibit deterrent devices that might seriously injure or kill a marine mammal, and that require fishermen to report unintentional marine mammal mortality.	The Proposed Action would be consistent with the MMPA to conserve marine mammals because the fisheries would be in compliance with Department of Commerce regulations to reduce to the lowest practical level the take of marine mammals incidental to commercial fishing operations. Although not specifically addressed in the Proposed Action, Department of Commerce regulations require Puget Sound fishermen to use non-lethal deterrent devices and to report unintentional marine mammal mortality. As chinook salmon are prey of marine mammals, implementation of the Proposed Action, in combination with the MMPA, will aid in the maintenance and recovery of marine mammal populations by ensuring that enough fish escape to produce more in subsequent generations as habitat improves.
The Endangered Species Act of 1973, as amended through December, 1996 (ESA).	The purpose of the ESA is "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species…" On July 10, 2000, NMFS issued a rule under section 4(d) of the ESA (referred hereafter as the 4(d) Rule). The 4(d) Rule provided limits on the application of the take prohibitions; i.e., take prohibitions would not apply to the plans and activities set forth in the rule if those plans and activities adequately address criteria of the rule, including that implementation and enforcement of the resource management plan will not appreciably reduce the likelihood of survival and recovery of affected threatened ESUs.	The Puget Sound Chinook Salmon ESU is listed as threatened under the ESA. The Proposed Action to implement the Puget Sound Chinook Salmon Resource Management Plan includes a condition that the Secretary of Commerce will determine whether that the Resource Management Plan adequately addresses the criteria outlined in Limit 6 of the ESA 4(d) Rule. Consequently, the Proposed Action would be consistent with the ESA by meeting these criteria designed to foster goals and objectives of the ESA, including to avoid appreciably reducing the likelihood of survival and recovery of Puget Sound Chinook Salmon ESU. The ESA would not only have a beneficial impact to listed Puget Sound chinook salmon, but species listed under the ESA also include predators of chinook salmon such as bull trout and bald eagles. Accordingly, it is predicted that implementation of the Proposed Action, in combination with the ESA, would potentially have both unquantifiable beneficial and adverse impacts to fish resources and listed wildlife species such as bald eagles that forage on fish.

Table 4.8.6-1 Cumulative effects on wildlife of the Proposed Action in combination with various plans, policies and laws. *continued*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of the earliest to the most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
Habitat Conservation Plans	Section 10 of the Endangered Species Act requires that Habitat Conservation Plans be developed and implemented as a condition of the incidental take permit process. These plans define the impacts of a proposed action on listed species, and the steps an applicant intends to take to minimize and mitigate these impacts.	Listed species inhabiting Puget Sound for which habitat conservation plans have been developed include the marbled murrelet (seven plans) and the bald eagle (six plans). All of these plans involve preserving forest habitat for these species in the general Puget Sound basin. By reducing mortality risks (net entanglement) to marbled murrelets and enhancing the foraging base for bald eagles, implementation of the Proposed Action in combination with the conservation goals of HCPs will benefit marbled murrelets. The HCPs in question are: Cedar River Watershed City of Tacoma, Tacoma Water Plum Creek Timber I-90 Port Blakely RB Eddy Tree Farm Simpson Timber NW Operations Washington DNR Forest Lands West Fork Timber (formerly Murray Pacific).
ESA Recovery Plans	The 1982 and 1988 amendments to the Endangered Species Act of 1973 require that recovery plans be developed and implemented to promote the conservation of listed species.	Recovery plans have been developed for the seven threatened and endangered wildlife species (Pacific leatherback turtle, marbled murrelet, bald eagle, California brown pelican, Steller sea lion, humpback whale, and fin whale) that at least occasionally inhabit Puget Sound. Implementation of the Proposed Action would likely reduce net entanglement risks for those species that potentially interact with the Puget Sound fisheries (the turtle, seabirds, and marine mammals), and benefit those listed species that forage on salmon (bald eagles and Steller sea lions). Thus, implementation of the Proposed Action in combination with the implementation of actions in the recovery plans should benefit these listed species.

Table 4.8.6-1 Cumulative effects on wildlife of the Proposed Action in combination with various plans, policies and laws. *continued*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of the earliest to the most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
The Clean Water Act, 1977 (CWA). A 1977 amendment to the Federal Water Pollution Control Act (FWPCA) was titled "The Clean Water Act."	The objective of the CWA is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. As stated in the CWA, maintaining or restoring water quality "provides for the protection and propagation of fish, shellfish, and wildlife…"	Primarily because the CWA would maintain water quality that provides for the protection and propagation of fish, it is predicted that implementation of the Proposed Action, in combination with the CWA, would have a net beneficial impact on fish resources. These benefits would also accrue to the wildlife species that forage on these fish.
The Migratory Bird Treaty Act	The MBTA "absolutely forbids killing, possessing, or trading in migratory birds except in accordance with regulations prescribed by the Secretary of the Interior."	By reducing the risks of net entanglement to migratory seabirds such as murrelets, auklets, and murres, the Proposed Action in combination with the MBTA is predicted to benefit migratory birds.
The Bald Eagle and Golden Eagle Protection Act	This legislation was first enacted in 1940 to protect bald eagles by prohibiting the take, sale, or purchase of these birds. Today, it provides a third level of protection for bald eagles along with the ESA and the MBTA.	Implementation of the Proposed Action is predicted to benefit bald eagles by increasing the available fish resources on which they forage. Consequently, the Proposed Action in combination with the Bald Eagle and Golden Eagle Protection Act is predicted to benefit bald eagles.
The Treaty between the Government of Canada and the Government of the United States of America concerning Pacific Salmon, 1985, including 1999 revised annexes (Pacific Salmon Treaty).	The Pacific Salmon Treaty calls on the U.S. and Canada (Parties) to conduct its fisheries in a manner to "prevent overfishing and provide for optimum production." The Pacific Salmon Treaty defines "overfishing" as "fishing patterns which result in escapements significantly less than those required to produce maximum sustainable yields [MSY]." Annex IV, Chapter 3, Chinook Salmon of the Pacific Salmon Treaty further states that the Parties shall establish a chinook salmon management program that "sustains healthy stocks and rebuilds stocks that have yet to achieve MSY or other biologically-based escapement objectives." Salmon subject to the Pacific Salmon Treaty include Pacific salmon stocks that originate in the waters of one Party and subject to interception by the other Party.	Puget Sound chinook salmon are intercepted in Canadian fisheries under the authority of the Pacific Salmon Treaty. The Proposed Action accounts for all sources of fishery-related chinook salmon mortality, including mortality related to Canadian fisheries. Although the Proposed Action would allow exploitation rates that would result in escapements less than those required to produce maximum sustainable yields in some years, it would, overall, sustain healthy populations and rebuild stocks toward maximum sustainable yield. Consequently, the Proposed Action would be consistent with the Pacific Salmon Treaty. Accordingly, it is predicted that implementation of the Proposed Action, in combination with the Pacific Salmon Treaty, would have a net beneficial impact on the wildlife species that forage on these fish.

Table 4.8.6-1 Cumulative effects on wildlife of the Proposed Action in combination with various plans, policies and laws. *continued*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of the earliest to the most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl, commonly referred to as the Northwest Forest Plan (NFP), 1994.	The NFP is an integrated, comprehensive design for ecosystem management, intergovernmental and public collaboration, and rural community economic assistance for federal forests in western Oregon, Washington, and northern California. The management direction of the NFP consists of extensive standards and guidelines, including land allocations that comprise a comprehensive ecosystem management strategy. Aquatic conservation strategy objectives outlined in the NFP (Attachment A of the NFP) include, but are not limited to: "Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations and communities are uniquely adapted;" and, "Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities."	The Proposed Action would be consistent with the intent of NFP to maintain and restore the distribution, diversity, and complexity of watersheds. Accordingly, it is predicted that implementation of the Proposed Action, in combination with the NFP, would have a net beneficial impact on fish resources. Implementation of the NFP also benefits wildlife species such as marbled murrelets (protecting forest breeding habitat), and bald eagles (protecting both breeding and foraging habitat). Together, implementation of the NFP and Proposed Action are predicted to benefit marbled murrelets and bald eagles.
Gravel to Gravel, Regional Salmon Recovery Policy for the Puget Sound and the Coast of Washington, Western Washington Treaty Tribes, July 25, 1997 (Gravel to Gravel Policy).	Major elements of the Gravel to Gravel Policy are to provide habitat protection and restoration, ensuring abundant spawners, managing fisheries, and integrating hatchery production.	The Proposed Action would be consistent with the Gravel to Gravel policy of managing fisheries to ensure abundant spawners. Accordingly, it is predicted that implementation of the Proposed Action, in combination with the Gravel to Gravel Policy, would have a beneficial impact on fish resources, which in turn would benefit wildlife species that forage on these fish.

Table 4.8.6-1 Cumulative effects on wildlife of the Proposed Action in combination with various plans, policies and laws. *continued*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of the earliest to the most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
Policy of Washington Department of Fish and Wildlife and Western Washington Treaty Tribes Concerning Wild Salmonids (Wild Salmon Policy). Adopted by Washington Fish and Wildlife Commission on December 5, 1997. (Despite the title, the tribal governments have not adopted this Wild Salmon Policy.)	The stated goals of the Wild Salmon Policy include restoring Washington stocks of wild salmon and steelhead to healthy, harvestable runs by "managing commercial and sport fishing to ensure enough wild runs return to spawn while providing fishing opportunities where possible."	The Proposed Action would be consistent with the intent of the Wild Salmon Policy to manage commercial and recreational fishing in a manner that ensures enough wild salmon return to spawn while providing fishing opportunities where possible. Accordingly, it is predicted that implementation of the Proposed Action, in combination with the Wild Salmon Policy, would have a beneficial impact on fish resources, and the wildlife species that forage on these fish.
Statewide Strategy to Recover Salmon, September 21, 1999 (SSRS).	The goal of the SSRS is to "[r]estore salmon, steelhead, and trout populations to healthy and harvestable levels and improve the habitats on which fish rely." The SSRS is the long-term vision or guide for salmon recovery within the State of Washington.	The Proposed Action would be consistent with the intent of SSRS to restore salmon populations to healthy and harvestable levels. Accordingly, it is predicted that implementation of the Proposed Action, in combination with the SSRS, would have a beneficial impact on fish resources, and the wildlife species that forage on these fish.
Local Plans, Policies, and Programs	Local activities that influence cumulative effects to fish include, but are not limited to: Water Supply Projects: Local water departments operate and maintain water reservoirs, pump stations, and water mains to deliver potable water to their customers. Local projects have minimized the adverse impacts of water withdrawal by installing additional water gauges to monitor flows and regulate water use, reducing water intake during critical environmental periods, and by purchasing existing water rights to return water to the system. Levee Maintenance: A levee is a natural or manmade structure, usually an earthen berm or riprap, that parallels the course of a river. It functions to prevent flooding of the adjoining countryside. However, it also confines the flow of the river resulting in deeper, faster flows. In recent years, local levee maintenance projects have included setting back or removing levees. Stormwater Management: Surface water runoff results from rainfall or	Many of these local activities are conducted in cooperation with federal, tribal, and state actions. The fisheries that would be allowed by the Proposed Action are predicted to have minimal to negligible effect on Washington State water quality. Because many of these local plans, policies, and programs would maintain water quality that provides for the protection and propagation of fish, it is predicted that implementation of the Proposed Action, in combination with local plans, policies, and programs, would have a net beneficial impact on fish resources, and the wildlife that feed on these fish.

Table 4.8.6-1 Cumulative effects on wildlife of the Proposed Action in combination with various plans, policies and laws. *continued*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of the earliest to the most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
	snow melt that does not infiltrate the ground or evaporate due to impervious surfaces. Instead, this runoff flows onto adjacent land, or into watercourses, or is routed into storm drainage collection systems managed by local entities. Local cities and counties are in the process of developing watershed plans, subbasin plans, and revising codes to minimize the adverse impacts of surface water runoff. Wastewater Treatment Projects: Municipal wastewater treatment plants process domestic sewage, and commercial and industrial wastewaters. Stormwater and groundwater infiltration may also enter wastewater treatment plants, though efforts are being made to segregate these flows. Local cities and counties are in the process of developing Facilities Plans and revising codes to minimize adverse impacts associated with wastewater treatment projects. Salmon Recovery Efforts: Local communities are undertaking activities to protect listed species and their habitat. Examples of activities conducted include, but are not limited to: reducing barriers to fish passage; improving habitat forming processes; increasing channel diversity; improving estuarine habitat; and enhancing streamside vegetation. Watershed Conservation Plans: As mandated by the 1998 State of Washington Watershed Management Act and Salmon Recovery Planning Act, counties are conducting watershed planning to address water quality, water quantity, and salmon habitat issues. Bald Eagle Management Plans: In 1984, the Washington State Legislature enacted laws to protect bald eagle habitat through WDFW management processes. From these laws, bald eagle protection rules were developed, requiring site-specific bald eagle management plans be developed where landowner-proposed activities may adversely impact bald eagle habitat. Since 1987, more than 1,150 plans have been developed, the majority in the Puget Sound region.	

4.9 Ownership and Land Use – Parks and Recreation

Activities under the Proposed Action or the alternatives considered are projected to have no perceptible adverse or beneficial effect on land ownership, land use, or designated recreational areas within the Puget Sound Action Area. Current trends in land use would continue under any alternative selected. Construction activities directly related to salmon fisheries during the duration of this action (the ~~2004~~ 2005–2009 fishing seasons) would likely be limited to maintenance and repair of existing facilities, not expected to result in additional impacts to riparian habitats associated with the fisheries regulated by the resource management plan.

Growth or decline in an economy is typically the propulsive force for land use changes. The probable economic consequences of the Proposed Action or alternatives would likely be too small to affect land use (see Subsection 4.6).

Facilities used in association with river fisheries are essentially all in place. If there is a reduction in the salmon fishery program, some access points to the water might experience a reduction in traffic, but in most cases would continue to be used for other river activities, such as recreational boating.

4.10 Water Quality

The Proposed Action or alternatives are not expected to differ significantly in their potential impacts to water quality since, in general, fishing activity has only a limited impact on water quality compared to the myriad of other sources of pollutant inputs to Puget Sound. Most pollutant sources affecting Puget Sound are land-based, as previously described in Subsection 3.10 (Puget Sound Water Quality Action Team 2002). While quantitative estimates of vessel traffic and pollution due to vessel activity are not available, the large number of potential land-based sources and their impact to water quality significantly exceeds potential variation in vessel activity that would result from differences between the Puget Sound Chinook Harvest Resource Management Plan and other fishing regime alternatives under consideration.

Most vessels are used for more than salmon fishing activity. This is probably most true for sport fishing vessels rather than for commercial fishing vessels, but the majority of fishing vessel activity within the Puget Sound Action Area is related to sport fishing. Both sport and commercial fishing vessels are used to harvest other resources (such as, shrimp, herring, crab, rock fish, and shellfish), and smaller vessels are used for other leisure activities (like family trips, diving, pleasure cruising, and water skiing). Although the reductions in angler trips predicted to result from Alternatives 2, 3 or 4 may result in a decrease in vessel traffic in some areas, the reduction is likely to be low or immeasurable given the alternative uses available for these vessels.

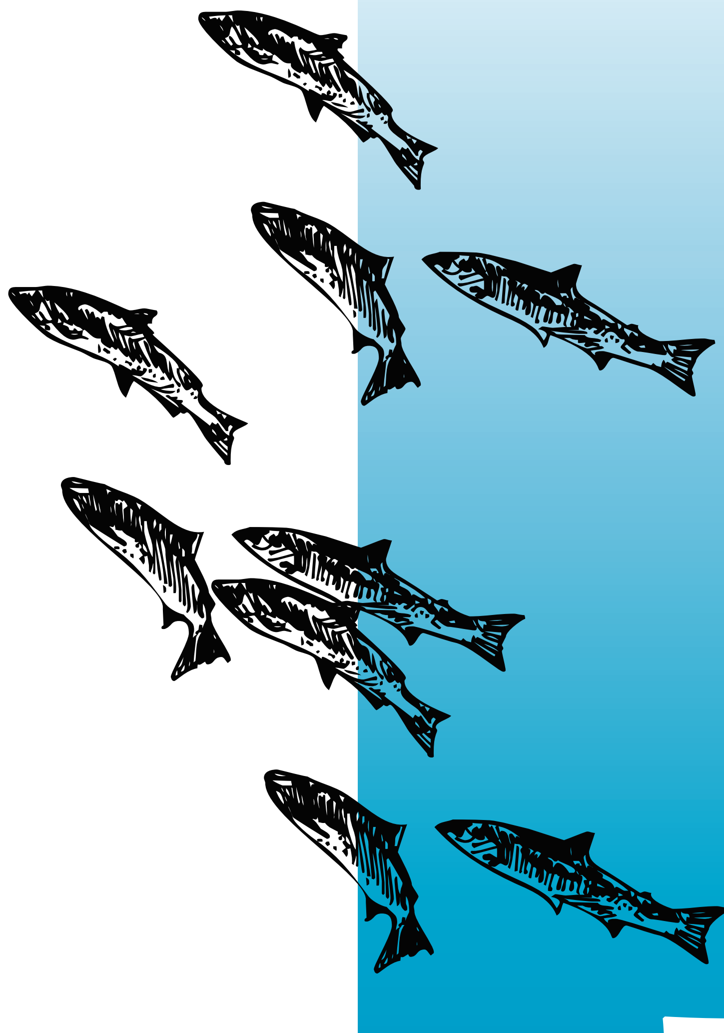
4.10.1 Sedimentation and Turbidity

Neither the Proposed Action nor the alternatives considered are predicted to have a measurable adverse or beneficial impact on the levels of sedimentation or turbidity in Puget Sound. No impact is expected. Also, no indirect, cumulative, or long-term impacts are expected to occur.

4.10.2 Non-Point Source Pollution

Neither the Proposed Action nor the alternatives considered are predicted to have a measurable adverse or beneficial impact on the level of non-point source pollution in Puget Sound. No impact is expected. Similarly, no indirect, cumulative, or long-term impacts are expected to occur.

Agency Determination of Preferred Alternative



5

5.0 IDENTIFICATION OF THE ENVIRONMENTALLY PREFERABLE AND AGENCY PREFERRED ALTERNATIVES

Section 5 describes the Environmentally Preferable Alternative, the agency's Preferred Alternative, and the primary factors in NMFS' decision concerning the Agency Preferred Alternative. C~~enter for~~ouncil on Environmental Quality (CEQ) Regulations (40 CFR §1502.14[e]) require that the NEPA lead agency "Identify the [agency's] preferred alternative or alternatives, if one or more exists, in the draft [environmental impact] statement…unless another law prohibits the expression of such a preference." CEQ Regulations do not require that the Environmentally Preferable Alternative be identified in the Draft Environmental Impact Statement (40 CFR §1505.2[b]), but rather in the Record of Decision based, in part, on the Final Environmental Impact Statement. However, both the agency's Preferred Alternative and the Environmentally Preferable Alternative are presented here in order to provide the public with information as early in the environmental review and decision-making process as possible. The Environmentally Preferable Alternative can be the same as the agency Preferred Alternative or differ in some respects, depending on the EIS analysis.

This section builds on the impact analysis of the individual options and alternatives presented in Section 4, Environmental Consequences. Subsection 5.1 summarizes the impacts described in Section 4 in tabular form. Subsection 5.2 then describes how those impacts were analyzed to identify the Environmentally Preferred Alternative and the NMFS Preferred Alternative.

5.1 Impacts Summary

Four alternatives have been analyzed in detail in the Environmental Impact Statement. The alternatives selected for detailed analysis represent different management frameworks from which to develop annual fishing regimes. Except for Alternative 4 (No Action/No Authorized Take), each alternative would provide a flexible framework for managing fisheries to meet conservation and use objectives. Each year, the co-managers would use the framework to develop annual fishing regimes for Puget Sound fisheries that are responsive to the year-specific circumstances related to the status of populations and other resource use objectives. Each alternative represents a distinctly different approach to setting management objectives, and each would have different outcomes in terms of escapement levels, harvest-related mortality, long-term resource protection, and harvest opportunity. The differences among the alternatives arise from 1) the type of management framework, and 2) the geographic scope of the fisheries. A more detailed description of each of the alternatives is provided in Section 2, Alternatives Including the Proposed Action. The predicted outcomes from implementing each of the alternatives are described in Section 4 of this Environmental Impact Statement, and summarized in Table 5.1-1 below.

Each alternative was evaluated for four scenarios that captured the general range in magnitude of abundance and the level of Puget Sound chinook salmon harvest in Canadian and Alaskan fisheries (Table 5.1-2) that is reasonably expected to occur across the duration of the Proposed Action (the ~~2004~~ 2005–2009 fishing seasons), in order to capture the range of anticipated impacts of the Proposed Action and its alternatives. A more detailed discussion of the basis for and choice of these scenarios is presented in Subsection 4.2, Basis for Comparison of Alternatives and Approach to Alternatives Analysis.

Table 5.1-1. Abundance and Canadian/Alaskan fishery scenarios evaluated for each alternative.

Scenario	Abundance	Canadian/Alaskan Fisheries
Scenario A	2003 Puget Sound abundance	2003 Canadian/Alaskan fisheries harvest
Scenario B	2003 Puget Sound abundance	High Canadian/Alaskan fisheries harvest
Scenario C	30% reduction from 2003 abundance	2003 Canadian/Alaskan fisheries harvest
Scenario D	30% reduction from 2003 abundance	High Alaskan/Canadian fisheries harvest

The indications of a plateau or potential reduction in marine survival and expectations that Canadian fisheries will continue to increase as they have in recent years led the Interdisciplinary Team to conclude that Scenario B is the *most likely* to occur during the implementation of the Proposed Action. Therefore, the results in Table 5.1-1 are presented for Scenario B. However, the other scenarios follow the same general pattern of impacts when comparing the alternatives as they relate to each resource.

To evaluate the effect of the various alternatives on listed and unlisted salmonids, NMFS compared the predicted impacts against several standards for assessing the effects of fishing actions on the sustainability of salmon populations. For listed Puget Sound salmonids, these standards are Rebuilding Exploitation Rates (RER), critical escapement thresholds (CETs), and/or viable escapement thresholds (VETs), as described in Subsection 4.3.1, Threatened and Endangered Fish Species: Environmental Consequences. For unlisted salmonids (coho, pink, chum, sockeye and steelhead), the standards are exploitation rate ceilings, or escapement goals established by the co-managers beginning with the 2001 management year (see Subsection 4.3.2, Unlisted Salmonid Species: Environmental Consequences), intended to optimize population production.

Fishing regimes that provide for harvest rates at or below the RER level, by definition, do not cause appreciable harm to the population or pose jeopardy to the ESU. Fishing regimes above the RERs may also not pose jeopardy to the ESU depending on the status and distribution of the chinook salmon populations throughout the ESU. The critical escapement threshold represents a point of biological instability, below which the risk of extinction increases significantly, due to declining spawning success, depensatory mortality, or risk of loss of genetic integrity. Viable escapement thresholds (in the context of this EIS analysis) are a level of spawning escapement associated with rebuilding to recovery, consistent with current environmental conditions. For most populations, VETs are well below the escapement levels associated with recovery, but achieving these goals under current conditions is a necessary step to eventual recovery when habitat and other conditions are more favorable.

In general, the farther the anticipated escapement is from the critical threshold, the less stable the populations, and the closer the anticipated escapement to the viable or optimal production threshold, the greater the confidence that the population will be sustainable over the long term. However, the status of the population and the change in resulting escapement among the four alternatives must be considered in the context of the environment of each population. In reality, alternatives in which modeling results indicate that some populations would just achieve their critical escapement thresholds may not perform any better than alternatives where those same populations are predicted to return just under their critical escapement thresholds. Conversely, substantial increases in spawning escapements may not result in commensurate increases in the progeny of those chinook salmon spawners. Salmon productivity is generally thought to increase over a range of escapement, then reach a plateau or decline at higher levels of escapement due to density-dependent survival; i.e., too many spawners for the available habitat, or too many juvenile salmon for the available food in the river.

Table 5.1-2 Comparison of predicted environmental effects among alternatives and a description of the Proposed Action for Scenario B in the order they appear in the EIS.

Environmental Components	Alternative 1 – Proposed Action/Status Quo	Alternative 2 – Escapement Goal Management, Management Unit Level	Alternative 3 – Escapement Goal Management, Population Level, Terminal Fisheries	Alternative 4 – No Action/No Authorized Take of Listed Puget Sound Chinook
Fish		No to low beneficial impacts to most populations relative to Alternative 1.	Beneficial impacts to most populations relative to Alternative 1.	Beneficial impacts to most populations relative to Alternative 1.
Threatened and Endangered Species	Meets 5 of 10 RERs. Exceeds 5 RERs by 4 to 10%.	Meets 5 of 10 RERs. Exceeds 5 RERs by 3 to 43%.	Meets 8 of 10 RERs. Exceeds 2 RERs by 2 to 7%.	Meets 9 of 10 RERs. Exceeds 1 RER by 7%.
	Exceeds 21 of 22 critical escapement thresholds by 2 to 1110%; average 383%.	Meets or exceeds 20 of 22 critical escapement thresholds by 15 to 1110%; average 364%.	Meets or exceeds 21 of 22 critical escapement thresholds by 15 to 1110%; average 378%.	Meets or exceeds 21 of 22 critical escapement thresholds by 15 to 1531%; average 547%.
	Meets or exceeds 9 of 19 viable escapement thresholds by 2 to 237%; average 68% (see Subsection 4.3.1.1).	Meets or exceeds 9 of 19 viable escapement thresholds by 0 to 105%; average 33% (see Subsection 4.3.1.2).	Meets or exceeds 10 of 19 viable escapement thresholds by 0 to 105%; average 57% (ee Subsection 4.3.1.3).	Meets or exceeds 11 of 19 viable escapement thresholds by 9-261%; average 107% (ee Subsection 4.3.1.4).
	NMFS has published a proposed determination for public comment that finds Alternative 1 meets the criteria of Limit 6 of the 4(d) Rule.			
	Exploitation rate management more robust to escapement goal management to uncertainty in survival and management error (see Subsection 4.3.8).	Escapement goal management less robust than exploitation rate management to uncertainty in survival and management error (see Subsection 4.3.8).	Escapement goal management less robust than exploitation rate management to uncertainty in survival and management error (see Subsection 4.3.8).	

Environmental Components	Alternative 1 – Proposed Action/Status Quo	Alternative 2 – Escapement Goal Management, Management Unit Level	Alternative 3 – Escapement Goal Management, Population Level, Terminal Fisheries	Alternative 4 – No Action/No Authorized Take of Listed Puget Sound Chinook
Unlisted Salmonids	At or below all exploitation rate ceilings by 13 to 27%.	Exploitation rates are low to substantially less than Alternative 1 (8 to 37%).	Exploitation rates are low to substantially less than Alternative 1 (8 to 37%).	Exploitation rates are low to substantially less than Alternative 1 (8 to 49%).
	Meets or exceeds 11of 15 escapement goals across all non-chinook salmon species by 6 to 294%.	Meets or exceeds 11 of 15 escapement goals across all non-chinook salmon species by 15 to 521%.	Meets or exceeds 11 of 15 escapement goals across all non-chinook salmon species by 15 to 521%.	Meets or exceeds 11 of 15 escapement goals across all non-chinook salmon species by 15 to 586%.
	Risk of density-dependent effects (ee Subsection 4.3.2.1).	Low to substantial beneficial effect to escapement depending on species, but increased risk of density-dependent declines in productivity (see Subsection 4.3.2.2).	Low to substantial beneficial effect to escapement depending on species, but increased risk of density-dependent declines in productivity (see Subsection 4.3.2.3).	Low to substantial beneficial effect to escapement depending on species, but increased risk of densitydependent declines in productivity (see Subsection 4.3.2.4).
Non-Salmonids	Adverse impacts from sport fisheries. Commercial catch unknown (see Subsection 4.3.3).	Substantial beneficial effect compared with Alternative 1 since no catch of groundfish and forage species. However, increased predation on forage species from reduced catch of salmon likely to reduce beneficial effects on forage species (see Subsection 4.3.3).	Substantial beneficial effect compared with Alternative 1 since no catch of groundfish and forage species. However, increased predation on forage species from reduced catch of salmon likely to reduce beneficial effects on forage species (see Subsection 4.3.3).	Substantial beneficial effect since no catch of groundfish and forage species compared with Alternative 1. However, increased predation on forage species from reduced catch of salmon likely to reduce beneficial effects on forage species (see Subsection 4.3.3).
Fish Habitat Affected by Fishing	No adverse impact to fish habitat (see Subsection 4.3.4).	Moderate adverse impact to fish habitat in freshwater areas compared to Alternative 1 (see Subsection 4.3.4).	Moderate adverse impact to fish habitat in freshwater areas compared to Alternative 1 (see Subsection 4.3.4).	Low beneficial impact to fish habitat compared to Alternative 1 (see Subsection 4.3.4).

Environmental Components	Alternative 1 – Proposed Action/Status Quo	Alternative 2 – Escapement Goal Management, Management Unit Level	Alternative 3 – Escapement Goal Management, Population Level, Terminal Fisheries	Alternative 4 – No Action/No Authorized Take of Listed Puget Sound Chinook
Marine-Derived Nutrients	Effects cannot be estimated due to variability in spawner density (which varies greatly between species and in different reaches of the rivers), and environmental factors (see Subsection 4.3.5.1).	Effects cannot be estimated due to variability in spawner density (which varies greatly between species and in different reaches of the rivers), and environmental factors (see Subsection 4.3.5.2.	Effects cannot be estimated due to variability in spawner density (which varies greatly between species and in different reaches of the rivers), and environmental factors (see Subsection 4.3.5.3).	Effects cannot be estimated due to variability in spawner density (which varies greatly between species and in different reaches of the rivers), and environmental factors (see Subsection 4.3.5.4).
Selectivity Effects on Salmonids of Fishing	No to low adverse effects (see Subsection 4.3.6.1).	Due to uncertainty about the contrasting effects of decreased effects from the elimination of pre-terminal fishing and possible increased use of selective gears in terminal fisheries, it is not possible to predict effects of this alternative (see Subsection 4.3.6.2).	Due to uncertainty about the contrasting effects of decreased effects from the elimination of pre-terminal fishing and possible increased use of selective gears in terminal fisheries, it is not possible to predict effects of this alternative (see Subsection 4.3.6.3).	No to low beneficial effects compared to Alternative 1 (see Subsection 4.3.6.4).
Hatchery-Related Effects				
Straying	Low to moderate adverse impact (see Subsection 4.3.7).	Moderate to substantial adverse impacts (see Subsection 4.3.7).	Moderate to substantial adverse impacts (see Subsection 4.3.7).	Moderate to substantial adverse impacts (see section 4.3.7).
Overfishing	See effects under Fish, above.	See effects under Fish, above.	See effects under Fish, above.	See effects under Fish, above.

Environmental Components	Alternative 1 – Proposed Action/Status Quo	Alternative 2 – Escapement Goal Management, Management Unit Level	Alternative 3 – Escapement Goal Management, Population Level, Terminal Fisheries	Alternative 4 – No Action/No Authorized Take of Listed Puget Sound Chinook
Tribal Treaty Rights and Trust Responsibilities	No or low adverse effect (see Subsection 4.4).	Substantial adverse effect (see Subsection 4.4).	Substantial adverse effect (see Subsection 4.4).	Substantial adverse effect (see section 4.4)
Treaty Indian Ceremonial and Subsistence Uses	No adverse effects (see Subsection 4.5.1).	Substantial adverse effects (see Subsection 4.5.2).	Substantial adverse effects (see Subsection 4.5.3).	Substantial adverse effects (see section 4.5.4)
Economic Activity				
Commercial	Moderate beneficial effects (see Subsection 4.6.1.1).	Substantial adverse effects (see Subsection 4.6.2.2).	Substantial adverse effects (see Subsection 4.6.3.2).	Substantial adverse effects (see Subsection 4.6.4.2).
Sport	Moderate beneficial effects to all sport fishing sectors (see Subsection 4.6.1.1).	Substantial adverse effects to all marine sport fishing sectors. Substantial adverse to 2 of 3 freshwater regions. Low beneficial effect to freshwater sport fishing sectors in Hood Canal (see Subsection 4.6.2.2).	Substantial adverse effects to all marine sport fishing sectors. Substantial adverse to 2 of 3 freshwater regions. Low beneficial effect to freshwater sport fishing sectors in Hood Canal (see Subsection 4.6.3.2).	Substantial adverse effects to all marine and freshwater sport fishing sectors (see Subsection 4.6.4.2).
Local and Regional Economy	Moderate beneficial effects to local economies and low beneficial effect to regional economies (see Subsection 4.6.1.1).	Substantial adverse effects to local economies and low adverse effects to regional economies (see Subsection 4.6.2.2).	Substantial adverse effects to local economies and low adverse effects to regional economies (see Subsection 4.6.3.2).	Substantial adverse effects to local economies and low adverse effects to regional economies (see Subsection 4.6.4.2).
Environmental Justice	Low to no effect (see Subsection 4.7.1).	Disproportionate and substantial adverse effect (see Subsection 4.7.2).	Disproportionate and substantial adverse effect (see Subsection 4.7.3).	Disproportionate and substantial adverse effect (see Subsection 4.7.4).

Environmental Components	Alternative 1 – Proposed Action/Status Quo	Alternative 2 – Escapement Goal Management, Management Unit Level	Alternative 3 – Escapement Goal Management, Population Level, Terminal Fisheries	Alternative 4 – No Action/No Authorized Take of Listed Puget Sound Chinook
Wildlife				
Marine Birds	Low adverse effect (see Subsection 4.8.1.1).	Low beneficial effect compared with Alternative 1 (see Subsection 4.8.1.2).	Low beneficial effect compared with Alternative 1 (see Subsection 4.8.1.3).	Low beneficial effect compared with Alternative 1 (see Subsection 4.8.1.4).
Marine Mammals	Low adverse effect (see Subsection 4.8.2.1).	Low beneficial effect compared with Alternative 1 (see Subsection 4.8.2.2).	Low beneficial effect compared with Alternative 1 (see Subsection 4.8.2.3).	Low beneficial effect compared with Alternative 1 (see Subsection 4.8.2.4).
Benthic Invertebrates	No to low adverse effect (see Subsection 4.8.3.1).	No to low beneficial effect compared with Alternative 1 (see Subsection 4.8.3.2).	No to low beneficial effect compared with Alternative 1 (see Subsection 4.8.3.3).	No to low beneficial effect compared with Alternative 1 (see Subsection 4.8.3.4).
Threatened and Endangered Species	Low adverse effect (see Subsection 4.8.4.1).	Low beneficial effect compared with Alternative 1 (see Subsection 4.8.4.2).	Low beneficial effect compared with Alternative 1 (see Subsection 4.8.4.3).	Low beneficial effect compared with Alternative 1 (see Subsection 4.8.4.4).
Ownership and Land Use	No effect (see Subsection 4.9).	No effect (see Subsection 4.9).	No effect (see Subsection 4.9).	No effect (see Subsection 4.9).
Water Quality	No effect (see Subsection 4.10).	No effect (see Subsection 4.10).	No effect (see Subsection 4.10).	No effect (see Subsection 4.10).

5.2 Identification of the Environmentally Preferable and Agency Preferred Alternatives

CEQ Regulations (40 CFR §1502.14[e]) require that the NEPA lead agency "Identify the [agency's] preferred alternative or alternatives, if one or more exists, in the draft [environmental impact] statement…unless another law prohibits the expression of such a preference." The Environmentally Preferable Alternative "ordinarily, means the alternative that causes the least damage to the biological and physical environment; it also means the alternative which best protects, preserves, and enhances historic, cultural and natural resources" (CEQ, 1981: 40 Most Asked Questions, No. 6a). The Preferred Alternative is the alternative NMFS believes will best fulfill the purpose and need for the Proposed Action. As provided for in NEPA and the CEQ NEPA implementing regulations, the Preferred Alternative and the Environmentally Preferable Alternative need not be the same, and in the case of NMFS' decision on this Proposed Action, they are not. NMFS has the authority to take into account various other considerations in choosing its Preferred Alternative, including such factors as the agency's statutory mission and responsibilities and economic, environmental, technical, and social factors (CEQ, 1981: 40 Most Asked Questions, No. 4a).

Based on Table 5.1-2 above, the following factors weighed most heavily in NMFS' decision concerning the Agency Preferred Alternative and the Environmentally Preferable Alternative: 1) fish, and in particular the ESA-listed Puget Sound chinook salmon; 2) various levels of restriction on tribal treaty rights (from voluntary to mandated), and trust responsibilities and the subsequent effects thereon; 3) treaty Indian ceremonial and subsistence uses; 4) various levels of environmental justice effects on Puget Sound tribes; 5) stable or increasingly adverse economic impacts to fishing communities; 6) secondary effects of fishing resulting from interactions of hatchery salmon that escape fisheries with wild salmon (i.e., straying); and, 7) fishing-related impacts to fish habitat. For other resources evaluated in the Environmental Impact Statement (i.e., wildlife, ownership and land use, water quality), there were no or very small differences among the alternatives, or uncertainty in the outcome precluded assessment of the effect (e.g., marine-derived nutrients).

5.2.1 The Environmentally Preferable Alternative

Based on the comparison of effects presented in Table 5.1-2, Alternative 4 (No Action/No Authorized Take of Listed Puget Sound Chinook) is the Environmentally Preferable Alternative because it is estimated to have, among the four alternatives considered, the most beneficial or least adverse effect on biological resources in terms of effects on salmonids (listed and unlisted) and non-salmonids, fish habitat and wildlife. The primary difference would be in the reduction of fish caught and, for salmon, a corresponding increase in the probability of recovery and survival of individual salmon populations in the Puget Sound Chinook Salmon ESU that may result from the reduction in harvest. Alternative 1 (the Proposed Action) and Alternative 4 are predicted to have less adverse effect on fish habitat than Alternative 2 or 3. Alternatives 2 through 4 are predicted to have a small beneficial effect on wildlife compared with Alternative 1.

With regard to effects on fish species, there would be some beneficial effect from the higher abundances predicted to result from Alternative 4, but it is difficult to determine how much difference in environmental benefit there would be for this resource between Alternative 4 and the Proposed Action. Habitat carrying capacity and productivity are limited in many salmon streams in Puget Sound (see Subsection 4.3.8, Indirect and Cumulative Effects), and escapements that return in excess of the capacity of these systems may create increased competition for mates, spawning and rearing area, food and other limited resources so that substantial increases in escapement may not translate into similar increases in subsequent returns. The same uncertainty exists regarding the potential effects of substantial increases in the number of coho and chum salmon hatchery adults in natural spawning areas, or increased predation by salmon on forage fishes that are predicted to occur under Alternative 4 when compared with Alternative 1. Potential increases in predation or competition for food resources could also negate benefits realized from increased abundance for either salmon or non-salmon species.

5.2.2 The Agency Preferred Alternative

Alternative 1, the Proposed Action, is the NMFS Preferred Alternative because NMFS believes this alternative would be most successful at balancing resource conservation, trust obligations to Native American tribes, promotion of sustainable fisheries, and prevention of lost economic potential associated with overfishing, declining species and degraded habitats. NMFS did not choose Alternative 4, the Environmentally Preferable Alternative, as its preferred alternative due to: 1) the substantial adverse impacts to tribal treaty rights, treaty Indian ceremonial and subsistence fishing uses, environmental justice effects, and economic effects on fishing communities predicted for this alternative; 2) the expected reduction in adverse biological impacts from implementation of Alternative 4 were not predicted to be substantial enough to outweigh the losses in these other areas, particularly for listed Puget Sound chinook salmon; and 3) failure to achieve the purpose and need for the Proposed Action. NMFS also did not select Alternatives 2 or 3 for the first two reasons described above.

NEPA regulations and guidance indicate that agencies have discretion in choosing a preferred alternative different from the environmentally preferred alternative “based on relevant factors including economic and technical considerations and agency statutory missions” (40 CFR 1505.2[b]). NMFS has three primary mandates with regard to this Proposed Action: 1) implement the ESA; 2) carry out federal trust responsibilities with Native American tribes, including protecting the exercise of federally-recognized treaty tribal fishing rights and; 3) provide for sustainable fishing opportunity. In addition, Presidential Executive Orders require that NMFS minimize conflicts between its implementation of the ESA and exercise of tribal activities (E.O. 13175); e.g., treaty-reserved fishing rights, and fishing (E.O. 12962). The Secretarial Order (Department of Interior Order 3206) requires that any restrictions of tribal fishing under the ESA 1) be reasonable and necessary for the conservation of the species at issue; 2) occur only when the conservation purpose of the restriction cannot be achieved by reasonable regulation of non-Indian activities; 3) be the least-restrictive alternative available to achieve the conservation purpose; 4) not discriminate against Indian activities either as stated or implied; and 5) that voluntary tribal measures are not adequate to achieve the necessary conservation purpose. NMFS staff propose to conclude that Alternative 1 (the Proposed Action) would not appreciably reduce the likelihood of survival or recovery of listed Puget Sound chinook salmon[1]. Therefore, the further reductions in fisheries, and tribal fisheries specifically, that would occur with implementation of Alternative 2, 3, or 4 are not required to meet ESA requirements, and would represent an unreasonable and unnecessary constraint on the exercise of federally-recognized treaty fishing rights. In addition, the approach represented in Alternative 1 is more robust overall to management error and key uncertainties in environmental parameters (see Subsection 4.3.8, Fish: Indirect and Cumulative Effects), and therefore should better protect salmonid resources evaluated in the Environmental Impact Statement and better promote sustainable fishing opportunities.

Under the most likely scenario to occur over the duration of the Proposed Action (the ~~2004~~ 2005–2009 fishing seasons), implementation of Alternative 2, 3, or 4 is predicted to result in the loss of more than 94 percent of the local and regional sales, employment, and personal income generated by commercial salmon fishing associated with the Puget Sound fishery. Reductions in sport fishing-related economic activity would range from 12 to 72 percent (see Subsection 4.6, Economic Activity and Value: Environmental Consequences). These predicted effects would be most severe in communities dependent upon commercial and sport fishing activities. Combined with substantial declines in fishing industries that these communities have already experienced over the past 20 years, these predicted effects would further affect the character and viability of these communities, especially tribal communities (see Subsection 4.5, Treaty Indian Ceremonial and Subsistence Salmon Uses: Environmental Consequences; and Subsection 4.7, Environmental Justice: Environmental

[1] NMFS' Proposed 4(d) Evaluation and Determination for the Puget Sound chinook resource management plan is currently undergoing public comment and review.

Consequences). As discussed in 5.2.1 above, the primary basis for the identification of Alternative 4 as the Environmentally Preferred Alternative was the increased abundance in fish species. Alternative 4 (as well as Alternative 2 or 3) would provide for substantially larger escapements of salmonids, larger abundance of forage fish, and a slightly greater possibility of rebuilding some individual listed Puget Sound chinook populations more quickly. However, given the discussion above, it is unclear what realistic effect this would have on the status of salmonid populations. NMFS has tentatively concluded that Alternative 1 will meet ESA requirements. Management objectives for the other salmonid species are also predicted to be met. Since Alternative 1 also provides for the conservation needs of these resources, NMFS does not consider the predicted reduction in adverse biological impacts from the implementation of Alternative 4 substantial enough to outweigh the significant economic losses that would be prevented under Alternative 1.

Finally, NEPA regulations require that the selected alternative be consistent with the purpose and need for the Proposed Action (see Subsection 2.3, Alternatives Considered in Detail). Alternative 4 would be inconsistent with several elements of the purpose and need for the Proposed Action, and would not have been considered were it not one of the alternatives identified for analysis in the settlement agreement to Washington Trout v. Lohn. It would not: 1) provide for the meaningful exercise of federally-protected treaty fishing rights; 2) provide for tribal and non-tribal fishing opportunity co-managed under the jurisdiction of U.S. v. Washington; or 3) optimize harvest of abundance of Puget Sound salmon while protecting weaker commingled chinook salmon stocks.

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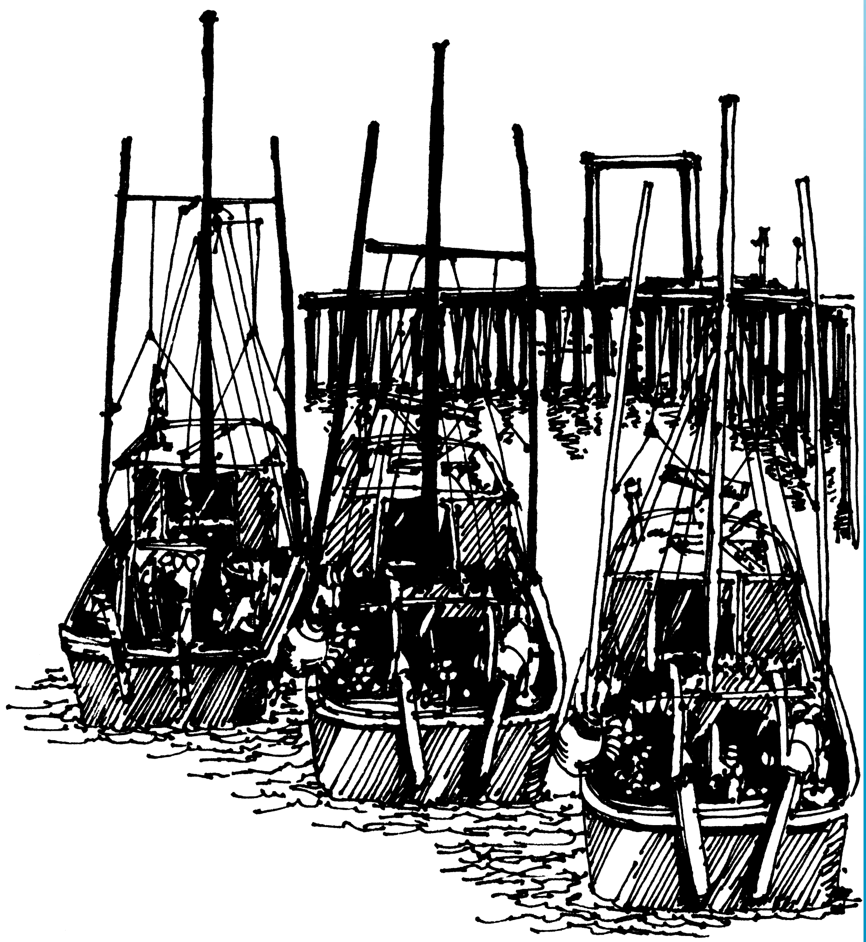

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3.2 Environmental Setting

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Appendices

APPENDIX A

Puget Sound Chinook Harvest Resource Management Plan

COMPREHENSIVE MANAGEMENT PLAN

FOR PUGET SOUND CHINOOK:

HARVEST MANAGEMENT COMPONENT

Puget Sound Indian Tribes

And

The Washington Department of Fish and Wildlife

March 1, 2004

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Executive Summary

This Harvest Management Plan outlines objectives that will guide the Washington co-managers in planning annual harvest regimes, as they affect listed Puget Sound chinook salmon, for management years 2004 - 2009. These objectives include total or Southern U.S. exploitation rate ceilings, and / or spawning escapement goals, for each of fifteen management units. This Plan describes the technical derivation of these objectives, and how these guidelines are applied to annual harvest planning.

The Plan guides the implementation of fisheries in Washington, under the co-managers' jurisdiction, but it considers the total harvest impacts of all fisheries, including those in Alaska and British Columbia, to assure that conservation objectives for Puget Sound management units are achieved. Accounting of total fishery-related mortality includes incidental harvest in fisheries directed at other salmon species, and non-landed chinook mortality.

The fundamental intent of the Plan is to enable harvest of strong, productive stocks of chinook, and other salmon species, and to minimize harvest of weak or critically depressed chinook stocks. However, the Puget Sound ESU currently includes many weak populations. Providing adequate conservation of weak stocks will necessitate foregoing some harvestable surplus of stronger stocks.

The rebuilding exploitation rate (RER) objectives stated for management units (Table 1) are ceilings, not annual target rates. The objective for annual, pre-season fishery planning is to develop a fishing regime that will exert exploitation rates that do not exceed the objectives established for each management unit. For the immediate future, annual target rates that emerge from pre-season planning will, for many management units, fall well below their respective ceiling rates. While management units are rebuilding, annual harvest objectives will intentionally be conservative, even for relatively strong and productive populations.

To insure that the diversity of genetic traits and ecological adaptation expressed by all populations in the ESU is protected, low abundance thresholds are specified (Table 1). These thresholds are intentionally set above the level at which a population may become demographically unstable, or subject to loss of genetic integrity. If abundance (i.e., escapement) is forecast to fall to or below this threshold, harvest impacts will be further constrained, by Critical Exploitation Rate Ceilings, so that escapement will exceed the low abundance threshold or the ceiling rate is not exceeded.

Rebuilding exploitation rates are based on the most current and best available information on the recent and current productivity of each management unit. Quantification of recent productivity (i.e., recruitment and survival) is subject to uncertainty and bias. The implementation of harvest regimes is subject to management error. The derivation of RERs considers specifically these sources of uncertainty and error, and manages the consequent risk that harvest rates will exceed appropriate levels. The productivity of each management unit will be periodically re-assessed, and harvest objectives modified as necessary, so they reflect current status.

Table 1.Rebuilding exploitation rates (RERs), expressed either as total, southern U.S. (SUS), or pre-terminal southern US (PT SUS) rates, upper management thresholds, and low abundance thresholds for Puget Sound chinook.

Management Unit	RER	Upper Management Threshold	Low Abundance Threshold
Nooksack [1]	Under development	4,000	
North Fork		2,000	1,000
South Fork		2,000	1,000
Skagit summer / fall	50%	14,500	4,800
Upper Skagit summer		8,434	2,200
Sauk summer		1,926	400
Lower Skagit fall		4,140	900
Skagit spring	38%	2,000	576
Upper Sauk		986	130
Cascade		440	170
Siuattle		574	170
Stillaguamish [1]	25%	900	650
North Fork summer		600	500
South Fork & MS fall		300	N/A
Snohomish [1]	21%	4,600	2,800
Skykomish		3,600	1,745
Snoqualmie		1,000	521
Lake Washington	15% PT SUS		
Cedar River [1]		1,200	200
Green	15% PT SUS	5,800	1,800
White River spring	20%	1,000	200
Puyallup fall	50%		500
South Prairie Creek		500	
Nisqually		1,100	
Skokomish	15% PT SUS	3,650 aggregate, 1,650 natural	1,300 aggregate 800 natural
Mid-Hood Canal	15% PT SUS	750	400
Dungeness	10% SUS	925	500
Elwha	10% SUS	2,900	1,000
Western JDF	10% SUS	850	500

[1] thesholds expressed as natural-origin spawners

This Plan will be submitted to the National Marine Fisheries Service (NMFS), for evaluation under the conservation standards of the Endangered Species Act. Criteria for exemption of state / tribal resource management plans from prohibition of the 'take' of listed species, are contained under Limit 6 of the salmon 4(d) Rule (50 CFR 223:42476). The 4(d) criteria advocate that harvest should not impede the recovery of populations, whose abundance exceeds their critical threshold, from increasing, and that populations with critically low abundance be guarded against further decline, such that harvest will not significantly reduce the likelihood of survival and recovery of the ESU. This Plan assures that the abundance of all populations will increase, if habitat conditions improve to support increased productivity, and that the harvest will be conducted more conservatively than required by the ESA.

1. Objectives and Principles

This Harvest Management Plan consists of management guidelines for planning annual harvest regimes, as they affect Puget Sound chinook, for the 2004 - 2009 management years. The Plan guides the implementation of fisheries in Washington, under the co-managers' jurisdiction, and considers the total harvest impacts of all fisheries on Puget Sound chinook, including those in Alaska, British Columbia, and Oregon. The Plan's objectives can be stated succinctly as intent to:

> *Ensure that fishery-related mortality will not impede rebuilding of natural Puget Sound chinook salmon populations, to levels that will sustain fisheries, enable ecological functions, and are consistent with treaty-reserved fishing rights.*

This Plan will constrain harvest to the extent necessary to enable rebuilding of natural chinook populations in the Puget Sound evolutionarily significant unit (ESU), provided that habitat capacity and productivity are protected and restored. It includes explicit measures to conserve and rebuild abundance, and preserve diversity among all the populations that make up the ESU. The ultimate goal of this plan, and of concurrent efforts to protect and restore properly functioning chinook habitat, is to rebuild natural productivity so that natural chinook populations will be sufficiently abundant and resilient to perform their natural ecological function in freshwater and marine systems, provide related cultural values to society, and sustain commercial, recreational, ceremonial, and subsistence harvest.

The co-managers and the Puget Sound Shared Strategy have adopted abundance and productivity goals for each population, which are the endpoint for all aspects of recovery planning, which will include components for management of harvest and hatchery production, and conservation and restoration of freshwater and marine habitat.

In order to achieve recovery, the Harvest Management Plan adopts fundamental objectives and guiding principles. The Plan will:

- **Conserve the productivity, abundance, and diversity** of the populations that make up the Puget Sound ESU.

- **Manage risk.** The development and implementation of the fishery mortality limits in this Plan incorporate measures to manage the risks, and compensate for the uncertainty associated with estimating current and future abundance and productivity of populations. In addition, the 'management error' associated with forecasting abundance and the impacts of a given harvest regime is built into simulating the long-term dynamics of individual populations. Furthermore, the Plan commits the co-managers to ongoing monitoring, research, and analysis, to better quantify and determine the significance of risk factors, and to modify the Plan as necessary to minimize such risks.

- **Meet ESA jeopardy standards**. The ESA standard, as interpreted by the NMFS, is that activities, such as harvest regulated by this Plan, may be exempted from the prohibition of take, prescribed in Section 9, only if they do not "appreciably reduce the likelihood of survival and recovery" of the ESU (50 CFR 223 vol 65(1):173). This Plan meets that standard, not just for the ESU as a whole, but in several respects sets a more rigorous standard for conserving the abundance, diversity, and productivity of each component population of natural chinook within the ESU.

- **Provide opportunity to harvest surplus production from other species and populations.** This Plan provides for continued harvest of sockeye, pink, and coho salmon, as well as the abundant hatchery production of chinook from Puget Sound and the Columbia River This Plan eliminates directed fisheries on depressed Puget Sound chinook but permits incidental catch of these runs in fisheries aimed at other runs with harvestable surpluses. The level of incidental catch is constrained by specific conservative exploitation rate ceilings or other management objectives.

- **Account for all sources of fishery-related mortality**, whether landed or non-landed, incidental or directed, commercial or recreational, and occurring in the U.S. (including Alaska) or Canada, when assessing total exploitation rates.

- **Adhere to the principles of the Puget Sound Salmon Management Plan** (PSSMP), and other legal mandates pursuant to *U.S. v. Washington* (384 F. Supp. 312 (W.D. Wash. 1974), and *U.S. v Oregon*, to ensure equitable sharing of harvest opportunity among tribes, and among treaty and non-treaty fishers.

- **Achieve the guidelines on allocation of harvest benefits and conservation objectives that are defined in the 1999 Chinook Chapter of Annex IV to the Pacific Salmon Treaty.**

- **Ensure exercise of Indian treaty rights**. Indian fishing rights were established by treaties, and further defined by federal courts in *U.S. v Washington.* The exercise of fishing rights by individual tribes is limited to 'usual and accustomed' areas, according to their historical use of salmon resources.

This Harvest Plan affects, primarily, management of Treaty Indian and non-Indian commercial and recreational salmon fisheries in Puget Sound, including net fisheries directed at steelhead. The geographic scope of the Plan encompasses fishing areas south of the Canadian border in the Strait of Juan de Fuca (east of Cape Flattery), and Georgia Strait. The Secretary of Commerce, through the Pacific Fisheries Management Council, is responsible for management of ocean salmon fisheries (i.e. troll and recreational) along the Oregon / Washington coast (i.e. in Areas 1 – 4B, from May through September). As participants in the PFMC / North of Falcon processes, the Washington co-managers consider the impacts of these ocean fisheries on Puget Sound chinook, and may modify them to achieve management objectives for Puget Sound chinook (PSSMP Section 1.3). Fisheries mortality in Alaska, Oregon, and British Columbia is also accounted in order to assess, as accurately as possible, total fishing mortality of Puget Sound chinook. Mortality of Puget Sound chinook in other Washington commercial and recreational fisheries, e.g. those directed at rockfish, halibut, shellfish, or trout, is not directly accounted.

Natural chinook abundance and productivity in Puget Sound is generally depressed, and for some populations, at critically low levels. Therefore, harvest of these populations must be limited, as part of a comprehensive recovery plan that addresses impacts from harvest, hatchery practices, and degraded habitat. Managing salmon fisheries in Washington to achieve this low impact on Puget Sound natural populations requires accounting of all sources of fishery-related mortality in all fisheries. This is not a trivial task since directed, incidental, and non-landed mortality must all be taken into account, and since Puget Sound chinook salmon are affected by fisheries in a large geographical area extending from southeast Alaska to the Oregon coast. However, since the 1980s research has focused on assessing fishing mortality across the entire range of Puget Sound chinook, so a large body of data and sophisticated computer models are available to quantify harvest rates and catch distribution.

The management regime will be guided by the principles of the Puget Sound Salmon Management Plan (PSSMP), and other legal mandates pursuant to *U.S. v. Washington* (384 F. Supp. 312 (W.D. Wash. 1974), and *U.S. v Oregon*, in equitable sharing of harvest opportunity among tribes, and among treaty and non-treaty fishers. The PSSMP is the framework for planning and managing harvest so that treaty rights will be upheld and equitable sharing of harvest opportunity and benefits are realized. The fishing rights of individual tribes are geographically limited to 'usual and accustomed' areas that were specifically described by subproceedings of *U.S. v. Washington*. This Plan is based on the principles of the PSSMP that assure that the rights of all tribes are addressed. Allocation of the non-Indian share of harvest among commercial and recreational users is decided by the policy of the Washington Department of Fish and Wildlife.

The 1999 Chinook Chapter to Annex IV of the Pacific Salmon Treaty also limits harvest in many of the fisheries that impact Puget Sound chinook. The abundance-based chinook management framework contained in the Chapter applies fishery-specific constraints to achieve reduced harvest rates when escapement goals for indicator stocks are not achieved (see section V.B.1). This Plan states how the annual fishing regime developed by the co-managers will comply with the PST agreement. Nearly all of the fisheries implemented under this Plan will be directed at the harvest of species other than chinook or directed at strong chinook runs from other regions or strong hatchery chinook runs from Puget Sound. Therefore, nearly all of the anticipated harvest-related mortality to natural Puget Sound chinook will be incidental to fisheries directed at other stocks or species. Consequently, a wide range of management plans and agreements had to be taken into account in developing this plan.

Harvest-related mortality must be assessed in the context of other constraints on chinook survival. Non-harvest mortality is several orders of magnitude greater than the impact of harvest. If an adult female lays 5,000 eggs, and only two to six of those survive to adulthood, the non-harvest mortality rate exceeds 99.9%. Consequently, a small increase in the rate of survival to adulthood has a much greater effect on abundance than reduction of harvest. Increasing productivity, i.e. the recruitment per female spawner, is essential to recovery. Listing of the Puget Sound ESU has engendered a broad effort, shared by federal, tribal, state, and local governments and the private sector, to protect and restore habitat. Therefore, harvest must be managed so as not to impede recovery, if the capacity and productivity of habitat increases

This Plan sets limits on annual fishery-related mortality for each Puget Sound chinook management unit. The limits are expressed either as exploitation rate ceilings, which are the maximum fraction of the total abundance that can be subjected to fishery-related mortality, or natural escapement thresholds, which trigger additional fishery conservation measures Exploitation rate ceilings for complex management units, comprised of more than one populations, were based, to the extent possible, on estimates of productivity for each component. Implementing this Plan requires assessing the effects of fisheries (i.e. the resulting escapement) for individual populations.

The Plan asserts a specific role for harvest management in rebuilding the Puget Sound ESU and its population components. Implementing the Plan will enable attainment of optimum (MSH) escapement for some populations, but for most populations constraint of harvest can only assure that escapement will remain stable and enable the population to persist. Moreover, constraint of harvest will provide increased escapement to take advantage of any increased productivity or capacity, should favorable conditions more favorable to survival occur. However, for a small number of critically depressed populations, harvest constraint cannot assure persistence, though extraordinary measures will be implemented to avoid increasing the risk of their extinction. Specific attention is paid to the projected escapement of all individual populations during annual fishery planning, and harvest restrictions applied where necessary to protect all populations. However, recovery of Puget Sound population depends on improving productivity (i.e., the capacity of freshwater and estuarine habitat, and the survival of embryonic and juvenile chinook in that habitat). Reducing harvest has no effect on productivity, except when such constraint may prevent escapement from falling to the point of biological instability.

The development and implementation of the fishery mortality limits in this Plan incorporate measures to manage the risks and compensate for the uncertainty associated with quantifying the abundance and productivity of populations, where the information is available for such assessment. In addition, the 'management error' associated with forecasting abundance and estimating the impacts of a given harvest regime is built into the simulation of the future dynamics of individual populations, which is the basis for selecting exploitation rate objectives for some units. Furthermore, the Plan commits the co-managers to ongoing monitoring, research and analysis, to better quantify and determine the significance of risk factors, and to modify the Plan as necessary to minimize such risks.

The 2001 and 2003 versions of the Plan (PSIT and WDFW 2001; PSIT and WDFW 2003) responded to the conservation standards of Section 4(d) of the Endangered Species Act (ESA), after Puget Sound chinook were listed as threatened. However, management objectives and tools have been evolving since the early 1990s in response to the declining status of Puget Sound stocks. Concern over the declining status of Puget Sound and Columbia River chinook has motivated conservation initiatives in the arena of the Pacific Salmon Treaty, and of the Pacific Fisheries Management Council (PFMC). Efforts continue within these forums to address the current status of Puget Sound chinook. This Plan as well will continue to evolve as necessary to address changing management requirements and the needs of this fishery resource.

The ESA conservation standard, as implemented by the NMFS in the salmon 4(d) rule, is that activities that involve take of listed chinook, such as harvest regulated by this plan, may be exempted from the prohibition of take, prescribed in Section 9, if they do not "appreciably reduce the likelihood of survival and recovery" (50 CFR 223 vol 65(1):173) of the ESU. This Plan meets that standard, and in several respects sets more rigorous standards for conserving the abundance, diversity and geographic distribution of Puget Sound chinook.

2. Population Structure – Aggregation for Management

This section describes the population structure of the Puget Sound chinook ESU, and how populations of similar run timing are aggregated for the purposes of harvest management in some river systems.

2.1 Population Structure

Puget Sound chinook comprise an evolutionarily distinct unit (ESU) defined by the geographic distribution of their freshwater life stages, life history, and genetic characteristics (Myers et al. 1998). This ESU includes many independent populations. The central intent of this Plan is to manage fishery-related risk, in order to conserve genetic and ecological diversity throughout the ESU, and to apply this standard to all its composite populations. The Chinook Status Review (Myers et al. 1998) designated the ESU to include populations originating from river basins beginning at the Elwha River, in the Strait of Juan de Fuca, continuing east and south through Puget Sound, and north to the Nooksack River. This Plan also includes chinook originating in the Hoko River, in the western Strait of Juan de Fuca.

Puget Sound chinook populations are classified, according to their migration timing, as spring, summer, or fall chinook, but specific return timing toward their natal streams, entry into freshwater, and spawning period varies significantly within each of these 'races'. Run timing is an adaptive trait that has evolved in response to specific environmental and habitat conditions in each watershed. Fall chinook are native to, or produced naturally, in the majority of systems, including the Hoko, lower Skagit, Snohomish, Cedar, Green, Puyallup, Nisqually, Skokomish, and mid-Hood Canal rivers, and in tributaries to northern Lake Washington. Summer runs originate in the Elwha, Dungeness, upper Skagit, lower Sauk, Stillaguamish, and Skykomish rivers. Spring (or 'early') chinook are produced in the South and North Forks of the Nooksack River, the upper Sauk River, Suiattle River, and Cascade River in the Skagit basin, and the White River in the Puyallup basin.

Puget Sound chinook populations were formerly identified in the Salmon and Steelhead Stock Inventory (WDF et al. 1993); the 2001 Harvest Plan was generally based on the SASSI designation. This Plan conforms with the Puget Sound Technical Recovery Team's (TRT) more recent population delineation (Ruckelshaus et al. 2004) that was developed as part of recovery planning. The Plan omits some populations that were included in the SASSI, either because recent assessment concludes that they are extinct, or that they exist only due to artificial production in the drainage, or as strays from other natural populations or hatchery programs. These include fall chinook in the Samish River, Gorst Creek and other streams draining into Sinclair Inlet, White River, Deschutes River, and several independent tributaries in South Puget Sound, which are only present due to local hatchery programs. Spring chinook in the Snohomish, Nisqually, Skokomish, and Elwha systems are extinct; spring chinook are no longer produced at Quilcene National Fish Hatchery.

The freshwater life history of most Puget Sound chinook populations primarily involves short freshwater ('ocean-type') residence following emergence (i.e. juvenile fish transform into smolts and emigrate to the marine environment during their first year). A small (less than 5 percent) proportion of juvenile fall chinook, and a larger and variable proportion of juvenile spring and summer chinook in some systems rear in freshwater for 12 to 18 months before emigrating, but expression of this 'stream-type' life history is believed to be influenced more by environmental factors than genotype (Myers et al. 1998).

The oceanic migration of Puget Sound chinook typically extends up from the Washington coast as far north as southeast Alaska, with a large, for some stocks a majority, of their harvest taken in the southern waters of British Columbia. Adult chinook generally become sexually mature at the age of three to six years, although a small proportion of males ('jacks') may mature precociously, at age-two. Most Puget Sound chinook mature at age-3 or age-4.

Freshwater life history and maturation rates for Puget Sound chinook populations were reviewed extensively in the Status Review (Myers et al. 1998).

Puget Sound chinook are genetically distinct and uniquely adapted to the local freshwater and marine environments of this region. Retention of their unique characteristics depends on maintaining healthy and diverse populations. A central objective of the Plan is to assure that the abundance of each population is conserved, at a level sufficient to protect its genetic integrity.

The most recent allozyme-based analysis of the genetic structure of the Puget Sound ESU indicates six distinct population aggregates – North and South Fork Nooksack River early, Skagit / Stillaguamish / Snohomish rivers, south Puget Sound and Hood Canal summer / falls, White River springs, and Elwha River (Ruckelshaus et al. 2004). Adult returns to South Sound and Hood Canal are influenced by large-scale hatchery production that utilized common original broodstock (primarily from the Green River), so their apparent genetic similarity may not have been true of indigenous populations. However analysis of samples collected from 33 spawning sites indicate that, with few exceptions, allele frequencies are significantly different, and that spatial or temporal isolation of spawning populations has maintained genetic distinctiveness, even among similar-timed populations within a watershed.

Life history traits were also useful in delineating natural population structure within Puget Sound. In order to determine the current population structure, the TRT (Ruckelshaus et al. 2004) examined juvenile freshwater life history, age of maturation, spawn timing, and physiographic characteristics of watersheds. Chinook also spawn naturally in other areas that may or may not have supported self-sustaining populations historically. Occurrence in these areas is thought be a consequence of straying from nearby natural systems or returns from hatchery programs. The most notable examples are in South Puget Sound, e.g. streams draining into Sinclair Inlet, and the Deschutes River entering Budd Inlet.

2.2 Management Units

A population is a biological unit. A management unit, in contrast, is an operational unit, whose boundaries depend on the fisheries acting on that unit. Salmon management units can range in size from something as large as the West Coast Vancouver Island (WCVI) coho run, which was managed as one unit in the WCVI troll fishery, to something as small as the males that return to a particular hatchery release site.

Prior to the conclusion of *U.S. v Washington* in 1974, almost all fisheries on Puget Sound salmon were conducted in marine waters, with no explicit management units or escapement goals. The Boldt Decision, however, encouraged the development of significant tribal fisheries at the mouths of Puget Sound rivers, and required the development of spawning escapement goals for each management unit. This left the co-managers (and the court) with the task of defining what the management units would be. It was now possible, with significant fisheries at the mouths of rivers, to manage for separate escapement goals for units returning to areas as small as a separate river system. However, unless there were differences in run timing between groups of fish, it was not possible to manage separately for finer units without perpetually wasting large numbers of harvestable fish. Therefore, the court-ordered PSSMP prescribed that management units would not be established for units smaller than a system that flows into saltwater, unless component populations exhibit a difference in migration timing, or as otherwise agreed by the co-managers. With this understanding, the co-managers defined the natural chinook management units in Puget Sound (Table 2), conforming, with the exception of the Mid-Hood Canal unit, to the TRT population delineation. The default escapement goal for these natural management units was maximum sustained harvest (MSH) escapement.

Table 2. Management units for natural chinook in Puget Sound.

Management Unit	Component Populations (category)
Nooksack Early	North Fork Nooksack River (1 South Fork Nooksack River (1)
Skagit Summer / Fall	Upper Skagit River Summer (1) Lower Sauk River Summer (1) Lower Skagit River Fall (1)
Skagit Spring	Upper Sauk River (1) Siuattle River (1) Upper Cascade River (1)
Stillaguamish	North Fork Stillaguamish River Summer (1) South Fork & mainstem Stillaguamish River Fall (1)
Snohomish	Skykomish River Summer (1) Snoqualmie River Fall (1)
Lake Washington	Cedar River Fall (1) North Lake Washington Tributaries Fall (2)
Green	Green River Fall (1)
White	White River Spring (1)
Puyallup	Puyallup River Fall (2)
Nisqually	Nisqually River Fall (2)
Skokomish	North and South Fork Skokomish River Fall (2)
Mid-Hood Canal [1]	Hamma Hamma River Fall (2) Duckabush River Fall (2) Dosewallips River Fall (2)
Dungeness	Dungeness River Summer (1)
Elwha	Elwha River Summer (1)
Western Strait of Juan de Fuca [2]	Hoko River Fall (1)

[1] The three rivers comprise one population.
[2] The western Strait of Juan de Fuca management unit is not part of the listed Puget Sound ESU.

For the next several years, management units were the smallest units considered in management of fisheries in Puget Sound. Then, in the early 1990s, the co-managers undertook the Wild Salmonid Restoration Initiative. As part of this initiative, they published a list, known as SASSI, of all the identified or hypothesized separate salmon populations in Washington, and their status. For chinook, some of these populations were the same as the existing management units, and some were smaller components of management units. Guided by this list, the co-managers then developed a Wild Salmonid Policy (WDFW et al. 1997), which was intended to review and revise as necessary the existing management objectives. Although the Wild Salmonid Policy was not adopted by all the tribes, there was agreement to accept the genetic diversity performance standard:

"*No stocks will go extinct as a result of human impacts, except in the unique circumstance where exotic species or stocks may be removed as part of a specific genetic or ecological conservation plan*."

Of the 15 management units covered in this Plan (Table 2), six contain more than one population. The other nine management units each consist of one population This Plan includes management measures intended to conserve the viability of all populations (see Chapter 6, and the management unit profiles for Skagit, Stillaguamish, and Snohomish in Appendix A). . This significant change in management means that management units are no longer the smallest units considered in management of Puget Sound fisheries. It does *not* mean that separate populations must be managed for the same objective as the management units (i.e., MSH escapement). It means that each separate population is managed to avoid its extinction.

The availability and quality of data to inform management of individual populations varies widely. For some populations, the only directly applicable data are spawning escapement estimates. In such cases, estimates of migratory pathways, entry patterns, age composition and maturation trends, age at recruitment, catch distribution and contributions must be inferred from the most closely related population for which such information is available. Obtaining the information to test and evaluate these inferences and assumptions is one of the key data needs identified in Chapter 7 of this Plan.

This Plan includes specific conservation measures for all populations within management units. However, it does not require that fisheries be managed to achieve the same objectives for each component population within a management unit (e.g., MSH escapement).

3. Status of Management Units and Derivation of Exploitation Rate Ceilings.

In this Plan, each management unit is classified according to its category and its abundance. The category determines the priority placed on recovery of that unit; the abundance determines the allowable harvest, depending on the category.

3.1 Management Unit Categories

The co-managers' Comprehensive Management Plan for Puget Sound chinook categorizes management units according to the presence of naturally produced, indigenous populations, the proportional contribution of artificial production, and the origin of hatchery broodstock.

- Category 1 units consist of native stocks that are predominantly naturally produced, or enhanced to a greater or lesser extent by hatchery programs that rear indigenous chinook.

- Category 2 units are predominantly of hatchery origin, in some cases comprised of non-indigenous broodstock, but where remnant indigenous populations may still exist, and where the habitat is capable of supporting self-sustaining natural production.

- Category 3 units are designated where production occurs only because of returns to a hatchery program, or due to straying from adjacent natural populations or hatchery programs. This Plan does not state harvest objectives for Category III units.

Conservation of Category 1 populations is the first priority of this plan, because they comprise genetically and ecologically essential and unique components of the ESU. The harvest management objectives for these units are set such that their recovery is not impeded, and the risk of decline in their status is very low. They include populations in the Nooksack, Skagit, Stillaguamish, Snohomish, Cedar, Green, White, Dungeness, Elwha, and Hoko rivers (Table 2). Hatchery supplementation is considered to be essential to protecting the genetic and demographic integrity of populations in the Nooksack, Stillaguamish, White, Dungeness, and Elwha rivers. Hatchery production in these systems is included in the ESA listing, because it deems essential to the recovery of the ESU (NMFS 1999).

Natural populations in the North Lake Washington tributaries, and the Puyallup, Nisqually, Skokomish, and mid-Hood Canal rivers have been heavily influenced by artificial production, in most cases based on non-indigenous stocks, and are, therefore, Category 2 management units. This influence persists, even in cases where artificial production may have been redesigned, scaled down, or terminated. Some Puget Sound stocks, most notably from the Green River, have been disseminated into several of these systems, and into the Snohomish system.

Past hatchery programs, frequently using non-indigenous stocks, were managed without informed consideration of the risk to indigenous populations, particularly when viewed in the light of current understanding of the ecological and genetic interactions of natural and hatchery production. Their primary goal was to enhance fisheries. Hatchery production was seen as a solution to increasing demand for fishing opportunity, particularly following the resolution of *U.S. v. Washington*, and the rapid urban growth around Puget Sound. This approach was also perceived to mitigate for severe and continuing habitat losses, including those from hydropower development, irrigation and other withdrawals, agricultural and forest practices, to name a few.

The policy intent was to fully utilize this increased hatchery production, and manage harvest primarily to achieve sufficient escapement to meet the broodstock requirements of the hatchery programs. The potential for restoring natural production in these systems was low, because of degraded habitat. The resulting high exploitation rates were not sustainable by the native, natural chinook populations.

This Plan emphasizes conservation of Category 2 populations, in order to assure their continued viability. In some cases, large-scale hatchery enhancement programs operate in these systems, and hatchery returns contribute significantly to natural spawning. There is continued focus on quantifying the capacity of habitat in these rivers, and the current productivity of naturally spawning chinook. Until the results of these studies are credible, constraint of harvest will assure stable natural escapement, and in some cases provide variable increasing escapement in excess of the interim escapement goals. Where hatchery programs have been implemented specifically as mitigation for habitat loss, e.g. in the Nisqually River and Skokomish River, where habitat loss has resulted in greatly reduced fishing opportunity, harvest may take priority over increasing escapement beyond the level of assuring persistence, until the capacity of habitat is clearly defined, or functional habitat is restored. Assuring the viability of all these populations now preserves future options to manage for higher natural-origin production later, should those populations be deemed essential to a recovered ESU.

Specific harvest objectives have not been established for Category 3 populations in this Plan, so their status is not discussed here in detail. Hatchery programs have been established on systems where there is no evidence of historical native chinook production. In these areas, terminal harvest is frequently managed to remove a very high proportion of the returning chinook, in excess of the broodstock required to perpetuate the program. However, if the harvest falls short of this objective, excess adults may spawn naturally, or be intentionally passed above barriers to utilize otherwise inaccessible spawning areas. Straying into adjacent streams is also likely under this condition. While some natural production may occur in these systems, the available habitat is not suitable to enable sustained production without the continued infusion of hatchery returns or strays.

3.2 Abundance Designations

This Plan classifies Puget Sound chinook management units into two abundance classifications: those that usually have harvestable surpluses, and those that usually don't. For those units without harvestable surpluses, the management units and their component populations are further classified by whether their abundance exceeds or is lower than their low abundance threshold. These abundance classifications are used to set the maximum allowable fishery-related mortality (see Implementation – Chapter 5).

3.2.1 Abundances with Harvestable Surpluses

The co-managers will establish an upper escapement level (hereafter, the ‘upper management threshold’), as the threshold for determining whether a MU has harvestable surplus. Consistent with the PSSMP, this threshold will be the escapement level associated with optimum productivity (i.e. maximum sustainable harvest (MSH), unless a different level is agreed to. After factoring in expected Alaskan catches, Canadian catches, and incidental, test, and ceremonial and subsistence catches in southern U.S. fisheries, if an MU is expected to have a spawning escapement greater than the upper management threshold, that MU will be classified as having harvestable surplus

Derivation of Upper Management Thresholds

The upper management threshold was calculated for some MUs (Skagit summer - fall, Skagit spring, Stillaguamish, and Snohomish) under current habitat conditions. The method used to calculate current productivity depends on the data available for that MU. Some MUs have data on spawning escapement, juvenile production, habitat measurements, CWT distribution, and adult recruitment; other units may have data only on escapement and terminal run size; and other units may have only index escapement counts and terminal area catches. The method used for each MU is described in its Management Unit Profile (Appendix A). Once the current productivity and capacity are calculated, the upper management threshold, depending on how it is defined, can be estimated from such methods as standard spawner-recruit calculations (Ricker 1975), empirical observations of relative escapement levels and catches, or Monte Carlo simulations that buffer for error and variability (Hayman 2003).

For other MUs, the upper management threshold was set as the current escapement goal. In some cases this level is the best available estimate of current MSH escapement. In other cases (e.g. Nooksack, Puyallup, Nisqually, Skokomish, Mid Hood Canal, and Dungeness) the current escapement goal is substantially higher than current MSH level, according to habitat-based analysis of current productivity.

Establishing the current MSH escapement level, or a buffered surrogate, as the upper management threshold is a conservative standard that assigns harvest management its rightful share of the burden of conservation, assures long-term increases in abundance, and does not impede recovery. As habitat conditions improve, this threshold can be increased to account for increased productivity or capacity (see Chapter 7, Plan Review).

3.2.2 Abundances With No Harvestable Surpluses

A MU that is projected to have a spawning escapement below its upper management threshold lacks harvestable surplus. Under this plan, no commercial or sport fisheries in Puget Sound can be conducted that target on MUs without harvestable surplus (see Application to Management section). Moreover, incidental impacts on each MU must be less than the specified ceiling rebuilding exploitation rate (RER). This ceiling is further reduced if the abundance of any MU, or a component population of a MU, is below a specified low abundance threshold (LAT).

Derivation of Rebuilding Exploitation Rates

Rebuilding exploitation rates were established for the Skagit summer / fall, Skagit spring, Stillaguamish, and Snohomish management units after simulating the future dynamic abundance of each unit under a range of exploitation rates. The RER is the highest exploitation rate that met the most restrictive of the following risk criteria:

- A very low probability (less than five percentage points higher than under zero harvest) of abundance declining to a calculated point of instability; and either

- A high probability (at least 80%) of the spawning escapement increasing to a specified threshold (see MU Profiles in Appendix A for details), **or** the probability of escapements falling below this threshold level differs from a zero harvest regime by less than 10 percentage points.

The simulation models relied on detailed information about the current productivity of the populations in question, including estimates of annual spawning escapement, maturation rates, harvest-related mortality that enable reconstruction of historical cohort abundance, and variability in marine and freshwater survival. With initial escapement and annual exploitation rate specified, the simulation predicts recruitment, harvest mortality, and escapement, for 25 years, under variable marine and freshwater survival and management error typical of recent years. Management error includes the differences between anticipated and actual chinook catch, changes in the harvest distribution of contributing stocks, and error in forecasting abundance.

The essential data, and the methods used for derivation of the recruitment functions, upper and lower threshold values, and selection of the RER, for each of the four management units, are detailed in Appendix A.

Risk tolerance criteria were chosen subjectively, through joint technical cooperation by tribal, state, and federal biologists, as adequately conservative for depressed chinook populations; they were not specified as jeopardy standards in the NMFS' salmon 4(d) rule. Upper and lower escapement criteria were derived by various methods, which are detailed in Appendix A. The upper 'rebuilding escapement threshold' is not equivalent, for all management units, the upper management thresholds which defines harvestable abundance. The lower 'critical abundance threshold' is not equivalent to the low abundance threshold applied as an indicator of critical status for management purposes.

The simulations indicate that the conservative risk criteria will be met if actual annual target exploitation rates are at the level of the RER. However, this Plan envisions actual annual exploitation rates to be less than the RER, for some units by substantial margins (see Table 12, Chapter 6), so the actual probability of increasing abundance is expected to exceed the 80% / 10% criteria, and the actual probability of falling to the point of instability is expected to be less than 5% higher than under zero harvest.

For units without such data, the ceiling rates were set with reference to observed minimum rates, or harvest ceilings set by the Pacific Salmon Treaty (see Appendix A). For these management units, total or southern U.S. (SUS, i.e., due to Washington and Oregon fisheries) exploitation rate ceilings are generally established at the low level of the late 1990s, which resulted in stable or increasing spawning escapement. These ceilings are usually SUS exploitation rates between 10 and 20 percent. Since this Plan eliminates fisheries targeted at MUs without harvestable abundance, these ceilings allow the spawning escapements for these units to benefit from the recent reductions in Canadian and U.S. fisheries, in some cases providing terminal runs that exceed the upper management threshold.

Derivation of Low Abundance Thresholds

Demographic and genetic theory indicates that when the spawning abundance of a salmon population falls to a very low level, there is a significant increase in the risk of demographic instability, loss of genetic integrity, and extinction. This level, termed the point of biological instability, has not been quantified for all salmon populations, but genetic and demographic theory has drawn its boundaries (McIlhaney et al. 2000). At low spawner abundance, ecological and behavioral factors can cause a dramatic decline in productivity. Low spawner density can affect spawning success by reducing the opportunity for mate selection, or finding suitable mates. Depensatory predation can significantly reduce smolt production. However, the level at which these factors exert their effect will differ markedly between populations.

The low abundance threshold (LAT), which triggers extraordinary conservation measures in fisheries (Table 3), is set well above the point of instability, so that harvest mortality can be constrained, severely if necessary, to prevent populations from becoming unstable. The derivation of the LAT varied, according to the data available for each population. In some cases, the threshold was set at or above an historical low escapement from which the population rebounded (i.e. survivors from that low brood escapement produced a higher number of subsequent spawners). In other cases, where spawner-recruit and management error data were deemed sufficient, we calculated a threshold at which the probability of falling below the calculated point of instability was acceptably low. In other cases, where specific data were lacking, we used values from the literature that estimated minimum effective population sizes that would avoid demographic instability or loss of genetic integrity (e.g., Franklin 1980; Waples 1990; Lande 1995; McElhany et al. 2000).

For example, thresholds for Skagit summer and fall populations were calculated as the forecast escapement level for which there is a 95 percent probability that actual escapement will be above the point of instability (i.e., 5 percent of the replacement escapement level). This calculation accounted for the difference between forecast and actual escapement in recent years, and the variance around recruitment parameters. For the Stillaguamish management unit, escapement of 500 was identified as the low abundance threshold, because this level has resulted in recruitment rates of 2 – 5 adults per spawner. For other Puget Sound populations the low abundance threshold was set in accordance with the scientific literature, or more subjectively, at annual escapement of 200 to 1,000 (see Appendix A).

3.3 Response to Critical Status

This harvest Plan is designed to constrain fisheries impacts on all listed Puget Sound management units by eliminating all but a few fisheries directed at listed chinook. The only directed fisheries, defined as those where a majority of encounters are listed chinook, are a few tribal ceremonial and subsistence fisheries with small harvests, or terminal fisheries targeting management units with fixed escapement goals where harvestable surpluses have been identified. If abundance declines, and the spawning escapement for any population or management unit is projected to fall to or below its low abundance threshold, the co-managers will implement extraordinary restrictions on SUS fisheries to increase the spawning escapement above the low threshold, or reduce the SUS exploitation rate to or below a specified ceiling level.

This response results in a significant reduction in incidental impacts on listed chinook, but preserves minimal harvest access to surplus production of non-listed chinook, and other salmon species. The response to critical status describes exploitation rate ceilings and fisheries that provide minimally acceptable access to sockeye, pink, chum, coho, and chinook salmon for which harvestable surpluses have been identified.

This response to critical status is intended to prevent further decline in abundance, toward the point of biological instability. Restriction of harvest will not, by itself, enable recovery of populations that have suffered severe decline in abundance, resulting from loss and degradation of properly functioning chinook habitat conditions. Restriction of fishing below the level defined in this critical response would effectively eliminate treaty and non-treaty opportunity on non-listed species and populations, without ensuring recovery. If further resource protection is necessary, it must be found by reducing exploitation rates in mixed-stock fisheries north of Washington State in Canadian and Alaskan fisheries, improving habitat conditions, and/or providing artificial supplementation where necessary and appropriate.

Table 3. Rebuilding exploitation rates, low abundance thresholds and critical exploitation rate ceilings for Puget Sound chinook management units.

Management Unit	Rebuilding Exploitation Rate	Low Abundance Threshold	Critical Exploitation Rate Ceiling
Nooksack North Fork South Fork	Under development	 1,000 [1] 1,000 [1]	7% / 9% SUS [3]
Skagit summer / fall Upper Skagit summer Sauk summer Lower Skagit fall	50%	4,800 2200 400 900	15% SUS even-years 17% SUS odd-years
Skagit spring Upper Sauk Upper Cascade Suiattle	38%	576 130 170 170	18% SUS
Stillaguamish North Fork Summer South Fk & MS Fall	25%	650 [1] 500 [1] N/A	15% SUS
Snohomish Skykomish Snoqualmie	21%	2,800 [1] 521 [1] 1745 [1]	15% SUS
Lake Washington Cedar River	15% PT SUS	 200 [1]	12% PT SUS
Green	15% PT SUS	1,800	12% PT SUS
White River spring	20%	200	15% SUS
Puyallup fall	50%	500	12% PT SUS
Nisqually	Terminal fishery managed to achieve 1,100 natural spawners		
Skokomish	15% PT SUS	1,300 [2]	12% PT SUS
Mid-Hood Canal	15% PT SUS	400	12% PT SUS
Dungeness	10% SUS	500	6% SUS
Elwha	10% SUS	1,000	6% SUS
Western JDF	10% SUS	500	6% SUS

[1] natural-origin spawners.
[2] The threshold is escapement of 800 natural and/or 500 hatchery (see Appendix A).
[3] Expected SUS rate will not exceed 7% in 4 out of 5 years (see Appendix A)

The management response to critical status has two principal components:

1. A Critical Exploitation Rate Ceiling (CERC) is established for each management unit (Table 3), imposing an upper limit on SUS impacts when spawning escapement for that unit is projected to fall below its low abundance threshold. The CERCs are defined as total SUS ceiling exploitation rates for most management units. For the Lake Washington, Green, Puyallup, Nisqually, Mid Hood Canal and Skokomish units, the ceiling rates apply only to pre-terminal fisheries. For these units, additional terminal fishery management responses are detailed in the unit profiles (Appendix A). Except for Mid-Hood Canal, they are composite populations in that hatchery production contributes substantially to fisheries and natural spawning

The MFR, which is described in detail in Appendix C for fisheries in Puget Sound and Washington coastal ocean areas, provides for Treaty Indian and non-Indian harvest of the surplus abundance of non-listed chinook, and sockeye, pink, coho, and chum salmon.

The MFR represents the lowest level of fishing mortality on listed chinook that is possible, while still allowing a reasonable harvest of non-listed salmon. Reducing tribal fisheries to those specified in the MFR, while requiring significant sacrifice of fishing opportunity guaranteed by treaty rights, represent the minimum level of fishing that allows some exercise of those rights, and demonstrates their commitment to contribute, with concomitant and essential habitat protection and other recovery actions, to the recovery of Puget Sound chinook salmon to levels that would satisfy their treaty rights.

The co-managers established the CERCs, after policy consideration of the MFR, and examination of FRAM simulations of the recent fisheries regimes that responded to critical status for some management units. Exploitation rates associated with constant mortality in SUS fisheries will change, in part due to variation in the abundance of stocks from British Columbia, the Columbia River, and Puget Sound, and variation in intercepting fishing mortality exerted by fisheries in British Columbia and Alaska. The CERCs reflect this source of variation (i.e. they are, in some cases, higher than the SUS exploitation rates projected in recent years). Furthermore, if significant changes are made to the FRAM that alter the calculation of exploitation rates, these ceilings may be adjusted in consultation with the NMFS.

2. Within the constraint established by the CERCs, southern U.S. fisheries will be limited so that their impact on critical management units does not exceed the levels projected to occur with the 2003 fisheries (see Implementation, below). The CERCs, thus, impose a hard ceiling on SUS exploitation rates, but annual fishing plans are likely to result in impacts that fall below the CERC for some critical units. New fisheries, beyond those planned for 2003, will not be implemented with the intention of increasing impacts on critical units, unless other fisheries are shaped to reduce fishing mortality on those units to an equivalent degree.

4. The Fisheries and Jurisdictions

Puget Sound chinook contribute to fisheries along the coast of British Columbia and Alaska, in addition to those in the coastal waters of Washington and Puget Sound. Their management, therefore, involves the local jurisdictions of the Washington co-managers, and the jurisdictions of the State of Alaska, the Canadian Department of Fisheries and Oceans, the Pacific Salmon Commission, and the Pacific Fisheries Management Council.

4.1 Southeast Alaskan Fisheries

In Southeast Alaska (SEAK) chinook are harvested in commercial, subsistence, personal use, and recreational fisheries throughout Southeast Alaska. Since 1995, the total landed chinook catch has ranged from 217,000 to 339,000 (Table 4). These fisheries are managed by the Alaska Board of Fisheries and the Department of Fish and Game, under oversight of the North Pacific Fisheries Management Council to ensure consistency of fisheries management objectives with the Sustainable Fisheries Act (1996).

Commercial fisheries employ troll, gillnet, and purse seine gear. Commercial trolling accounts for about 68% of the chinook harvest (NMFS 2002). Approximately 6% of the catch of chinook and coho is taken outside of State waters, in the Economic Exclusive Zone (EEZ). The majority of troll catch occurs during the summer season; but 'winter' and 'spring' troll seasons are also scheduled from October through April. The summer season usually opens on July 1st, targeting chinook, then shifts to a coho-directed fishery in August. Incidental harvest of pink, chum, and sockeye salmon also occurs in the troll fishery. Gillnet and seine fisheries occur within State waters, and target pink, sockeye, and chum salmon, with substantial incidental catch of coho, and relatively low incidental catch of chinook.

Table 4. Chinook salmon harvest, all fisheries combined, in Southeast Alaska, 1998 – 2002 (PSC 2001, PSC 2002).

1998	271,000
1999	251,000
2000	263,300
2001	260,000
2002	442,200

Recreational fishing in Southeast Alaska, in recent years, has comprised more than 500,000 angler days annually. It occurs primarily in June, July, and August. A majority of the effort is associated with non-resident fishers, and is targeted at chinook salmon. Fishing is concentrated in the vicinity of the major populations centers; Ketchikan, Petersburg, Sitka, and Juneau, but it also occurs along the coast of Prince of Wales Island and other remote areas. Fishing in the vicinity of Sitka accounts for 47% of the recreational chinook harvest (Jones and Stokes 1991).

Chinook from the Columbia River, Oregon coast, Washington coast, west coast of Vancouver Island (WCVI), and northern B.C. contribute significantly to harvest in Southeast Alaska (CTC 2003). Few Puget Sound chinook are caught in Alaska, except for Strait of Juan de Fuca stocks, which have significant exploitation rates in Southeast Alaska (up to 30% of the catch of Elwha, and, in some years, over 50% of the catch of Hoko chinook). Also, in some years, between 5%

and 10% of the catch of Stillaguamish chinook has been taken in Southeast Alaska (Chinook TC 1999).

More than 3,000 subsistence and personal use permits were issued in Southeast Alaska in 1996 (NMFS 2002), but only a small proportion of the subsistence harvest of salmon (33,000 in 1996) is made up of chinook.

4.2 Fisheries in British Columbia

In British Columbia, troll fisheries occur on the northern coast and on the WCVI. Conservation concerns over WCVI and Fraser River chinook and coho stocks have constrained these fisheries in recent years. Commercial and test troll fisheries directed at pink salmon in northern areas, and sockeye on the WCVI and the southern Strait of Georgia incur relatively low incidental chinook mortality. Time / area restrictions, and selective gear regulations have been implemented to reduce the harvest of weak chinook and coho stocks.

Net fisheries, including gillnet and purse seine gear, in British Columbia marine inshore waters are primarily directed at sockeye, pink, and chum salmon, but also incur incidental chinook mortality. Conservation measures have limited chinook retention in many areas. Chinook catch in the Northern B.C. and WCVI troll fisheries increased markedly in 2002 (Table 5).

Table 5. Landed chinook harvest in British Columbia inshore marine fisheries in 2001 and 2002 (CDFO 2001, CDFO 2002).

	2001	2002
Northern BC troll	13,100	94,748
WCVI troll	77,000	133,693
Georgia Strait troll	485	369
Northern BC net	22,035	11,041
Central BC net	4,589	4,827
Native North and Central	7,231	5,379
Johnstone Strait net	1,000	1,025
WCVI outside sport	36,000	22,009
QCI & North coast sport	38,500	41,300
Central coast sport	7,736	6,305
JDF, GS, JS sport	57,526	84,426
Total	265,202	404,753

Recreational harvest of chinook in the Queen Charlotte Islands and on the WCVI have been similarly constrained by time / area and size regulations to conserve weak chinook stocks. Nearshore waters along the entire WCVI were closed to salmon fishing in 1999 – 2001 (CDFO 2000; CDFO 2001). Limited recreational fisheries have been implemented in the 'inside' waters of the WCVI (e.g. in Nootka Sound, Esperanza Inlet, and Tlupana Inlet). Marine recreational fisheries occur along the Central B.C. coast, Johnstone Strait, Georgia Strait, and the Strait of Juan de Fuca. Sport fisheries in inshore marine areas comprise the largest portion of the chinook harvest in southern B.C.

Fisheries in northern B.C. target local stocks, but chinook from the Columbia River, Washington and Oregon coasts, Georgia Strait, and the WCVI are also caught (CTC 2001). Puget Sound chinook make up a minor portion of the catch, but a significant portion of the mortality of North Sound and Strait of Juan de Fuca spring and summer/fall chinook can occur in these fisheries (see Catch Distribution, below). WCVI fisheries, which target on Columbia River, Puget Sound, and Georgia Strait stocks, have a major impact on all Puget Sound summer/fall stocks, with a lower, but significant impact on springs. Georgia Strait fisheries target on Georgia Strait and Puget Sound chinook, and have heavy impacts on North Sound springs, North Sound summer/falls, and Hood Canal summer/falls, and significant, but lower impacts on all other Puget Sound stocks (Chinook TC 1999).

4.3 Washington Ocean Fisheries

Treaty Indian and non-treaty commercial troll fisheries directed at chinook, coho, and pink salmon, and recreational fisheries directed at chinook and coho salmon are scheduled from May through September, under co-management by the WDFW and Treaty Tribes. The Pacific Fisheries Management Council (PFMC), pursuant to the Sustainable Fisheries Act (1996), oversees annual fishing regimes. Tribal fleets operate within the confines of their usual and accustomed fishing areas. Principles governing the co-management objectives and the allocation of harvest benefits among tribal and non-Indian users, for each river of origin, were developed under *Hoh v Baldrige* (522 F.Supp. 683 (1981)). The declining status of Columbia River origin chinook stocks has been the primary constraint on coastal fisheries, though consideration is also given to attaining allocation objectives for troll, terminal net, and recreational harvest of coastal-origin stocks from the Quillayute, Queets, Quinault, Hoh, and Grays Harbor systems. These fisheries primarily target Columbia River chinook (Chinook Technical Committee 2001). Puget Sound chinook make up a low percentage of the catch, with South Sound and Hood Canal stocks exploited at a slightly higher rate than North Sound and Strait of Juan de Fuca chinook.

The ocean troll fishery (Table 6) has been structured, in recent years, as chinook-directed fishing in May and June, and chinook- and coho-directed fishing from July into mid-September, to enable full utilization of Treaty and non-Treaty chinook and coho quotas. These quotas (i.e. catch ceilings) are developed in a pre-season planning process that considers harvest impacts on all contributing stocks. Time, area, and gear restrictions are implemented to selectively harvest the target species and stock groups. In general, the chinook harvest occurs 10 to 40 miles offshore, whereas the coho fishery occurs within 10 miles off the coast, but annual variations in the distribution of the target species cause this pattern to vary. The majority of the chinook catch has, in recent years, been caught in Areas 3 and 4 (which, during the summer, includes the westernmost areas of the Strait of Juan de Fuca – Areas 4B). In the last five years, troll catch has ranged from 18,000 to 93,000 (Table 6).

Table 6. Commercial troll and recreational landed catch of chinook in Washington Areas 1 – 4, 1998 – 2002 (Simmons et al. 2002).

	Treaty Troll	Non-Treaty troll	Recreational	Total
1998	14,859	5,929	2,187	22,975
1999	27,664	17,456	9,887	55,007
2000	7,770	10,269	8,478	26,517
2001	28,100	21,229	22,974	72,303
2002	39,184	53,819	57,821	150,824

In odd-numbered years, the coastal troll fishery may also target pink salmon, the majority of which originate in the Fraser River. In the last six odd-numbered years, the annual troll harvest of pink salmon has ranged from 1,800 to 48,300.

Recreational fisheries, in Washington Ocean areas, are also conducted under specific quotas for each species, and allocations to each catch area. WDFW conducts creel surveys at each port to estimate catch and keep fishing impacts within the overall quotas. Most of the recreational effort occurs in Areas 1 and 2, adjacent to Ilwaco and Westport. Generally recreational regulations are not species directed, but certain time / area strata have had chinook non-retention imposed, as conservation concerns have increased, and to enable continued opportunity based on more abundant coho stocks. In the last five years, recreational chinook catch in Areas 1 – 4 has ranged from 2,187 to 53,819 (Table 3).

Puget Sound chinook stocks comprise less than 10 percent of coastal troll and sport catch (see below for more detailed discussion of the catch distribution of specific populations). The contribution of Puget Sound stocks is higher in northern areas, along the coast. The exploitation rate of most individual chinook management units in these coastal fisheries is, in most years, less than one percent. However, these exploitation rates vary annually in response to the varying abundance of commingled Columbia River, local coastal, and Canadian chinook stocks.

Amendment 14 to the PFMC Framework Management Plan restricts the direct oversight of conservation to those chinook stocks whose exploitation rate in fisheries under the jurisdiction of the PFMC (i.e., coastal ocean fisheries between the borders of Mexico and British Columbia, including Washington catch areas 1 – 4) have exceeded two percent, in a specified base period. However, the PFMC must also align its harvest objectives with conservation standards required for salmon ESUs, listed under the Endangered Species Act. Additionally, this Plan, along with the Puget Sound Salmon Management Plan, commits the co-managers to explicit consideration of coastal fishery impacts, to ensure that the overall conservation objectives are achieved for all Puget Sound Management Units. This requires accounting all impacts on all management units, even in fisheries where contribution is very low.

4.4 Puget Sound Fisheries

4.4.1 Tribal Ceremonial and Subsistence Fisheries

Indian tribes schedule ceremonial and subsistence chinook fisheries to provide basic nutritional benefits to their members, and to maintain the intrinsic and essential cultural values imbued in traditional fishing practices and spiritual links with the natural resources. The magnitude of ceremonial and subsistence harvest of chinook is small relative to commercial and recreational harvest, particularly where it involves critically depressed stocks.

4.4.2 Commercial Chinook Fisheries

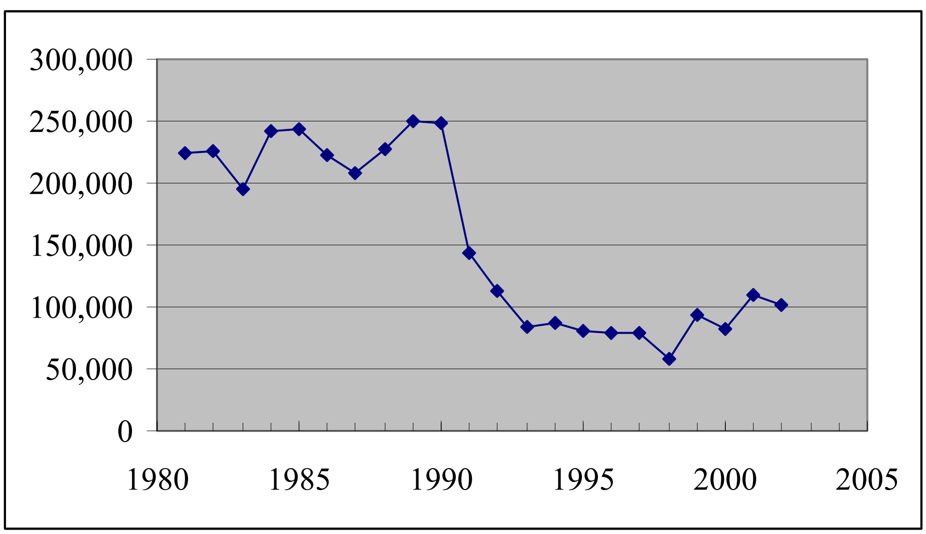
Commercial salmon fisheries in Puget Sound, including the U.S. waters of the Strait of Juan de Fuca, Rosario Strait, Georgia Strait, embayments of Puget Sound, and Hood Canal, are co-managed by the tribes and WDFW under the Puget Sound Salmon Management Plan. Several tribes conduct small-scale commercial troll fisheries directed at chinook salmon in the Strait of Juan de Fuca and Rosario Strait. In the western Strait of Juan de Fuca, most of the effort occurs in winter and early spring, with annual closure from mid-April to mid-June to protect maturing spring chinook. Annual harvest has ranged from 1,000 to 2,000 in the last five years.

Commercial net fisheries, using set and drift gill nets, purse or roundhaul seines, beach seines, and reef nets are conducted throughout Puget Sound, and in the lower reaches of larger rivers. These fisheries are regulated, by WDFW (non-treaty fleets) and by individual tribes, with time/area and gear restrictions. In each catch area, harvest is focused on the target species or stock according to its migration timing through that area. Management periods are defined as that interval encompassing the central 80% of the migration timing of the species, in each management area. Because the migration timings of different species overlap, the actual fishing schedules may be constrained during the early and late portion of the management period to reduce impacts on non-target species. Incidental harvest of chinook also occurs in net fisheries directed at sockeye, pink, and coho salmon.

Due to current conservation concerns, chinook-directed commercial fisheries are of limited scope and are mostly directed at abundant hatchery production in terminal areas; Bellingham /Samish Bay and the Nooksack River, Tulalip Bay, Elliot Bay and the Duwamish River, Lake Washington, the Puyallup River, the Nisqually River, Budd Inlet, Chambers Bay, Sinclair Inlet, southern Hood Canal and the Skokomish River. Purse or roundhaul seine vessels operate in Bellingham Bay and Tulalip Bay, although these are primarily gillnet fisheries. A small-scale, onshore, marine set gillnet fishery is conducted in the Strait of Juan de Fuca and on the coast immediately south of Cape Flattery. Small scale gillnet research or evaluation fisheries are also used in-season to acquire management and research data in the Skagit River, Elliot Bay, Puyallup River, and Nisqually River. Typically, these involve two or three vessels making a prescribed number of sets at specific locations, one day per week, during the run's passage.

Total commercial net and troll harvest of chinook has fallen from levels in excess of 200,000 in the 1980s to an average of 89,500 for the period 1998 – 2002. (Figure 1).

Figure 1. Commercial net and troll catch of chinook in Puget Sound, 1980 – 2002 (TFT database).



4.4.3 Commercial Sockeye, Pink, Coho, and Chum Fisheries

Net fisheries directed at Fraser River sockeye are conducted annually, and at Fraser River pink salmon in odd-numbered years, in the Strait of Juan de Fuca, Georgia Strait, and the Straits and passages between them (i.e., catch areas 7 and 7A). Nine tribes and the WDFW issue regulations for these fisheries, as participants in the Fraser River Panel, under Pacific Salmon Treaty Annexes. Annual management plans include sharing and allocation provisions, but fishing schedules are developed based on in-season assessment of the abundance of early, early summer, summer, and late-run sockeye stocks and pink salmon.

Sockeye harvest has exceeded 2 million in the last ten years, but the fishery has been constrained in recent years due to lower survival and pre-spawning mortality of sockeye, so harvest has ranged from 20,000 to 512,500 since 1998 (Table 7). In the last six seasons (1991 – 2001) the fishery for Fraser River pink salmon in harvested up to 1.74 million fish (Table 7). Most of the pink salmon harvest is taken by purse seine gear. Specific regulations to reduce incidental chinook mortality, including requiring release of all live chinook from non-treaty purse seine fishery hauls, have reduced incidental contribution to less than 1% of the total catch.

Table 7. Fraser sockeye and pink salmon harvest, and incidental chinook catch, in Puget Sound, 1996 – 2002. (TFT database, 2002 data are preliminary).

		1996	1997	1998	1999	2000	2001	2002
Strait of	sockeye	30,314	12,509	26,728	20,230	41,974	34,973	45,600
Juan de Fuca	pink	6	3,017	35	4,105	91	7,064	173
	chinook	606	492	264	589	640	931	1,074
Rosario and	sockeye	243,918	1,268,078	499,939	22	428,661	206,435	389,921
Georgia Strait	pink	1	1,740,356	807	10	253	466,494	21
	chinook	3,934	29,215	3,804	3	1091	970	2,229

Commercial fisheries directed at Cedar River sockeye stocks occur in Elliot Bay, the Ship Canal, and Lake Washington, and much smaller scale fisheries on Baker river sockeye may occur in the Skagit River. The Cedar River stock does not achieve harvestable abundance consistently, but significant fisheries occurred in 1996, 2000, and 2002. However, these fisheries exert very low incidental chinook mortality.

Commercial fisheries directed at Puget Sound-origin pink salmon occur in terminal marine areas and freshwater in Bellingham Bay and the Nooksack River, Skagit Bay and Skagit River, and Possession Sound / Port Gardner (Snohomish River system). In the last six seasons, catch in the Nooksack system has ranged up to 17,500; in the Skagit system catch has ranged up to 525,000, and in the Snohomish system catch has ranged up to 86,100 (Table 8). Terminal-area pink fisheries involve significant incidental catch of chinook.

Table 8. Commercial net fishery harvest of pink salmon from the Nooksack, Skagit, and Snohomish river systems, 1991 – 2001. 2001 data are preliminary. (TFT database).

	Bellingham Bay & Nooksack River	Skagit Bay & Skagit River	Possession Sound & Port Gardner
1991	17,447	133,672	46,039
1993	1,335	143,880	9,648
1995	7,339	524,810	48,006
1997	1,196	46,169	34,537
1999	2,484	32,339	13,055
2001	12,280	198,534	86,097

Commercial fisheries directed at coho salmon, also occur throughout Puget Sound and in some rivers. Coho are also caught incidentally in fisheries directed at chinook, sockeye, pink, and chum salmon. In the last five years total landed coho catch has ranged from 107,646 to 315,124, with over 40% of the catch taken in central and south Puget Sound, and 20% taken in each of the Nooksack – Samish, and Snohomish regions (Table 9). Catch in every region has increased since 2000 relative to the late-1990s, but is still below the levels of the early 1990s, when the total harvest exceeded one million coho.

Table 9. Landed coho harvest for Puget Sound net fisheries, 1998 - 2002. Regional totals include freshwater catch (TFT database).

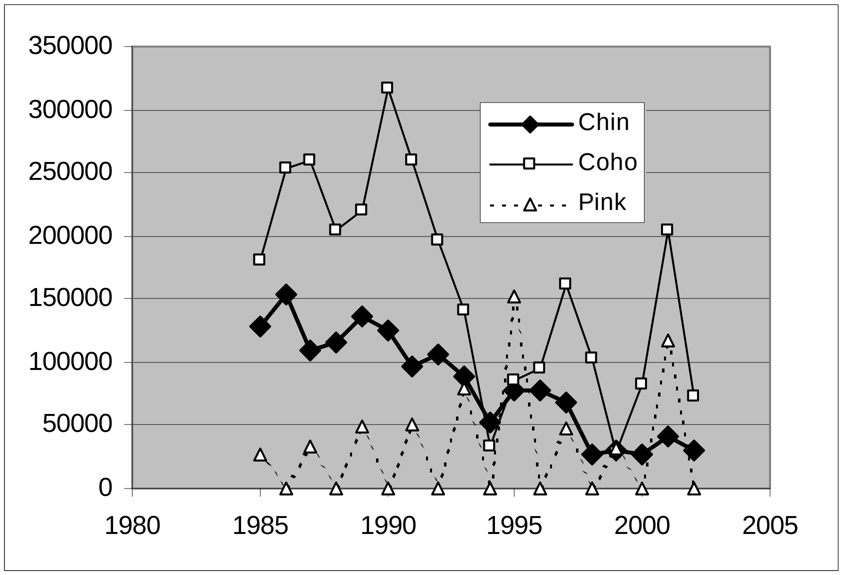
	Strait of Juan de Fuca	Georgia & Rosario Strait	Nooksack Samish	Skagit	Stillaguamish Snohomish	So Puget Sound	Hood Canal	Total
1998	8,083	1,980	22,892	10,359	24,743	65,617	21,974	155,648
1999	5,586	1	50,175	7,411	18,439	21,189	4,845	107,646
2000	4,338	1,501	67,587	11,151	86,328	186,397	20,860	378,162
2001	15,521	721	76,232	15,948	60,863	137,327	8,512	315,124
2002	9,458	3,638	50,863	7,688	48,578	107,236	7,547	235,008

4.4.4 Recreational Fisheries

Recreational salmon fisheries in Puget Sound occur in marine (Areas 5 – 13) and freshwater areas, under regulations promulgated by the Washington Department of Fish and Wildlife. In marine areas, the principal target species are chinook and coho salmon. Since the mid-1980s the total annual marine harvest of chinook has steadily declined from levels in excess of 100,000 in the late 1980s to an average of 31,150 in the last five years (Figure 2). Marine-area coho harvest has varied widely in the last five years, averaging 98,250. Odd-year pink salmon harvest has also varied widely; it exceeded 117,000 in 2001.

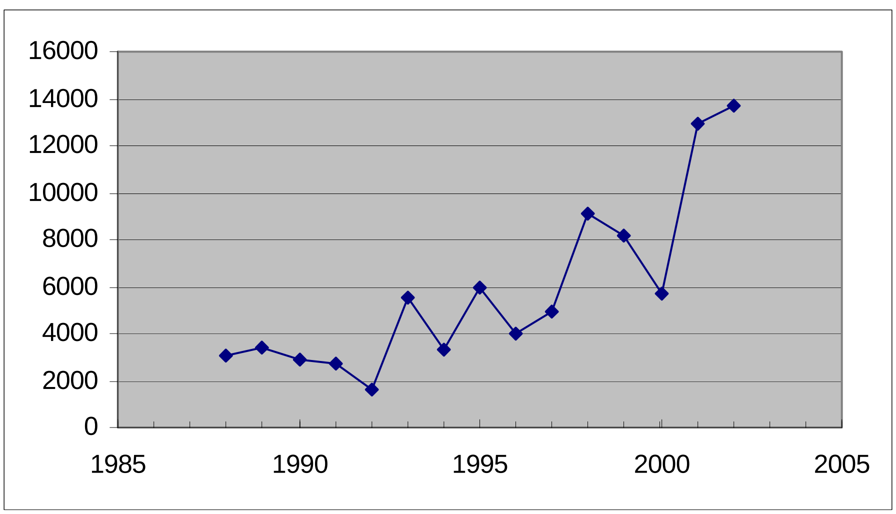
Recreational fisheries that target immature chinook ('blackmouth') occur during the summer months (July – September), and continue through the fall and winter months, and into the early spring, primarily in central Puget Sound. Recreational chinook catch has been increasingly constrained to avoid overharvest of weak Puget Sound populations. Recreational fisheries are managed under the same harvest objectives for chinook and coho salmon that apply to commercial fisheries. WDFW has exercised their policy prerogative in allocating, in recent years, more of the non-Treaty fishing opportunity to the recreational sector.

Figure 2. Recreational salmon catch in Puget Sound marine areas, 1985 – 2002 (WDFW CRC estimates; 2002 data are preliminary).



Perhaps in response to increasingly constrained bag limits and seasons in marine areas, and the increasing abundance of some stocks, recreational harvest of chinook in freshwater areas of Puget Sound has shown an increasing trend since the early 1990s (Figure 3).

Figure 3. Recreational chinook harvest in Puget Sound freshwater areas 1988 - 2002 (WDFW Catch Record Card estimates; excludes jacks).



4.4.5 Non-Landed Fisheries Mortality

In all fisheries, each type of commercial and recreational gear also exerts 'non-landed' mortality on chinook. The rates currently used to assess non-landed mortality are shown below (Table 10). A more detailed description of the basis for these rates and their application is included in Appendix B.

Hook-and-line fisheries are regulated by size limits, recreational bag limits, and non-retention periods. A proportion of all fish not kept will die from hooking trauma. A large body of relevant literature expresses a very broad range of hooking mortality rates. Rates are assumed to be higher for commercial troll than recreational gear, and higher for smaller fish. As bag limits on recreational fisheries have decreased, the proportion of non-landed mortality has risen accordingly. The Washington co-managers and the PFMC have periodically reviewed the literature, and adjusted the non-landed mortality rates associated with hook-and-line fisheries, so that fisheries simulation models used in management planning express the best available science. For hook and line gear, the release mortality (or "shaker mortality") rate refers to the percentage of fish which are brought to the boat and released, because they are below the legal size limit, or a species for which regulations preclude retention. Drop-off mortality rate is calculated as a proportion of the landed catch, but refers to fish that are hooked but escape before being brought to the boat.

The various types of net gear also exert non-landed mortality. Studies to quantify rates are difficult to design and implement, so few reference data are available. Though survival of gillnet entanglement is not well understood, a small proportion, currently assumed to be 3% of landed catch in pre-terminal areas, 2% in terminal fisheries, drops out of the mesh before the gear is retrieved. Marine mammal predation adds a significant additional loss in many areas of Puget Sound, but their effect varies from year to year, and among areas. The assumed rates do not express this variation in mammal predation, and the few available studies that exist are specific to certain areas (Young 1989). Purse seine gear, for the non-treaty fleet, has been modified, by regulation, to reduce the catch of immature chinook by incorporating a strip of wide-mesh net at the surface of the bunt. Nonetheless, small chinook are caught by seine gear, and are assumed more likely to be killed. Non-treaty seine fishers have been required to release all chinook in all areas of Puget Sound in recent years, in order to allocate mortality to other fisheries. Mortality rates vary due to a number of factors, but studies have shown that two-thirds to half of chinook survive seine capture, particularly if the fish are sorted immediately or allowed to recover in a holding tank before release. Because total catch is typically small for beach seine and reef net gear, chinook may be released without harm. Research continues into net gear that reduces release mortality, with promising results from recent tests of tangle nets (Vander Haegen et al. 2003; Vander Haegen et al. 2002(a); Vander Haegen et al. 2002(b); Vander Haegen et al. 2001). In any case, non-landed mortality is accounted by managers, according to the best available information, to quantify the mortality associated with harvest.

Table 10 . Chinook incidental mortality rates applied to commercial and recreational fisheries in Washington.

Fishery	Release Mortality	Drop-off, Drop-out, etc
Ocean Recreational	14%	5%
Ocean troll - barbless hooks	26%	5%
- barbed hooks	30%	5%
Puget Sound recreational	> 22" - 10%	5%
	< 22" - 20%	5%
Gillnet		terminal areas - 2% pre-terminal areas - 3%
Skagit Bay	52.4%	
Purse Seine	immature fish- 45%	0%
	mature fish - 33%	0%
Beach Seine		
Skagit Bay pink fishery	50%	0%
Reef Net	0%	0%

4.5 Regulatory Jurisdictions Affecting Washington Fisheries

Fisheries planning and regulation by the Washington co-managers are coordinated with other jurisdictions, in consideration of the effects of Washington fisheries on Columbia River and Canadian chinook stocks. Pursuant to *U.S. v Washington* (384 F. Supp. 312), the Puget Sound Salmon Management Plan (1985) provides fundamental principles and objectives for co-management of salmon fisheries.

The Pacific Salmon Treaty, originally signed in 1984, commits the co-managers to equitable cross-border sharing of the harvest and conservation of U.S. and Canadian stocks. The Chinook Chapter of the Treaty, which is implemented by the Pacific Salmon Commission, establishes ceilings on chinook exploitation rates in southern U.S. fisheries The thrust of the original Treaty, and subsequently negotiated agreements for chinook, was to constrain harvest on both sides of the border in order to rebuild depressed stocks.

The PFMC is responsible for setting harvest levels for coastal salmon fisheries in Washington, Oregon, and California. The PFMC adopts the management objectives of the relevant local authority, provided they meet the standards of the Sustainable Fisheries Act. The Endangered Species Act has introduced a more conservative standard for coastal fisheries, when they significantly impact listed stocks.

4.5.1 Puget Sound Salmon Management Plan (U.S. v. Washington)

The PSSMP remains the guiding framework for jointly agreed management objectives, allocation of harvest, information exchange among the co-managers, and processes for negotiating annual harvest regimes. At its inception, the Plan implemented the court order to provide equal access to salmon harvest opportunity to Indian tribes, but its enduring principle is to “promote the stability and vitality of treaty and non-treaty fisheries of Puget Sound …. and improve the technical basis for …management.” It defined management units (see Chapter III), and regions of origin, as the basis for harvest objectives and allocation, and established maximum sustainable harvest (MSH) and escapement as general objectives for all units. The PSSMP also envisioned the adaptive management process that motivated this Plan. Improved technical understanding of the productivity of populations, and assessment of the actual performance of management regimes in relation to management objectives and the status of stocks, would result in continuing modification of harvest objectives.

4.5.2 Pacific Salmon Treaty

In 1999, negotiations between the U.S. and Canada resulted in a new, comprehensive chinook agreement, which replaced the previous fixed-ceiling regime with a new approach based on the annual abundance of stocks. It includes increased specificity on the management of all fisheries affecting chinook, and seeks to address the conservation requirements of a larger number of depressed stocks, including some that are now listed under the ESA.

The new agreement establishes exploitation rate guidelines or quotas for fisheries subject to the PST based on the forecast abundance of key chinook stocks. This regime will be in effect for the 1999 through 2008 period. Fisheries are classified as aggregate abundance-based management regimes (AABM) or individual stock-based management regimes (ISBM). As provided in the new chinook chapter of the agreement: “an AABM fishery is an abundance-based regime that constrains catch or total adult equivalent mortality to a numerical limit computed from either a pre-season forecast or an in-season estimate of abundance, and the application of a desired harvest rate index expressed as a proportion of the 1979-1982 base period.” (PSC 2000).

Three fishery complexes are designated for management as AABM fisheries: 1) the SEAK sport, net and troll fisheries; 2) the Northern British Columbia troll (statistical areas 1-5) and the Queen Charlotte Islands sport (statistical areas 1 - 2); and 3) the WCVI troll (statistical areas 21,23-27, and 121-127) and sport, for specified areas and time periods. The estimated abundance index each year is computed by a formula specified in the agreement for each AABM fishery. Table 1 of the chinook chapter of the new Annex IV specifies the target catch levels for each AABM fishery as a function of that estimated abundance index.

All chinook fisheries subject to the Treaty that are not AABM fisheries are classified as ISBM fisheries, including freshwater chinook fisheries. As provided in the new agreement, “an ISBM fishery is an abundance-based regime that constrains to a numerical limit the total catch or total adult equivalent mortality rate within the fisheries of a jurisdiction for a naturally spawning chinook stock or stock group.” For these fisheries the agreement specifies that Canada and the U.S. shall reduce the total adult equivalent mortality rate by 36.5% and 40% respectively, relative to the 1979-1982 base period, for a specified list of indicator stocks. In Puget Sound these include Nooksack early, Skagit summer/fall and spring, Stillaguamish, Snohomish, Lake Washington, and Green stocks.

If such reductions do not result in the biologically based escapement objectives for a specified list of natural-origin stocks, ISBM fishery managers must implement further reductions across their fisheries as necessary to meet those objectives or as necessary to equal, at least, the average of those reductions that occurred during 1991-1996. Although the specified ISBM objectives must be achieved to comply with the agreement, the affected managers may choose to apply more constraints to their respective fisheries than are specifically mandated by the agreement. The annual distribution of allowable impacts is left to each country’s domestic management processes.

4.5.3 Pacific Fisheries Management Council

The Pacific Fisheries Management Council (PFMC) provides recommendations to the Secretary of Commerce regarding management regulations and sets annual harvest levels for salmon and groundfish fisheries in the coastal marine waters of Washington, Oregon, and California, within the 200-mile EEZ of the United States. The Council was created by the Magnuson Fishery Management and Conservation Act in 1977, and re-authorized by Congress' passage of the Sustainable Fisheries Act in 1996. The Council coordinates and oversees the ocean fishery management objectives among the three state jurisdictions by mandating regulations that prevent overfishing and maintain sustainable harvest. The Council's function is to assure that conservation objectives are achieved for all chinook and coho stocks, and that harvest is equitably shared among the various user groups. The State of Washington asserts jurisdiction regarding regulation of fisheries inside the EEZ (i.e., within three miles of the coast), by adopting the same catch quotas that are approved annually by the PFMC.

The fundamental principles and implementation of the conservation standards are outlined in the Framework Management Plan (FMP). The Council has adopted amendments to the FMP to address specific conservation and management issues. The FMP includes specific management goals and objectives for salmon stocks, usually stated as escapement goals or exploitation or harvest rates. These objectives are based on the fundamental principle of providing optimum yield, which was re-defined to mean 'maximum sustainable yield, as reduced by relevant economic, social, or ecological factors" (PFMC 1999).

Amendment 14 to the Pacific Coast Salmon Plan included conservation objectives, expressed as the number of natural, adult spawners, for chinook stocks from Puget Sound and the Strait of Juan de Fuca. These objectives could be revised without FMP amendment according to procedures in the PSSMP. Stocks listed under the ESA are treated as the third exception to the application of overfishing criteria in the SFA. The NMFS conducts a consultation to determine whether the impact of coastal fisheries pose jeopardy to listed species. The PFMC considers the requirements of the ESA are sufficient to also achieve the intent of the SFA's overfishing provision. This implies that it is insufficient to just achieve current MSH escapement; the objective to achieve recovery to MSH escapement under restored habitat conditions. Meeting the jeopardy standard may be sufficient to stabilize the population until freshwater habitat is restored (Amendment 14 Section 3.2.4.3).

4.6 Distribution of Fishing Mortality

A significant portion of the fishing mortality on many Puget Sound chinook stocks occurs outside the jurisdiction of this plan, in Canadian and, in some cases, Southeast Alaskan fisheries (Table 11), based on recoveries of coded-wire tagged indicator stocks. Of the Puget Sound indicator stocks, more than half of the total mortality of Stillaguamish summer, Hoko fall, Nooksack early, and Skagit spring chinook occurs in Alaska and Canada. Washington ocean troll fisheries generally account for a small proportion of the mortality of Puget Sound chinook, but their impact exceeds 5 percent of total fisheries-related mortality for Skokomish and South Puget Sound fall indicator stocks. Puget Sound net and Washington sport fisheries account for the largest proportion of fishing mortality for most Puget Sound stocks

Table 11. Distribution of harvest for Puget Sound chinook indicator stocks, expressed as an average (1996-2000) proportion of total, annual, adult equivalent fishing exploitation rate (CTC 2003).

	Alaska	B.C.	Washington troll	Puget Sound Net	Washington Sport
Samish Fall	2.3%	43.0%	1.8%	40.2%	12.7%
Stillaguamish Sum	17.8%	50.3%	0.3%	2.6%	29.1%
South Puget Snd Fall	2.0%	29.6%	6.0%	21.7%	40.7%
Nisqually Fall	0.5%	14.5%	2.6%	44.9%	37.6%
Skokomish Fall	1.7%	37.4%	9.0%	7.2%	44.7%
Hoko Fall	74.2%	25.3%	0.0%	0.6%	0.0%
Nooksack Spring	1.6%	75.7%	1.5%	3.0%	18.3%
Skagit Spring	1.0%	51.4%	1.2%	7.1%	39.2%
White River Spring	0.0%	4.5%	0.6%	3.5%	91.4%

4.7 Trends in Exploitation Rates

FRAM ‘validation’ runs, which incorporate catch and stock abundance from post-season assessment, are available for management years 1983 – 2000, and provide an index of the trend in the total exploitation rate of Puget Sound chinook (A. Rankis, NWIFC, pers comm. October 27, 2003). For these models, post-season abundances, in terms of total recruitment, are estimated from the observed terminal run sizes by using pre-terminal expansion factors estimated either from CWT preterminal exploitation rates, or from fishing effort scale factors

For Category 1 MUs, fisheries management has reduced exploitation rates steadily since the 1980s. Total exploitation rates on Skagit, Stillaguamish, and Snohomish units have declined 56 to 64 percent from the 1983 - 1987 average to the 1998 – 2000 average (Figure 4). Total exploitation rates on spring chinook have also declined. The average rate on Nooksack early chinook has declined 63 percent, on White River spring chinook 51 percent, and on Skagit spring chinook 57 percent. (Fig 5). (A. Rankis, NWIFC pers. comm. October 27, 2003)

Figure 4. Trend in total exploitation rate for Skagit, Stillaguamish, and Snohomish summer/fall chinook management units (post season FRAM estimates).

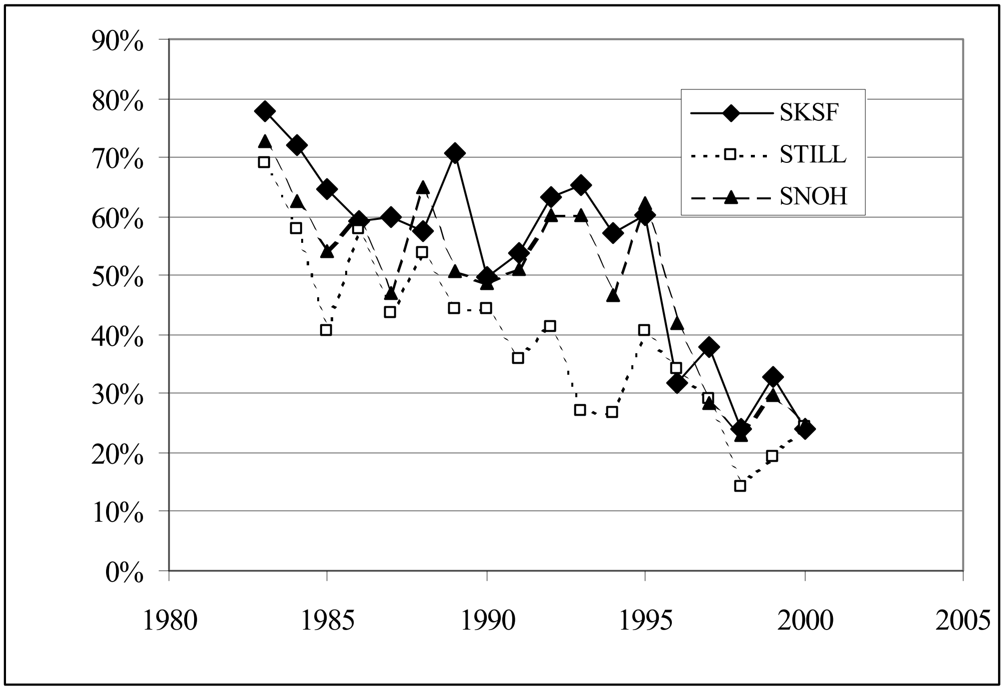
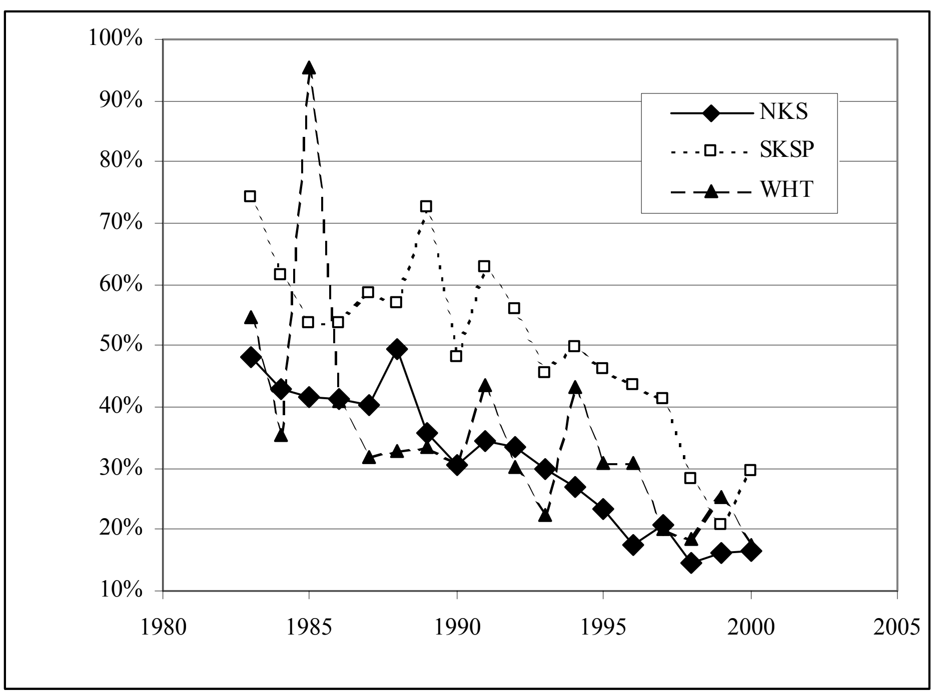


Figure 5. Trend in total exploitation rate for Nooksack, Skagit, and White spring chinook management units (post-season FRAM estimates).



5. Implementation

5.1 Management Intent

The co-managers' primary intent is to control impacts on weak, listed chinook populations, in order to avoid impeding their rebuilding, while providing sufficient opportunity for the harvest of other species, abundant returns of hatchery-origin chinook, and available surpluses from stronger natural chinook stocks. For the duration of this Plan, directed fisheries that target listed chinook populations are precluded, unless a harvestable surplus exists, and except for very small-scale tribal ceremonial and subsistence harvest, and research-related fisheries in a few areas.

For the purposes of this Plan, 'directed' fisheries are defined as those in which more than 50 percent of the total fishery-related mortality is made up of listed, Puget Sound-origin chinook. Total mortality includes all landed and non-landed mortality (see Appendix B).

Landed and non-landed incidental mortality of listed chinook will occur in fisheries directed at non-listed hatchery-origin chinook and other salmon species, but will be strictly constrained by harvest limits that are established expressly to conserve listed chinook.

5.2 Rules for Allowing Fisheries

The annual management strategy, for any given chinook management unit, shall depend on whether a harvestable surplus is forecast. This Plan prohibits targeted harvest on listed populations of Puget Sound chinook, unless they have harvestable surplus. In other words, if a management unit does not have a harvestable surplus, then harvest-related mortality will be constrained to incidental impacts. Directed and incidental fishery impacts are constrained by stated harvest rate ceilings or escapement goals for each management unit. The following rules define how and where fisheries can operate:

- Fisheries may be conducted where there is reasonable expectation that more than 50 percent of the resulting fishery-related mortality will accrue to management units and species with harvestable surpluses, as defined in Chapter 3.

- Within this constraint, the intent is to limit harvest of listed chinook populations or management units that lack harvestable surplus, not to develop a fishing regime that exerts the highest possible impact that does not violate specified ceiling exploitation rates or escapement goals.

- Incidental harvest of weak stocks will not be eliminated, but to avoid increasing the risk of extinction of weak stocks, harvest impacts will be reduced to the minimal level that still enables fishing opportunity on non-listed chinook and other species, when such harvest is appropriate.

- Exceptions may be provided for test fisheries that are necessary for research, and limited tribal ceremonial and subsistence fisheries.

Where it is not possible to effectively target productive natural stocks or hatchery production, without a majority of the fishery impacts accruing to runs without a harvestable surplus, use of the above rules will likely necessitate foregoing the harvest of much of the surplus from those more productive management units.

5.3 Rules That Control Harvest Levels

The co-managers' will use the following guidelines when assessing the appropriate levels of harvest for proposed annual fishing regimes:

- The annual fishing regime will be devised to meet the conservation objectives of the weakest, least productive management unit or component population. Because these units commingle to some extent with more productive units, even in terminal fishing areas, meeting the needs of these units may require reduction of the exploitation on stronger units to a significantly lower level than the level that would only meet the conservation needs of the stronger units.

- A management unit shall be considered to have a harvestable surplus if, after accounting for expected Alaskan and Canadian catches, and incidental, test, and tribal ceremonial and subsistence catches in southern U.S. fisheries, an MU is expected to have a spawning escapement greater than its upper management threshold [1] (see Section III), and its projected ER is less than its RER ceiling. In that case, additional fisheries (including directed fisheries) may be implemented until the exploitation rate ceiling is met, consistent with the Rules for Allowing Fisheries (above), or its expected escapement equals the upper management threshold. In this case, impacts may *not* be limited to incidental harvest mortality. The array of fisheries that may harvest the surplus can be widened, to include terminal-area, directed fisheries.

- Implementation of SUS fisheries targeting harvestable surplus for any management unit will be initiated conservatively. Consistent forecasts of high abundance, substantially above the upper management threshold, and preferably corroborated by post-season assessment, would be necessary to initiate such fisheries. This condition is not expected to be met for any Puget Sound management unit within the duration of this plan.

- If a MU does not have harvestable surplus, then, consistent with the rules for allowing fisheries (above), only incidental, test, and tribal ceremonial and subsistence harvests of that MU will be allowed in Washington areas.

- The projected exploitation rate for management units with no harvestable surplus will not be allowed to exceed their rebuilding exploitation rate ceiling (RER). In the event that the projected ER exceeds the ceiling RER, the incidental, test, and subsistence harvests must be further reduced until the ceiling RER is not exceeded (except as noted below).

- The annual fishing regime must meet the guidelines established by the Pacific Salmon Treaty chinook agreement, such that the non-ceiling fishery index will not exceed the Treaty-mandated ceiling (see Section IV, Pacific Salmon Treaty). If the ISBM index is projected to be exceeded, U.S. fisheries must be further reduced until the mandated ceiling is achieved.

[1] For complex management units, meeting the unit upper threshold may not meet the upper thresholds for all component populations.

- After accounting for anticipated Alaskan and Canadian interceptions, test fisheries, ceremonial and subsistence harvest, and incidental mortality in southern U.S. fisheries, if the spawning escapement for any management unit is expected to be lower than its low abundance threshold, Washington fisheries will be further shaped until either the escapement for the unit is projected to exceed its low abundance threshold, or its projected exploitation rate does not exceed the CERC (see section 5.5, below).

- The comanagers may implement additional fisheries conservation measures, where analysis demonstrates they will contribute significantly to recovery of a management unit, in concert with other habitat and enhancement measures.

5.4 Steps for Application to Annual Fisheries Planning

Annual planning of Puget Sound fisheries proceeds concurrently with that of coastal fisheries, from February through early-April each year, in the Pacific Fishery Management Council and North of Cape Falcon forums. These offer the public, particularly commercial and recreational fishing interest groups, access to salmon status information and opportunity to interact with the co-managers in developing annual fishing regimes. Conservation concerns for any management unit are identified early in the process. The steps in the planning process are:

Abundance forecasts are developed for Puget Sound, Washington coastal, and Columbia River chinook management units in advance of the management planning process. Forecast methods are detailed in documents available from WDFW and tribal management agencies. Preliminary abundance forecasts for Canadian chinook stocks, and expected catch ceilings in Alaska and British Columbia, are obtained through the Pacific Salmon Commission or directly from Canada Department of Fisheries and Oceans.

The Pacific Fishery Management Council's annual planning process begins in March by establishing a range of allowable catch ('options') for each coastal fishery. For Washington fisheries, this involves recreational and commercial troll chinook catch quotas for Areas 1 – 4 (including Area 4B in the western Strait of Juan de Fuca).

An initial regime for Puget Sound fishing is evaluated. Recreational fisheries are initially set at levels similar to the previous year's regime. Incidental chinook harvest in pre-terminal net fisheries is projected from recent-year catch data, and the anticipated scope of fisheries for other species in the current year. Terminal area net fisheries in chinook management periods are scaled to harvest surplus production and achieve natural and / or hatchery escapement objectives. The fishery regimes for pre-terminal and terminal net fisheries directed at other salmon species are initially set to meet management objectives for those species.

The FRAM is configured to simulate this initial regulation set for all Washington fisheries, based on forecast abundance of all contributing chinook management units. Spawning escapement for each population, and total and SUS exploitation rates, projected by this model run, are then examined for compliance with management objectives for each Puget Sound chinook management unit, and their component populations.

The initial model runs are used to reveal the scope and magnitude of conservation concerns for any management units in critical status (i.e. where escapement falls short of the low abundance thresholds), and a more general perspective on the achievement of management objectives for all other management units. In accordance with the preceding rules that control harvest levels, regulations governing directed and incidental chinook harvest impacts are adjusted, through technical assessment and negotiation among the co-managers, in order to arrive at a fishery regime that addresses the conservation concerns for weak stocks, ensures that exploitation rate ceilings are not exceeded and / or escapement objectives are achieved for all other units, while achieving the annual harvest objectives of the co-managers.

5.5 Response to Critical Status

When initial FRAM modeling indicates that Puget Sound Chinook units are in critical status (i.e., projected escapement their low abundance thresholds):

1. The pre-season 2003 SUS fishing regime will be modeled, with current forecast abundance, to determine an SUS ER for each critical stock.

2. The objective of pre-season planning will be to achieve an SUS ER less than or equal to that rate (from step 1), provided that rate is below the CERC.

3. If the 2003 fisheries-based rate exceeds the CERC for any critical management unit, the CERC will be the planning objective.

However, the co-managers may, by mutual consent, set the annual management objective for any critical unit between the 2003 fisheries-based rate and the CERC. Under no circumstances will the CERC be exceeded.

Response to Expanding Northern Fisheries

In 2002 and 2003, chinook harvest in some coastal fisheries in British Columbia increased substantially, indicating that those fisheries may reach the limits imposed by Annex IV, Chapter 3 (1999) of the Pacific Salmon Treaty, within the duration of this harvest plan. Increasing Canadian fishery impacts on Puget Sound chinook, in combination with recent SUS fishing regimes, may result in total fisheries impacts exceeding the rebuilding exploitation rates (RER) for one or more of those Puget Sound chinook management units that have total RERs established in this plan.

During preseason planning, if the total exploitation rate for a management unit is projected to exceed the RER established by this Plan (Table 3), the co-managers will constrain their fisheries such that either the RER is not exceeded, or the SUS exploitation rate is less than or equal to the CERC. Modeling exercises have demonstrated potential for this to occur for several Puget Sound units that are unlikely to fall into critical status in the duration of this plan. The CERC, in this circumstance, would constrain SUS fisheries to the same degree as if that unit were in critical status. While this measure imposes a further conservation burden on Washington fisheries, pursuant to the underlying rationale for the MFR, it maintains access to the harvestable surplus of non-listed chinook, and other species

Because of annual variability in abundance among the various populations, there is no single fishing regime that can be implemented from one year to the next to achieve the management objectives for all Puget Sound chinook units. The co-managers have, at their disposal, a range of management tools, including gear restrictions, time / area closures, catch or retention limits, and complete closures of specific fisheries. Combinations of these actions will be implemented in any given year, as necessary, to insure that management objectives are achieved.

Discretionary Conservation Measures

The co-managers may, by mutual agreement, implement further conservation constraint on SUS fisheries, in response to critical status of any management unit, or in response to declining status or heightened uncertainty about status of any management unit, or to achieve allocation objectives. In doing so, they will consider the most recent information regarding the status and productivity of the management unit or population, and past performance in achieving its management objectives. The conservation effect of such measures may not always be quantifiable by the FRAM, but, based on the best available information on the distribution of stocks, will be judged to have beneficial effect

5.7 Compliance with Pacific Salmon Treaty Chinook Agreements

The proposed regime will be examined for compliance with PST chinook agreements, and further adjustments implemented as necessary to achieve compliance.

In 1999, the parties to the Pacific Salmon Treaty agreed to a new abundance-based chinook management regime for fisheries in the United States and Canada. Southern U.S. fisheries are to be conducted as individual stock-based management (ISBM) fisheries keyed to specific stock groups. With respect to Puget Sound chinook, this agreement refers to the abundance status (i.e. spawning escapement) of certain indicator stock groups with respect to their identified escapement goals[2]. The summer/fall indicator group includes the Hoko, Skagit, Stillaguamish, Snohomish, Lake Washington, and Green units; the spring indicator group includes Skagit spring and Nooksack early units. Stepped reductions in ISBM fisheries will be imposed when two or more of these indicator units are projected not to meet their escapement objectives. These reductions will comply with the pass through provisions and general obligations for individual stock-based management regimes (ISBM) pursuant to the chinook chapter within the US/Canada Pacific Salmon Treaty.

Escapement projected by the FRAM, at the conclusion of pre-season planning, will be compared to PST objectives. According to the PST agreement: "the United State shall reduce by 40%, the total adult equivalent mortality rate, relative to the 1979-82 base period, in the respective ISBM fisheries that affect those stocks." The reduction shall be referred to as the "general obligation".

For those stock groups for which the general obligation is insufficient to meet the agreed escapement objectives, the jurisdiction within which the stock group originates shall implement additional reductions:

i) reductions as necessary to meet the agreed escapement objectives; or

ii) which taken together with the general obligation, are at least equivalent to the average of those reductions that occurred for the stock group during the years 1991-96.

[2] Escapement goals for the Puget Sound indicator stocks, equivalent to the upper management thresholds stated in this plan, have been proposed to the Joint Chinook Technical Committee of the Pacific Salmon Commission for incorporation into the chinook agreement.

The Chinook Technical Committee defined the non-ceiling fishery index (CTC 1996). The PST defers to any more restrictive limit mandated by the Puget Sound chinook management plan, or otherwise implemented by the co-managers.

5.8 Regulation Implementation

Individual tribes promulgate and enforce regulations for fisheries in their respective 'usual and accustomed' areas, and WDFW promulgates and enforces non-Indian fishery regulations, consistent with the principles and procedures set forth in the PSSMP. All fisheries shall be regulated to achieve conservation and sharing objectives based on four fundamental elements: (1) acceptably accurate determinations of the appropriate exploitation rate, harvest rate, or numbers of fish available for harvest; (2) the ability to evaluate the effects of specific fishing regulations; (3) a means to monitor fishing activity in a sufficient, timely and accurate fashion; and (4) effective regulation of fisheries, and enforcement, to meet objectives for spawning escapement, harvest sharing, and fishery impacts.

The annual fishing regime, when developed and agreed-to by the co-managers through the PFMC and NOF forums, will be summarized and distributed to all interested parties, at the conclusion of annual pre-season planning. This document will summarize regulatory guidelines for Treaty Indian and non-Indian fisheries (i.e. species quotas, bag limits, time/area restrictions, and gear requirements) for each marine and freshwater management area on the Washington coast and in Puget Sound. Preseason forecasts and management agreements will be detailed in Management Status reports, as required by the Puget Sound Salmon management Plan. Regulations enacted during the season will implement these guidelines, but may be modified, based on catch and abundance assessment, by agreement between parties. In-season modifications shall be in accordance to the procedures specified in the PSSMP and subsequent court orders.

Further details on fishery regulations may be found in the respective parties regulation summaries, and other State/Tribal documents. The co-managers maintain a system for transmitting, cross-indexing and storing fishery regulations affecting harvest of salmon. Public notification of fishery regulations is achieved through press releases, regulation pamphlets, and telephone hotlines.

5.9 In-season Management

Fisheries schedules and regulations may be adjusted or otherwise changed in-season, by the co-managers or through other operative jurisdictions (e.g. the Fraser Panel, Pacific Fisheries Management Council). Schedules for fisheries governed by quotas, for example, may be shortened so that harvest quotas are not exceeded. Commercial net fishery schedules in Puget Sound may be modified to achieve allocation objectives or in reaction to in-season assessment of the abundance of target stocks, or of stocks harvested incidentally. In each case, the co-managers will assess the effect of proposed in-season changes with regard to their impact on natural chinook management units, and determine whether the management action constrains fishery impacts within the harvest limits stated in this plan. Particular attention will be directed to in-season changes that impact management units or populations in critical status, or where the pre-season plan projections indicated that total impacts were close to ceiling exploitation rates or projected escapement close to the respective escapement goals.

The co-managers will notify the NMFS when in-season management decisions will result in an exploitation rate higher than the relevant ceiling prescribed by this Plan or escapement less than the low abundance threshold for any management unit. The notification will include a description of the change, an assessment of the resulting fishing mortality, and an explanation of how impacts of the action still achieve the larger objective of not impeding recovery of the ESU.

5.10 Enforcement

Non-treaty commercial and recreational fishery regulations are enforced by WDFW. The WDFW Enforcement Program currently employs 163 personnel. Of that number, 156 are fully commissioned Fish and Wildlife officers who ensure compliance with licensing and habitat requirements, and enforce prohibitions against the illegal taking or poaching of fish and wildlife (www.wa.gov/wdfw/enf/enforce.htm). The Fish and Wildlife Enforcement Program is primarily responsible for enforcing the Washington State Fish and Wildlife Code (Title 57). However, officers are also charged with enforcing many other codes as well, and are often called upon to assist local city, county, other state, or tribal law enforcement agencies. On an average, officers currently make more than 300,000 fisheries-related public contacts annually (93% of Enforcement FTE's are field deployed). WDFW Enforcement also cooperates with the U.S. Fish and Wildlife Service, the NMFS Enforcement branch, and the U.S. Coast Guard in fisheries enforcement.

Each tribe exercises authority over enforcement of tribal commercial fishing regulations, whether fisheries occur on or off their reservation. In some cases enforcement is coordinated among several tribes by a single agency (e.g. the Point No Point Treaty Council is entrusted with enforcement authority over Lower Elwha Klallam, Jamestown S'Klallam, and Port Gamble S'Klallam, tribal fisheries). Enforcement officers of one tribal agency may be cross-deputized by another tribal agency, where those tribes fish in common areas. Prosecution of violations of tribal regulations occurs through tribal courts and governmental structures.

Participation by Indian and non-treaty fishers in pre-season fishery planning, at local meetings conducted by tribal resource managers and WDFW, and through the Pacific Fisheries Management Council hearings and the North of Cape Falcon forum, promotes education about salient conservation concerns that are of particular relevance to planning fisheries. These forums also promote a wide awareness of changes in regulations, well in advance of the onset of most fisheries, directly to fishers and through the news media.

6. Conservative Management

This chapter summarizes the conservative rationale and technical methods underlying the harvest management objectives of the Plan, noting how they have changed from previous management practices, and how they exceed the conservation standards of the ESA. As stated in Chapter 1, this Plan constrains harvest of all management units to the point where fishing mortality does not impede rebuilding and eventual recovery of the ESU. However, rebuilding and recovery is, for most populations, contingent on restoring the functionality of habitat. Harvest constraint will play an essential role in maintaining the existing diversity of populations that make up the ESU, by stabilizing, and in some cases increasing natural spawning escapement. However, rebuilding more robust population abundance, and effecting progress toward recovery, depends on the restoration of higher productivity that will only result from improved habitat quality.

The conservation standard of the ESA, as expressed in Limit 4 of the salmon 4(d) rule (50 CFR 223 vol 65 p 170 - 188) regarding state / tribal harvest management plans (Limit 6), is that harvest-related mortality must not "appreciably reduce the likelihood of survival and recovery of the ESU". The 4(d) rule defines 'survival and recovery' as protecting the abundance, productivity, and diversity of the ESU. . Limit 6 of the 4(d) rule asserts that harvest actions should: 1) maintain healthy populations at abundance above their recovery thresholds; 2) not impede the recovery of populations whose abundance is above their low threshold but below their recovery threshold; and 3) not impose increased demographic or genetic risk on populations at critically low abundance, unless imposing greater risk does not appreciably reduce the likelihood of survival and recovery of the entire listed ESU (50 CFR 223, 65(132): 42476).

The management objectives and constraints imposed by the Plan will maintain healthy populations (i.e., those at or near the abundance associated with recovery) by assuring that spawning escapement is sufficient for optimum productivity (MSH escapement). However the abundance of most of the populations in Puget Sound is well below the level associated with recovery, and in some cases is severely or chronically depressed. For some of these depressed populations, harvest constraint can only maintain escapement at the optimum level associated with current habitat quality. When that optimum level is not defined with certainty, harvest constraint will experimentally probe optimum capacity by providing higher numbers of spawners in some years, to better define current productive capacity. For very depressed populations, harvest will be severely constrained. Extraordinary measures defined by the Plan are expected to assure that the abundance of these populations will remain above their point of instability. However, because natural production (survival) is so reduced for these weak populations, some populations require hatchery supplementation for their maintenance Further harvest constraint would not materially improve the likelihood that these populations will survive in the long term.

Considering the significant influence that harvest has on abundance (i.e. spawning escapement), the objectives and conservation measures contained in this Plan were developed with specific intent to maintain all populations at their current status and allow them to rebuild as other constraining factors are alleviated. This chapter describes how the Plan's objectives protect the abundance and diversity of the ESU.

6.1 Harvest Objectives Based on Natural Productivity

The harvest objectives for each management unit are stated as ceiling exploitation rates or escapement goals for naturally spawning or, for some units, natural-origin chinook. Though fisheries in some areas are shaped to harvest surplus hatchery production, the primary objective is to assure protection and conservation of natural populations.

Specifying the objectives for all management units in terms of natural production is a significant change, when compared to past management practices. Formerly, management of some units was based primarily on harvesting surplus hatchery production, without regard to the consequences of these high harvest rates on natural-origin chinook. These units were designated 'secondary' in the Puget Sound Salmon Management Plan. This Plan imposes conservation constraints on harvest for all natural populations. It establishes specific escapement goals for Category II (formerly secondary) units, to ensure that natural production remains viable. For these units, in-season abundance assessment tools, followed by specific management responses when abundance falls short of the forecast level, will be implemented or under development.

Prior to 1998, chinook harvest objectives were stated as escapement goals for many Puget Sound management units. The PSSMP stated the preference that escapement goals be based on achieving maximum sustainable harvest, which implied the ability to quantify current natural productivity (i.e. spawner – recruit functions) and productive capacity. However, the escapement goals that were established by the co-managers for 'primary' management units were not always biologically based, but often consisted of an historical average of escapement during a period of relatively high abundance and survival, (i.e. 1968 - 1977 for summer fall stocks, 1959 - 1968 for Skagit River spring stocks). For most units, these historical escapements were a result of fishing levels in the base years, and were not related to the current capacity or quality of spawning or freshwater rearing habitat, or marine survival, particularly as habitat conditions were further degraded through the 1980s and 1990s. These goals were in effect until the late 1990s. Continuing decline in stock status, and the subsequent listing of Puget Sound chinook as threatened, with its requirement for development of recovery goals, prompted re-assessment of the old escapement goals, and development of new harvest objectives for many management units.

This Plan commits the co-managers to setting harvest and escapement objectives for all management units to conform with their current or recent productivity, to the extent the requisite data are available. Rebuilding exploitation rate ceilings may be developed and implemented, within the duration of this plan, for additional management units. For other units, even where current productivity is estimated, shaping of terminal fisheries to achieve escapement goals, particularly where in-season assessment provides more accurate estimates of abundance, will remain the preferred management approach. In-season assessment methods will be developed and refined, and escapement estimates refined, to improve the performance of escapement goal management.

6.2 Accounting for Uncertainty and Variability

Uncertainty and annual variability are inherent in estimating the productivity of salmon populations. In order to manage the associated risk, the derivation of biologically based harvest objectives must account and compensate for this uncertainty and variability. Methods outlined in Chapter 3, and described in detail in Appendix A, describe how the current procedure for developing rebuilding exploitation rates accomplishes this objective. This strategy may be summarized as follows:

- To the extent possible, variability in freshwater and marine survival rates will be quantified separately;

- Simulation of population dynamics will incorporate a range of values for marine and freshwater survival parameters that were typical of recent years, and therefore probably characteristic of the immediate future;
- Even when current survival is relatively high, as is currently believed to be the case for marine survival of Puget Sound populations, the simulation will assume lower survival in the future;
- Adaptive management will update these objectives as actual exploitation rates, escapement, and survival are monitored closely.

6.3 Protection of Individual Populations

This Plan establishes harvest limits (i.e. ceiling exploitation rates) for entire management units, but annual fishing planning will also pay specific attention to the status (i.e., projected spawning escapement) of individual populations, where a unit consists of more than one population, providing that data are available that quantify productivity and capacity for those populations. Annual exploitation rate targets will be influenced by escapement that is projected for each population, by the fishery simulation model, and the recent historical trend in population escapement. Actual exploitation rates, for most units, are likely to fall well below the exploitation rate ceilings, due to concern for weak or critical populations. Specific conditions are established for implementing fisheries that would increase the exploitation rate up to the ceiling for any unit. In order to guard against escapement declining to a level that may jeopardize demographic or genetic integrity, a low abundance threshold is established, for each population, as triggers for further constraint of harvest.

6.3.1 Populations exceeding their low abundance thresholds

Escapement for most Puget Sound chinook populations has, in recent years, exceeded the critical abundance threshold referred to in the 4(d) rule. Harvest of these populations is managed such that escapement, if habitat conditions allow, will attains or exceed the level associated with optimum current productivity (see Table 12) This assurance of stable or increasing escapement achieves the 4(d) standard of not impeding recovery of the ESU.

For populations with sufficient data, current productivity is quantified by spawner – recruit analysis (see Chapter 3). Freshwater conditions are highly variable, so ‘current’ productivity reflects the range of survival and recruitment rates observed in recent years. Exploitation rate ceilings are established for these units at the level consistent with achieving MSH escapement (Table 14) Implementation of this harvest plan will result in actual exploitation rates that are lower than that ceiling in most years, thereby intentionally exceeding MSH escapement under current conditions. The strategy of managing harvest under exploitation rate ceilings, as implemented under this plan, carries some risk of exceeding the spawning capacity of habitat, and lowering productivity, but will enable higher production should conditions in freshwater improve.

The strategy of this Plan is to probe the productivity of populations at increased escapement levels, and capitalize on favorable environmental conditions as they occur, or as habitat is restored. It also recognizes the current limits of management tools. Given the current accuracy of abundance forecasting, and the capability of the fishery simulation model, exploitation rates for a specified fishery regime can be projected with greater accuracy than spawning escapement. Exploitation rates may also be consistently and accurately estimated post-season, enabling continual, adaptive assessment of management performance.

The Plan sets also sets total exploitation rate objectives for the Puyallup fall and White spring populations that have been demonstrated to provide adequate seeding of spawning habitat. Analysis of the current potential of habitat (see Profile, Appendix A) suggests that the productivity is quite low in the Puyallup system, but returns from local hatchery production have contributed significantly to natural spawning and smolt production. Returns to the White River have increased, under the current exploitation rate objective, to levels well in excess of the low abundance threshold. Research is underway to refine estimates of current productivity and habitat capacity in these systems.

For other management units, exploitation rate ceilings are specified in this plan for southern U.S. fisheries, or ceilings are specified for pre-terminal fisheries in combination with specific terminal-area management measures, to assure that the naturally- populations remain viable. For the duration of this plan they will persist, at abundance substantially above their low abundance thresholds. The upper management threshold for some of these units may be achieved or exceeded in some years. For other units, the upper management threshold will be achieved only if existing habitat constraints are alleviated. Hatchery-origin chinook contribute to natural spawning in these systems, and provide a necessary measure of assurance that natural production will be stable or increase in these systems where habitat conditions cannot currently sustain abundance absent supplementation

6.3.2 Management Units In Critical Status

The critical or near-critical abundance expected for a small group of Puget Sound populations, will necessitate severe constraint of fisheries, in order to prevent further decline in their status, and achieve the conservation guidelines stated under Limit 6 of the 4(d) rule. For some populations (e.g. the North and South Fork Nooksack and Dungeness), recent natural-origin spawning escapement has been consistently below their low abundance thresholds (Table 3). Extraordinary fisheries conservation measures, described in Chapters 3 and 5, are prescribed by this Plan to prevent further decline in natural-origin spawner abundance.

For some other populations, escapement has in some years fallen below their low abundance thresholds (e.g., Lake Washington, Mid Hood Canal). Hatchery supplementation programs have maintained natural spawning abundance, in some cases well above their low threshold, for some populations (e.g. Stillaguamish, White, and Elwha), but natural productivity has been chronically depressed. As described in their management unit profiles (Appendix A) terminal area fisheries affecting these populations have, in recent years, been constrained or eliminated, as if they were in critical status. Upper management thresholds been established for these populations, but, because of their status, the objective most relevant to current management is their low abundance threshold. Habitat-based analyses of productivity indicate that the upper management threshold is substantially higher than current MSH for the North Fork and South Fork Nooksack, Mid-Hood Canal, and Dungeness populations. However, the management intent is to exceed current MSH escapement as often as possible, to guard against the uncertain ecological and genetic risks of low abundance.

Table 12. Escapement levels (upper management thresholds) consistent with optimum productivity or capacity under current habitat conditions, and recent escapement for Puget Sound chinook management units

Management Unit	Upper Mgmt Threshold [1]	1997	1998	1999	2000	2001	2002
Nooksack early	4000 [2]	254	194	251	444	531	513
Skagit spring	2000 [3]	1041	1086	471	1021	1856	1065
Skagit sum / fall	14500 [3]	4872	14609	4924	16930	13793	19591
Stillaguamish S/F	900 [4]	1156	1540	1098	1646	1349	1588
Snohomish S/F	4600 [5]	4292	6304	4799	6092	8164	7220
L. Washington Cedar River	1200 [6]	227	432	241	120	810	369
Green R.	5800 [7]	9967	7300	9100	6170	7975	13950
White R. spring	1000 [8]	400	316	553	1523	2002	803
Puyallup	1200 [9]	1550	4995	1986	1193	1915	1,590
Nisqually	1100 [10]	340	834	1399	1253	1079	1,542
Skokomish	3650 [11]	2337	6761	9119	4959	10729	1,479
Mid Hood Canal	750 [12]	N/A	287	873	438	322	65
Dungeness	925 [13]	50	110	75	218	453	633
Elwha River	2900 [14]	2517	2358	1602	1851	2208	2,376
Juan de Fuca Hoko River	850 [15]	765	1618	1497	612	768	645

[1] Management threshold from quantified current productivity or best available estimate of current habitat capacity
[2] Nooksack Endangered Species Action Team 2000.
[3] Hayman 2003,
[4] Stillaguamish management unit profile (Appendix A)
[5] Snohomish management unit profile (Appendix A)
[6] Hage et al. 1994.
[7] Ames and Phinney 1977.
[8] WDFW et al 1996. Natural-origin spawners transported past Mud Mountain Dam
[9] Puyallup citation?.
[10] Nisqually Chinook Recovery Team. 2001. Nisqually Chinook Recovery Plan.
[11] Ames and Phinney 1977. Composite of 1,650 natural spawners and hatchery escapement target of 2000.
[12] U.S. v. Wash. Civil 9213, Ph. I (Proc. 83-8). Order Re: Hood Canal Management Plan (1985).
[13] Smith and Sele 1994.
[14] Ames and Phinney 1977. Composite of 500 natural and 2,400 hatchery escapement. Hatchery is listed as essential to recovery.
[15] Ames and Phinney 1977. Modified to exclude capture of adults for supplementation program.

6.4 Equilibrium Exploitation Rates

Managing harvest under rebuilding exploitation rate ceilings assures stable or increasing escapement for those management units. The underlying recruitment function, which is based on current performance, predicts that productivity declines as abundance (escapement) increases, such that for any level of escapement an exploitation rate may be identified that assures replacement of the parent brood. Setting the rebuilding exploitation rate objective conservatively, with a view to recent abundance, assures a high probability that escapement will trend upward. The following analysis illustrates this concept for the Skagit River summer / fall and spring management units.

The equilibrium exploitation rate at each level of spawning escapement (i.e., the exploitation rate that would, on average, maintain the spawning escapement at the same level) was calculated from the Ricker spawner-recruit parameters used in the RER analyses that set the ER ceilings for each management unit. These equilibrium rates are represented by the curve that forms the border between the shaded and white regions in Figures 6 and 7. Note that, due to declining productivity, the equilibrium ER *decreases* as escapement increases. In the region below this curve (i.e., the exploitation rate is lower than the equilibrium rate that applies to that level of spawning escapement), escapement should, on average, increase in the next cycle. In the region above this curve, escapement should, on average, decrease in the next cycle.

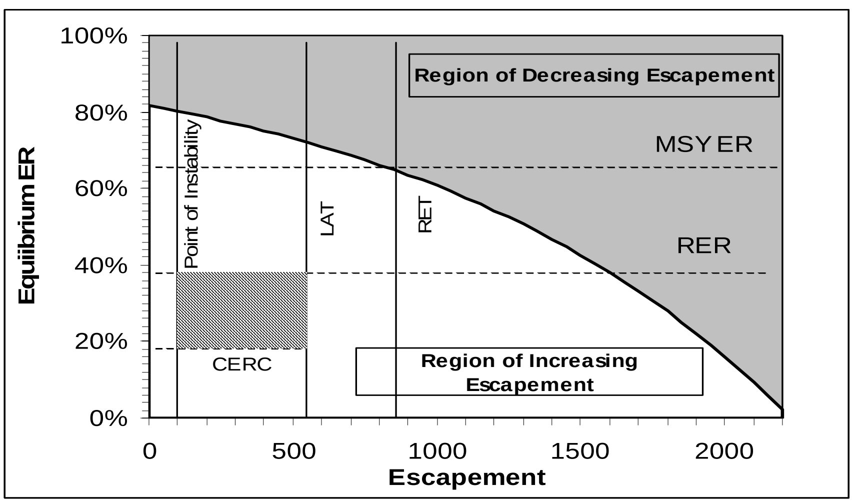
For Skagit chinook, NMFS' "viable threshold" is the same thing as the "rebuilding escapement threshold" that was used in the RER analyses to set the ER ceiling. For Skagit spring chinook, this is the MSY escapement level, which, from the Ricker spawner-recruit parameters that were used in the RER analysis, is about 850 spawners (Fig. 6). The Limit 6 "critical threshold", however, is NOT the same thing as the "critical threshold" defined in this plan – the Limit 6 threshold is a point of instability below which the spawner-recruit relation destabilizes and the risk of extinction increases greatly. The low abundance threshold in this plan, in contrast, is a buffered level that is set sufficiently *above* the point of instability that the risk of getting an escapement below the point of instability, through management error or uncertainty, is low. The critical threshold for Skagit spring chinook, in this plan, is 576 spawners; the point of instability (i.e., the Limit 4 "critical threshold"), calculated using the Ricker parameters from the RER analysis and Peterman's (1977) rule-of-thumb, (i.e., that the point of instability is 5% of the replacement level), would be about 110 spawners (Fig. 6)."

The plan mandates that, if escapement is projected to fall below the LAT, SUS fisheries will be constrained to exert an exploitation rate less than or equal to the CERC, though the total exploitation rate may range higher, as shown in the crosshatched region in Figure 6, due to northern fisheries.

For Skagit spring chinook, when abundance is between the point of instability and the viable threshold, this plan's ER ceiling is well within the region of increasing escapement (Fig. 6), which satisfies the criterion that the plan must allow abundances in this range to increase to the viable level. In fact, even ER's significantly *above* the ER ceiling satisfy this criterion. For escapements greater than the viable threshold, the ER ceiling allows for increasing escapements up to the point where the ER ceiling intersects the equilibrium ER curve. This occurs at an escapement of about 1700 (Fig. 6). For escapements above that level, if harvest met the ER ceiling each year (which is not what is expected under this plan), escapements would tend to decrease in the next cycle; however, they would be expected to stabilize around an escapement of about 1700, which is well above the viable threshold. Thus, the plan also satisfies the criterion that, for escapements above the viable threshold, abundance will, on average, be maintained in that region.

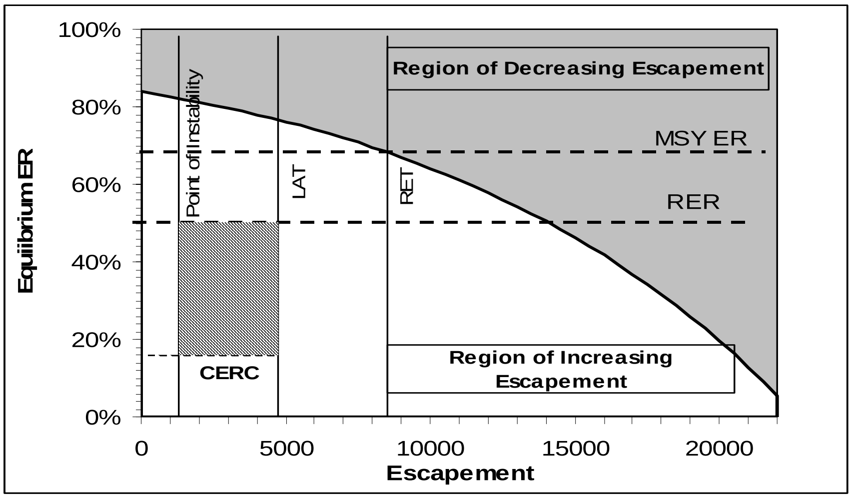
For escapements below the point of instability, recruitments will, by definition, be inconsistent and largely unrelated to the escapement level. This means that harvest management cannot be used effectively to increase escapements above the point of instability. Rebuilding above this level could only be accomplished through fortuitous returns or increase in productivity. This plan deals with abundances below the point of instability largely by trying to prevent abundance from getting that low. For Skagit springs, the trigger for reducing SUS impacts to the minimum regime occurs at a threshold of 576, which is over 5 times higher than the calculated point of instability, and, at that threshold and exploitation rate, is well within the region of increasing escapement (Fig. 6). In the event that abundance falls below the point of instability, and then was followed by a fortuitous recruitment that exceeded that level, the ceiling exploitation rate is low enough that equilibrium momentum will tend to increase the escapement further, rather than reduce it to below the point of instability again. Thus, this plan should not increase the genetic and demographic risk of extinction for Skagit springs. In practical application, the lowest observed Skagit spring chinook escapement has been 470 (in 1994 and 1999), which is over 4 times higher than the calculated point of instability – escapements have exceeded 1,000 during each of the last 3 years, which is higher than the viable threshold, and again indicates that this plan should not increase the genetic and demographic risk of extinction for Skagit springs.

Figure 6. The equilibrium exploitation rate, at each escapement level, for Skagit spring chinook. Exploitation rates below the curve should, on average, result in higher escapements on subsequent cycles; exploitation rates above the curve should, on average, result in lower escapements on subsequent cycles. Equilibrium rates were calculated from the Ricker parameters that were used for the RER analysis used to set the ER ceiling for the Skagit spring chinook management unit. The MSY exploitation rate (MSY ER), rebuilding exploitation rate (RER), and critical exploitation rate ceiling (CERC), and three escapement levels – the calculated point of instability, the low abundance threshold (LAT), and the rebuilding escapement threshold (RET), are marked for reference (see text)



For Skagit summer/fall chinook, the rebuilding escapement threshold is approximately 8500 spawners; the low abundance threshold is 4800; and the calculated point of instability is approximately 1100. As with Skagit springs, in the range between the point of instability and the MSH escapement level, the ER ceiling is well within the region of increasing escapement (Fig. 7), which satisfies the criterion that the plan must allow abundances in this range to increase to the viable level. For escapements greater than the calculated MSH level, the ER ceiling allows for increasing escapements up to an escapement of about 13,500 (Fig. 7). If escapement was higher than that, and harvest met the ER ceiling each year (which, again, is not what is expected under this plan), escapements would be expected to stabilize around an escapement of about 13,500, which is well above the viable threshold. Thus, this plan also satisfies the criterion that, for escapements above the viable threshold, summer/fall abundance will, on average, be maintained in that region.

Figure 7. The equilibrium exploitation rate, at each escapement level, for Skagit summer/fall chinook.
Exploitation rates below the curve should, on average, result in higher escapements on subsequent cycles; exploitation rates above the curve should, on average, result in lower escapements on subsequent cycles. Equilibrium rates were calculated from the Ricker parameters that were used for the RER analysis used to set the ER ceiling for the Skagit summer/fall chinook management unit. The MSY exploitation rate (MSY ER), rebuilding exploitation rate (RER), and critical exploitation rate ceiling (CERC), and three escapement levels – the calculated point of instability, the low abundance threshold (LAT), and the rebuilding escapement threshold (RET), are marked for reference (see text).



As previously noted for Skagit spring chinook, the combined impacts from northern fisheries and constrained SUS fisheries, that would be implemented if the summer / fall unit were to decline to critical status, would be expected to exert total exploitation rates well below the equilibrium rate, and assure higher subsequent escapement *well below the equilibrium ER* that applies to escapements between the LAT and the point of instability, so, on average, equilibrium pressures would force escapement to increase.

As with spring chinook, it is not possible to project any relation between escapement and recruitment for escapements below the point of instability. To prevent summer/fall escapements from falling below this level, the trigger for reducing SUS impacts to the minimum regime occurs at a threshold of 4800, which is over 4 times higher than the calculated point of instability, and, at that threshold and exploitation rate, is well within the region of increasing escapement (Fig. 7). The same equilibrium momentum would, on the next cycle, tend to increase escapements further, rather than reduce them, if escapement did drop below the point of instability and then experienced a fortuitous recruitment. In terms of actual observations, the lowest observed Skagit summer/fall chinook escapement has been 4900 (in 1997 and 1999), which is over 4 times higher than the calculated point of instability, and escapement has exceeded 13,500 during each of the last 3 years, which is well above the calculated MSH escapement level. Thus, for Skagit summer/fall chinook, this plan should not increase the genetic and demographic risk of extinction.

6.5 Reduction in Exploitation Rates

The annual exploitation rate targets that will result from implementing this Plan will likely be substantially lower than the rates that occurred in the 1980s. Annual exploitation rates for Category 1 management units have declined 44 to 64 percent, based on comparison of the 1983-1987 and 1998 -2000 average rates estimated by post-season FRAM runs (Table 13). Pre-season model projections confirm that total exploitation rates are being held to this low level in the past three years. Exploitation rates in Washington fisheries (ocean and Puget Sound areas combined) have fallen 28 to 77 percent for Category 1 units.

Table 13. Decline in average total, adult-equivalent exploitation rate, from 1983 – 1987 to 1998-2000, and 2001 – 2003, for Category 1 Puget Sound chinook management units (post-season FRAM estimates for 1983 – 2000, preseason estimates for 2001- 2003).

	83-87 Avg	98-00 Avg	% Decline	01 - 03 Avg	% Decline
Skagit S/F	0.67	0.27	59.7%	0.34	49.0%
Stillaguamish	0.54	0.19	64.1%	0.15	71.2%
Snohomish	0.59	0.26	56.4%	0.20	66.8%
Green	0.65	0.36	44.1%	0.49	24.0%
Nooksack Spr	0.43	0.16	63.3%	0.17	60.1%
Skagit Spr	0.60	0.26	56.6%	0.22	62.8%
White	0.52	0.20	60.5%	0.19	62.8%
JDF	0.76	0.38	50.7%	0.18	76.5%

In consequence, the actual risk incurred by management units with RER objectives will be lower than the 4(d) risk criteria used to select the RERs. The probability of achieving the upper management threshold, or current MSH escapement, will be higher than 80%, and the probability of falling to critical abundance will also be reduced. For MUs without RER objectives, Table 12 suggests that risks due to excessive harvest pressure have already been substantially eliminated.

6.6 Recovery Goals

The Washington co-managers have identified recovery goals for several Puget Sound management units, based on quantitative assessment of the potential productivity associated with recovered habitat conditions (Table 14). These interim planning targets are intended to assist local governments, resource management agencies, and public interest groups with identifying harvest and hatchery management changes, and habitat protection and restoration measures necessary to achieve recovery in each watershed and the ESU as a whole. Recovery goals are expressed as a range of natural-origin or natural spawning escapement and associated recruitment rates (i.e. adult recruits per spawner). The lower boundary represents the number of spawners that will provide maximum surplus production (i.e. MSH) under properly functioning habitat conditions, assuming recent marine survival rates. The upper boundary represents the equilibrium escapement under these conditions, (i.e. the number of adults surviving to spawn is equal to the parent brood-year escapement).

In most cases, the management objectives (upper management thresholds), and recent escapements, are substantially below the lower end of the recovery range (see section 6.7, below), reflecting their different points of reference with regard to habitat quality. Notable exceptions include the Upper Skagit summer, Cascade Spring, and Siuattle Spring populations, where recent escapement has exceeded the lower boundary of the recovery goals. These three examples notwithstanding, upper management thresholds represent MSH escapement under current habitat conditions, and imply that current conditions limit the potential for recovery for most populations.

Table 14. Escapement levels and recruitment rates for Puget Sound chinook populations, at MSH and at equilibrium, under recovered habitat conditions.

Population	MSH		Equilibrium
	Escapement	Adult R/S	Escapement [1]
North Fork Nooksack	3,400	3.3	14,000
South Fork Nooksack	2,300	3.6	9,900
Upper Cascade Spring	290	3.0	1,160
Suiattle Spring	160	2.8	610
Upper Sauk Spring	750	3.0	3,030
Lower Skagit Fall	3,900	3.0	15,800
Upper Skagit Summer	5,380	3.8	26,000
Lower Sauk Summer	1,400	3.0	5,580
North Fork Stillaguamish	4,000	3.3	18,000
South Fork Stillaguamish	3,600	3.4	15,000
Snoqualmie	5,500	3.6	25,000
Skykomish	8,700	3.4	39,000
Puyallup	5,300	2.3	18,000
Nisqually	3,400	3.0	13,000
Mid Hood Canal	1,320	2.9	5,200
Dungeness	1,170	3.0	4,740

[1] Recruitment (returns per spawner) at equilibrium, by definition, equals 1.0.

With the exceptions noted above, the recovery goals are not of immediate relevance to current harvest management objectives. A subset, at least, of management units will have recover for the ESU to be de-listed, but ESU recovery (i.e. that subset or alternative subsets of recovered units) has not been defined. The recovery goals, as stated by the co-managers, exceed the increase in abundance and productivity necessary for delisting.

6.6.1 Harvest Constraint Cannot Effect Recovery

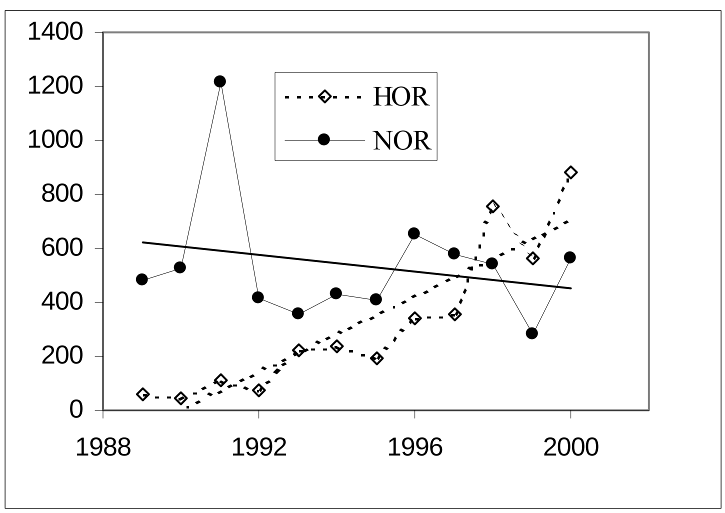
Population recovery (i.e., increase in abundance to levels well above the stated upper thresholds, for most populations) cannot be accomplished solely by constraint of harvest. If harvest mortality is not excessive, and spawning escapement is not reduced to the point where depensatory mortality and other ecological factors become significant and threaten genetic integrity, harvest does not affect productivity. Productivity is primarily constrained by the quality and quantity of freshwater and estuarine environment that determines embryonic and juvenile survival, and oceanic conditions that influence survival up to the age of recruitment to fisheries.

Physical or climatic factors, such as stream flow during the incubation period, will vary annually, and are expected in some years to markedly reduce smolt production. The capacity of chinook to persist under these conditions is primarily dependent on their diverse age structure and life history, and habitat factors (e.g. channel structure, off-channel refuges, and watershed characteristics that determine runoff) that mitigate adverse conditions

For several Puget Sound populations, mass marking of hatchery production has enabled accurate accounting of the contribution of natural- and hatchery-origin adults to natural escapement. Sufficient data has accumulated to conclude that a significant reduction of harvest rates, in concert with increased marine survival, has increased the number of hatchery-origin fish that return to spawn, whereas returns of natural-origin chinook, though stable, have not increased. It is evident that natural production has not increased under reduced harvest pressure, and is constrained primarily by the condition of freshwater habitat. Therefore, the current, relatively low, harvest rates proposed in the HMP, are not impeding recovery.

These escapement data are also available for the North Fork Nooksack and Skykomish populations, but the North Fork Stillaguamish trend is cited here as an example. Fingerlings released by the summer chinook supplementation program are coded wire tagged, enabling accurate estimation of their contribution to escapement. Harvest exploitation rates have fallen 70% since the late 1980s (Table 12). The return of hatchery-origin chinook has increased markedly, exceeding 800 in 2000, while natural-origin returns have remained relatively stable, averaging 522 in the last five years. (Figure 8),

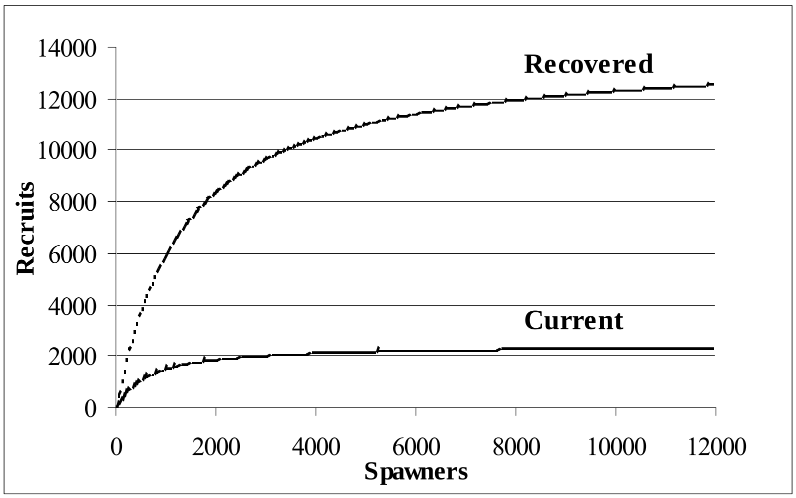
Figure 8. The return of natural-origin (NOR) chinook to the North Fork Stillaguamish River has not increased, while the number of hatchery-origin adults (HOR) have increased significantly under reduced harvest rates



Harvest constraint has, for most populations, resulted in stable or increasing trends in escapement on the spawning grounds (for many populations this includes a large proportion of hatchery-origin adults). But the trend in NOR returns strongly suggests that, although escapement may be stable or even trend upward toward or above the optimum (MSH) level associated with current habitat condition, NOR recruitment will not increase much beyond that level unless constraints limiting freshwater survival are alleviated. Habitat quality appears to be the biggest constraint on freshwater productivity.

Spawner-recruit functions for the North Fork Stillaguamish population, under current and recovered habitat conditions, provide an example (Figure 9). Derived from EDT analysis of habitat capacity under current and recovered conditions, they demonstrate that natural production is now constrained to a ceiling (asymptote) far below that associated with recovery ('properly functioning condition' or 'PFC+').

Figure 9. Productivity (adult recruits) of North Fork Stillaguamish summer chinook under current and recovered habitat (PFC+) conditions. Beverton-Holt functions derived from habitat analysis using the EDT method.



The reduction of harvest pressure in SUS fisheries has, at least, stabilized NOR escapement, and the listed hatchery supplementation program further guards against catastrophic decline. While acknowledging the risk of density dependent effects, implementing the HMP will experimentally test production at these higher escapement levels, and capitalize on favorable freshwater survival conditions that may occur. Under the current harvest objectives, NOR escapement may achieve the current MSH level, but a significant increase in productivity will be necessary for the population to recover. Further harvest constraint will not, by itself, effect an increase above the asymptote associated with current productivity, until habitat conditions improve.

Very similar conclusions can be drawn from examination of current NOR escapement trends in the North Fork Nooksack, Skykomish, and Dungeness rivers. In these systems, NOR returns have remained at very low levels, while total natural escapement has increased where hatchery supplementation programs exist. The contrast between current productivity, and the higher level of recruitment possible under restored habitat condition is marked in all cases.

6.7 Protecting the Diversity of the ESU

The Plan includes management objectives for 21 chinook populations in the Puget Sound ESU, and the one population (the Hoko River) in the western SJDF. The HMP provides a high degree of assurance that, within its six-year duration, all of these populations will persist. The Plan asserts that all extant populations are valuable diversity elements of the ESU. It will allow some populations to reach their viable thresholds, hold others at stable abundance levels, well above their critical thresholds, and assure persistence of those at or near critical abundance. It assures that no population will decline to extinction as a result of harvest.

Highly conservative management objectives are established for the eight natural populations in the Skagit and Snohomish systems. Despite habitat constraints in their watersheds and estuaries, these core populations, in the aggregate, comprise abundant and essential natural production by indigenous stocks that is not dependent on hatchery augmentation. These populations inhabit large watersheds, with habitat, capable of supporting genetically diverse subpopulations of chinook with diverse life histories. The Plan, therefore, emphasizes protection of these core populations which, for the foreseeable future, comprise the strongest element of the ESU, given the uncertainty about recovery of production in other more densely developed and degraded watersheds Protection of these core populations is essential to the integrity of the ESU.

Management objectives for these populations are based on a low tolerance for risk of decline to critical status. Should survival rates and abundance decline, ceiling exploitation rates for SUS fisheries would be reduced. This lower exploitation rate would be well below the equilibrium ER (see section 6.4) that applies to escapements between the LAT and the point of instability, so, on average, equilibrium pressure would force escapement to increase. The rebuilding exploitation rate ceiling provides similar assurance that, given sufficient abundance, under current productivity (survival) conditions, escapement will achieve the level associated with optimum productivity (MSH), as defined by the rebuilding escapement threshold. Escapement will increase, even at exploitation rates higher than the RER, according to the equilibrium exploitation rate assessment, so the RER ceiling gives assurance of not impeding rebuilding. Furthermore, annual target exploitation rates for these populations are expected to be substantially lower than their respective ER ceilings, in most years, thus further improving the probability that escapement will increase or remain at optimum levels. .

Indigenous populations persist in the North Fork Nooksack, North and South Forks of the Stillaguamish River, the Cedar River, the White River, the Green River, the Elwha River and the Dungeness River. Natural spawning is supplemented by hatchery production in the North Fork Nooksack, North Fork Stillaguamish, White, Green, Elwha, and Dungeness rivers, and, for the foreseeable future, will be required, in order to maintain these populations at current abundance levels. Non-indigenous populations persist, and are supplemented by hatchery production, in the Puyallup, Nisqually, and Skokomish rivers.

Except for the Stillaguamish system, the productivity of the naturally spawning chinook in these systems is not yet quantified. Rebuilding exploitation rate and critical exploitation rate ceilings for the Stillaguamish populations provide the same kind of risk-averse management objectives provided for the core, larger populations described above. Habitat-based analysis (EDT), or other information, suggests that natural productivity is very low in the remainder of these systems. Constrained fishing exploitation rates will continue to assure that escapement to natural spawning areas will meet or exceed current escapement goals.

The ecological and genetic risks associated with hatchery supplementation programs, as well as their benefits to ESU diversity and harvest opportunity, have been addressed and considered in the Puget Sound Chinook Hatchery Management Plan (2003). For most of these populations the benefits provided by hatcheries in maintaining higher levels of natural production and continued harvest opportunity may outweigh their ecological or genetic risks. Fishery constraints, by either exploitation rate ceilings and / or escapement goals, are expected to maintain the current status of these ten populations, well above their low abundance thresholds. For the remaining populations, pre-terminal or total SUS harvest is constrained by ER ceilings, and terminal fisheries are carefully structured to meet, and in many cases exceed, natural escapement goals. For the populations whose abundance has been at critical or near-critical levels in the recent past (e.g. the

Nooksack, Stillaguamish, Cedar[3], and White rivers), terminal-area harvest has been and will continue to be tightly constrained to minimize even the small remaining incidental fishery mortality. Rebuilding of abundance to viable levels for these populations may be a long-term prospect (100+ years), dependent on alleviating habitat constraints. The potential for recovery may be higher in drainages that are not heavily urbanized or developed for industrial purposes, such as the Nooksack, the Stillaguamish, and the Elwha systems, providing that stringent habitat protection measures are implemented. Habitat protection and restoration is being aggressively pursued in each watershed.

Populations with critically low abundance are present in the South Fork Nooksack, Mid-Hood Canal, and Dungeness rivers. A hatchery supplementation program has increased the returns to the Dungeness system in recent years, and affords assurance that this population will not become extinct. Harvest mortality of these populations, in SUS waters, is highly constrained because of their critical status, and because the precision of fishery simulation modeling for these small populations is subject to error. The harvest plan, by imposing very low SUS exploitation rate ceilings, will ensure that their risk of extinction is not increased, and will provide sufficient escapement to these rivers to allow these populations to persist in the near term. Critical exploitation rate ceilings will assure small but significant increases in the proportion of each population that escapes to spawn, and maintenance of their genetic diversity. However, given the status of the South Fork Nooksack and Mid-Hood Canal populations, the comanagers will consider the need for artificial supplementation programs to protect them against extinction.

The limits on harvest mortality provided by this plan, or further reduction of incidental harvest mortality in SUS fisheries, will not, by themselves, provide assurance of increased abundance or viability. They can only contribute to recovery of the ESU if habitat constraints are alleviated.

The role of harvest management to enable recovery of the ESU is to ensure that spawning escapement is sufficient to optimize the productivity of populations, in the context of current habitat conditions. Harvest objectives and their implementation will compensate for the uncertainty in productivity and for management error. The constraints on harvest exerted by the HMP assure that the majority of any increase in abundance associated with favorable survival in the freshwater or the marine environment, will accrue to escapement, in order to facilitate increased future production that benefits from the improved productivity conditions. Implementation of the HMP will, in general, allow escapements higher than the current MSH level, to capitalize on the production opportunity provided by favorable, higher freshwater survival conditions. For populations with more uncertain current productivity, implementation will provide stable natural escapement (in many cases considerably higher than the optimum level likely under current conditions) to preserve options for recovering production throughout the ESU in the long term.

In summary, the HMP provides a high degree of assurance that, for the next six years, the core indigenous populations in the Puget Sound ESU will continue to rebuild, and that all other populations will persist at, or above, their current abundance. A recovered ESU will necessarily include regional balance (i.e. geographic and diversity). The NMFS has not yet defined which of the extant populations are essential to a recovered ESU, so the qualifying language in the 4(d) rule, with respect to non-essential populations, does not provide a criterion for the adequacy of this plan. Clearly, systems where non-indigenous populations have been established through

[3] An independent population may also exist in the northern tributary streams of Lake Washington, but specific management objectives for that population await development of key information regarding the abundance and distribution of natural-origin chinook in those streams.

hatchery programs also comprise valuable elements of geographic and genetic diversity. But the ability of harvest management to preserve all existing diversity is limited. Despite the optimism created by the complex recovery planning effort now underway, the current diversity of the ESU may not persist unless habitat constraints are alleviated, thus allowing the natural productivity of chinook population to increase. For those populations that are unlikely to recover in the near term, due to habitat constraints, the HMP preserves the future option to recover if the collective societal will is exerted to preserve their habitat.

6.8 Summary of Conservation Measures

1. Exploitation rates have been substantially reduced from past levels. The fisheries constraints in this plan will keep ER's at low rates.

2. Exploitation rate ceilings established for each management unit using the best available biological information, have been shown to achieve a high degree pf probability of stable abundance under current habitat constraints, while not impeding recovery to higher abundance as habitat conditions and marine survival allow.

3. Rebuilding exploitation rates are ceilings, not annual targets for each management unit. Under current conditions most management units are not producing a harvestable surplus, as defined by this plan, so weak stock management procedures that assure meeting conservation needs of the least productive unit(s) forces the annual target rates for most units below the RER ceiling. Projected ER's in 2000 – 2002 for the Skagit, Stillaguamish, and Snohomish management units were substantially below their respective ceiling rates (Table 15).

Table 15. Annual projected total exploitation rates compared with RERs for natural chinook management units in Puget Sound.

Management Unit	RER	Projected ER			
		2000	2001	2002	2003
Skagit summer/fall	52%	26%	38%	24%	48%
Skagit spring	42%	21%	22%	24%	23%
Stillaguamish summer/fall	25%	13%	17%	14%	17%
Snohomish summer/fall	35% (2000); 32% (2001-02); 24% (2003)	20%	21	18%	19%

4. If a harvestable surplus is available for any management unit, that surplus will only be harvested if a fishing regime can be devised that is expected to exert an appropriately low incidental impact on weaker commingled populations, so that their conservation needs are fully addressed.

5. Exploitation rate objectives will be met for each MU, unless interceptions in Canadian and Alaskan fisheries increase to the extent that unacceptable further reductions in Washington fishing opportunity, on harvestable chinook or species, is necessary to achieve those objectives.

6. If annual abundance is forecast to result in escapement at or below the low abundance threshold, SUS fisheries exploitation rate will be further reduced to the CERC. The low abundance thresholds are intentionally set at levels substantially higher than the actual point of biological instability, so that fisheries conservation measures are implemented to prevent abundance falling to that point.

7. High exploitation rates in the past may have selected against larger, older spawners, thereby changing the age composition or reducing the size of spawning chinook. To the extent that this has occurred, the reduction in exploitation rates required under this plan will increase the proportion of larger, older spawners. The potential for size-, age-, and sex-selective effects of fisheries on spawning chinook are reviewed in Appendix F.

8. The reduction in exploitation rates required under this plan will increase the number of chinook carcasses on the spawning grounds. Any increase in productivity that results from this increase in carcasses will accelerate recovery beyond what was assumed when deriving the ceiling ER's (see Chapter 8 and Appendix D for a more detailed discussion of the nutrient re-cycling role of salmon carcasses).

9. Under all conditions of management unit status, whether critical or not, the co-managers maintain the prerogative to implement conservation measures that reduce fisheries-related mortality farther below any ceiling stated in this Plan. Responsible resource management will take into account recent trends in abundance, freshwater and marine survival, and management error for any unit.

7. Monitoring, Assessment and Adaptive Management

The performance of the fishery management regime will be evaluated annually, to assess whether management objectives were achieved, and identify the factors contributing to success or failure of management. This performance assessment will be documented in an annual report, to be completed by mid-February each year for reference during the annual fishery management planning process.

While much of the information in the annual report will be preliminary, and it can only point to major events, the annual review is intended to inform the co-managers of any significant reasons for possible deviations from expected outcomes in the immediately preceding season. To the extent possible, the co-managers will use this information to assess whether these deviations were caused by the management system, or to unpredictable variation in the catch distribution of the various management units, migration timing, freshwater entry timing, or other environmental and behavioral factors. Management system inaccuracies might include error or bias in abundance forecasts, inaccuracy or bias in the FRAM fishery simulation, inaccurate in-season abundance assessment tools, or the failure of specific regulations to constrain harvest-related impact in the desired manner.

The co-managers recognize that some degree of inaccuracy and imprecision is inherent in these aspects of the management system. The intent of the annual review is to detect significant and consistent inaccuracies that may become problematic over the short term, and to adjust existing tools or devise new tools, to address them.

7.1 Monitoring and Evaluation

The Northwest Washington Indian Tribes and the Washington Department of Fish and Wildlife (WDFW), independently and jointly conduct a variety of research and monitoring programs that provide the technical basis for fisheries management. These activities were mandated by the PSSMP in 1985, though activities related to chinook management have evolved as management tools have improved. Monitoring and assessment essential to the management of Puget Sound chinook is described in detail below, with discussion of how the information is used to validate and improve management regimes. This section is not an exhaustive inventory of chinook research. A wide variety of other studies are underway to identify factors that limit chinook production in freshwater, and to monitor the effectiveness of habitat restoration.

7.1.1 Catch and fishing effort

Chinook harvest in all fisheries, including incidental catch, and fishing effort are monitored and compared against pre-season expectations. Commercial catch, and ceremonial, subsistence, and ‘take-home’ harvest in Washington waters are recorded on sales receipts (‘fish tickets’), copies of which are sent to WDFW and tribal agencies and recorded in a jointly maintained database. A preliminary summary of catch and effort is available four months after the season, though a final, error-checked record may require a year or more to develop.

Catch and effort are estimated in-season for certain chinook fisheries that are limited by catch quotas, such as the ocean troll and recreational fisheries that are managed under the purview of the Pacific Fisheries Management Council. Recreational catch in Areas 1 – 6 is estimated in-season by creel surveys. Creel sampling regimes have been developed to meet acceptable standards of variance for weekly catch.

For other Puget Sound fishing areas, recreational harvest is estimated from a sample of catch record cards obtained from all anglers. The baseline sampling program for recreational fisheries provides auxiliary estimates of species composition, effort, and catch per unit effort (CPUE) to the Salmon Catch Record Card System. The baseline sampling program is geographically stratified among Areas 5-13 in Puget Sound. For this program, the objectives are to sample 120 fish per stratum for estimation of species composition, and 100 boats per stratum for the estimation of CPUE.

Catch and effort summaries allow an assessment of the performance of fishery regulations in constraining catch to the desired levels. Time and area constraints, and gear limitations, are imposed by regulations, but with some uncertainty regarding their exact effect on harvest. For many fisheries, catch is often projected preseason based on the presumed effect of specific regulations. Post-season comparison to actual catch assesses the true effect of those regulations, and guides their future application or modification.

Incidental mortality in fisheries directed at other species has comprised an increasingly significant proportion of the total harvest mortality of Puget Sound chinook, after the elimination of most directed harvest . For many commercial net fisheries in Puget Sound, incidental mortality is projected by averaging a recent period, either as total chinook landed or as a proportion of the target species catch. Recent-year data are the basis for continually updating these projections.

Non-landed mortality of chinook is significant for commercial troll, recreational hook-and-line, and certain net fisheries, regulations for which may mandate release of sub-adult chinook, or all chinook, during certain periods. Studies are periodically undertaken to estimate encounter rates and hooking mortality for these fisheries. Findings from these studies are required to validate the encounter rates and release mortality rates used in fishery simulation models.

Higher priority has been assigned to sampling the catch from certain terminal-area fisheries, to collect biological information about mature chinook. Collection of scales, otoliths, and sex and length data will characterize the age and size composition of the local population, and distinguish hatchery- and natural-origin fish.

7.1.2 Spawning escapement

Chinook escapement is estimated from surveys in each river system. A variety of sampling and computational methods are used to calculate escapement, including cumulative redd counts, peak counts of live adults, cumulative carcass counts, and integration under escapement curves drawn from a series of live fish or redd counts. A detailed description of methods used for Puget Sound systems is included in Appendix E.

Escapement surveys also provide the opportunity to collect biological data from adults to determine their age, length, and weight, and to recover coded-wire tags. Tissue or otolith samples are also used to determine whether they are of hatchery or wild origin, and coded wire tags or otoliths may be used to identify strays from other systems. Depending on the accuracy required of such estimates, more sampling effort will be directed to gathering basic biological data to determine age and sex composition. State and tribal technical staff are currently focusing attention on the design and implementation of these studies.

Escapement surveys also describe the annual variation in the return timing of chinook populations. Given that terminal-area fisheries for chinook have been highly restricted or eliminated throughout Puget Sound, escapement surveys are increasingly relied on to monitor run timing, as well as age composition.

7.1.3 Reconstructing Abundance and Estimating Exploitation Rates

Estimates of spawning escapement and its age composition, and of fishery exploitation rates enable reconstruction of cohort abundance. After adjustment to account for non-landed and natural mortality, these estimates of recruitment define the productivity of specific populations. The principal intent of the current chinook harvest management regime is to set management unit objectives based on the current productivity of their component populations. These objectives will change over time, therefore, in response to change in productivity.

Indicator stocks, using local hatchery production, have been developed for many Puget Sound populations, as part of a coast-wide program established by the Pacific Salmon Commission. These include Nooksack River early, Skagit River spring, Stillaguamish River summer, Green River fall, Nisqually River fall, Skokomish River fall, and Hoko River fall stocks. Additional indicator stocks are being developed for Skagit River summer and fall, and Snohomish summer stocks. To the extent possible, indicator stocks have the same genetic and life history characteristics as the wild stocks that they represent. Indicator stock programs are intended to release 200,000 tagged juveniles annually, so that tag recoveries will be sufficient for accurate estimation of harvest distribution and fishery exploitation rates.

Commercial and recreational catch in all marine fishing areas in Washington is sampled to recover coded-wire tagged chinook. For commercial fisheries, the objective is to sample at least 20% of the catch in each area, in each statistical week, throughout the fishing season. For recreational fisheries, the objective is to sample 10% of the catch in each month / area stratum. These sampling objectives have been consistently achieved or exceeded in recent years (cite Milward or annual 2001 and 2002 annual reports). Mass marking of hatchery-produced chinook, by clipping the adipose fin, has necessitated electronic sampling of catch and escapement to detect coded-wire tags.

Coded-wire tag recovery data enables the calculation of total, age-specific fishing mortality in specific fisheries. These estimates of fishery mortality may be compared with those made by the fishery simulation model (FRAM) to check model accuracy. The FRAM may incorporate forecast or actual abundance and catch, which are scaled against base-year abundance and fisheries. It is recognized that the model cannot perfectly simulate the outcome of the coast-wide chinook fishing regime, so, periodically, the bias in simulation modeling will be assessed. The migration routes of chinook populations may vary annually, and the effect of changing fisheries regulations cannot be perfectly predicted in terms of landed or non-landed mortality.

Mark-selective fisheries, if implemented on a large scale, will exert significantly different landed and non-landed mortality rates on marked and unmarked chinook populations. Accurate post-season assessment of age- and fishery-specific harvest mortality, through a gauntlet of non-selective and mark-selective fisheries, represents a daunting technical challenge, particularly due to the complex age structure of chinook. Release of double index CWT groups (i.e. equal numbers of marked (adipose clipped) and unmarked fish containing distinct tag codes) has been initiated for many indicator stocks, as a means of maintaining the objectives of the coast-wide CWT indicator stock programs. Analyses are in progress to assess if the accuracy of exploitation rates is significantly reduced.

7.1.4 Smolt Production

Smolt production from several Puget Sound management units is estimated to provide additional information on the productivity of populations, and to quantify the annual variation in freshwater (i.e. egg-to-smolt) survival. Methods and locations of smolt trapping studies are described in detail elsewhere (e.g. Seiler et al. 2002, Patton 2003), but in general, traps are operated through the outmigration period of chinook (January – August). By sampling a known proportion of the channel cross-section, with experimental determination of trapping efficiency, estimates of the total production of smolts are obtained. These estimates are essential to understanding and predicting the annual recruitment, particularly in large river systems where freshwater survival has been shown to vary greatly. Abundance forecasts may incorporate any indications of abnormal freshwater survival.

Survival of juvenile chinook is highly dependent on favorable conditions in the estuarine and near-shore marine zones. For many Puget Sound basins, degraded estuarine and near-shore marine habitat is believed to limit chinook production. Studies are underway to describe estuarine and early marine life history, and to quantify survival through the critical transition period as smolts adapt to the marine environment (Beattie 2002).

7.2 Annual Chinook Management Report

The co-managers will write an annual report on chinook fisheries management. Post-season review is part of the annual pre-season planning process, and is necessary to permit an assessment of the parties' annual management performance in achieving spawning escapement, harvest, and allocation objectives. The co-managers review stock status annually and where needed, identify actions required to improve estimation procedures, and correct bias. Such improvements provide greater assurance that objectives will be achieved in future seasons. Annual review builds a remedial response into the pre-season planning process to prevent excessive fishing mortality levels relative to the conservation of a management unit. The annual report will include:

Fisheries Summary
The chronology and conduct of all fisheries within the co-managers' jurisdiction will be summarized, comparing expected and actual fishing schedules, and landed chinook catch. Significant deviations from the pre-season plan will be highlighted, with a summary of in-season abundance assessments and changes in fishing schedules or regulations.

Catch
Landed catch of chinook in all fisheries during the management year (May – April) will be compared with pre-season expectations of catch, including revised estimates of landed catch for the previous management year. For the most recent management year, preliminary estimates of commercial catch from all fisheries will be reported. Creel survey-based estimates of recreational catch in Areas 1 – 6 will also be available. The causes of significant discrepancies between expected and actual catch will be examined, with a view to improving the accuracy of the pre-season projections.

Non-landed Mortality:
Recreational and troll fisheries typically allow retention of chinook above a minimum size, or prohibit retention of chinook during some periods. The ocean troll fishery has been monitored since 1999, using on-board observers and fishers to collect data on encounters with sub-legal chinook. These studies enable comparison of encounters, and consequent mortality, with pre-season expectations.

Spawning Escapement
Spawning escapement for all management units will be compared to pre-season projections, with detail on individual populations reported as possible. Escapements will be compared to escapement goals and critical escapement thresholds. Final and detailed estimates of escapement for the previous year will also be tabulated.

Sampling Summary
The annual review will also include summary of CWT sampling rates achieved in the previous year, and describe biological sampling (i.e., collection of scales, otoliths, and sex and size data) of catch and escapement.

Exploitation Rate Assessment
Annual, adult equivalent exploitation rates for each management unit will be estimated periodically, using the FRAM, incorporating actual chinook catch from all fisheries, and estimates of the actual annual abundance of all chinook units, based on spawning escapement or terminal abundance. These rates will be compared to the preseason expected ER's and ceiling ER's. The 2002 annual report will include post-season FRAM estimates through 2000. Methods are also being developed for assessing annual exploitation rates, for management units with representative indicator stocks, based on coded-wire tag data.

ISBM Index Rates:
The annual report will summarize the Chinook Technical Committee's assessment of whether non-ceiling fishery exploitation rates for indicator management units achieved the PST benchmarks (either 60% of the 1979-1982 mean non-ceiling rate or the 1991-1996 average reduction compared with that base period), for units failing to achieve agreed escapement goals for two consecutive years

The following assessments will be done every 5 years:

Cohort Reconstruction and Exploitation Rate (from CWT data)
Coded-wire tag data will be used to reconstruct brood year AEQ recruitment and exploitation rates for management units with representative indicator stocks, for the five most recently completed broods with complete data. Because coded-wire tag recoveries require at least one year to process and record, estimates for a given brood year will be made six years later, (i.e. after the brood is completely matured).

Comparison to FRAM
The AEQ fishing year and brood year exploitation rates generated from coded-wire tag data will be compared to the corresponding rates estimated annually from post-season runs of the assessment model. Biases will be examined and either accounted for or corrected in future management.

Spawner-Recruit Parameters
The spawner-recruit parameters used to generate the ceiling ER's, thresholds, and recovery goals will be re-examined by including the most recent data on escapement, juvenile production, habitat productivity, marine survival, and recruitment. As appropriate, the ceiling ER's, thresholds, and recovery goals will be updated to account for changes in productivity.

7.3 Spawning Salmon – A Source of Marine-derived Nutrients

Adult salmon provide essential marine-derived nutrients to freshwater ecosystems, as a direct food source for juvenile or resident salmonids and invertebrates, and as their decomposition supplies nutrients to the food web. A body of scientific literature, reviewed in Appendix D, supports the contention that the nutrient re-cycling role played by salmon is particularly important in nutrient-limited, lotic systems in the Northwest. Some studies assert that declining salmon abundance and current spawning escapement levels exacerbate nutrient limitation in many systems. Controlled experiments to test the effect of fertilizing stream systems with salmon carcasses or nutrient compounds show increased primary and secondary productivity, and increased growth rates of juvenile coho and steelhead.

The question this issue poses to chinook harvest management is whether the management objectives stated in this Plan will result in spawning escapement levels that, in fact, are likely to cause or exacerbate nutrient limitation, and thus negatively influence the growth and survival of juvenile chinook, or otherwise constrain recovery of listed populations. Several aspects of this issue are relevant to determining whether such negative influence exists

The role of adult chinook must be examined in the context of escapement (i.e. nutrient potential) of all salmon species. In the large river systems that support chinook, escapements of pink, coho, and chum salmon comprise a large majority of total nutrient input. Changing chinook escapement, therefore, will not increase nutrient loading significantly.

The fertilizing influence of salmon carcasses on chinook depends on a complex array of factors, including their proximity to chinook rearing areas, the influence of flow and channel structure on the length of time carcasses are retained, and chinook life history.

Harvest management strategy must be informed by credible direct or circumstantial evidence indicating that chinook survival is currently limited by nutrient supply.

Post-emergent survival of juvenile chinook is undoubtedly affected by a complex array of other biotic and physical factors. The incidence and magnitude of peak flow during the incubation season, for example, is correlated very strongly with outmigrant smolt abundance in the Skagit River and other Puget Sound systems (Seiler et al. 2000).

Currently available evidence does not support the contention that increasing escapement goals, for chinook or other species, would likely to result in higher chinook abundance or, in the long term, increased harvestable surplus. Under exploitation rate management, which this Plan describes for several management units, escapement will increase as abundance increases. These principles have been in effect since 1998, and increases in escapement have resulted in some systems. This has the same effect as increasing the escapement goal.

The nutrient benefit of increased escapement affects, predominantly, smolt production from that brood year, especially for chinook populations that outmigrate as sub-yearlings. Spawner – recruit analyses will reflect the potential effect of nutrient loading on productivity. Regular updating of the spawner – recruit function is mandated by this plan, and will detect changes in productivity that result from widely variable, and in some systems, increasing, nutrient loading associated with spawning escapement of all salmon.

Unquestionably, further study of the potential for nutrient limitation of chinook growth and survival is warranted. Studies should be designed and implemented to test nutrient limitation hypotheses in several chinook-bearing systems, and in smaller tributary systems that allow controlled experimental design. These studies should include monitoring secondary production of aquatic macroinvertebrates, fingerling condition, smolt abundance and survival to adulthood under controlled conditions to allows isolation of the effect of carcass nutrient loading. They will be difficult to design and implement, such that results are clear and unconfounded by the complexity of physical factors and trophic dynamics freshwater systems. Such studies may, ultimately, lead to quantifying nutrient loading thresholds where effects on chinook growth and survival are evident, to guide harvest management.

Manipulating spawning escapement, or supplementing nutrient loading with surplus hatchery returns will require resource management agencies to consider benefits and potential negative effects from a wider policy perspective. Artificial nutrient supplementation, despite its potential benefits to salmon production, contradicts the long-standing effort to prevent eutrophication of freshwater systems. Use of surplus carcasses from hatcheries also has serious potential implications for disease transmission. Public policy will, therefore, have to be carefully crafted to meet potentially conflicting mandates to protect water quality and restore salmon runs (Lackey 2003).

7.4 Age- and Size-Selective Effects of Fishing

Commercial and recreational salmon fisheries exert some selective effect on the age, size, and sex composition of mature adults that escape to spawn (Appendix F). When and where fisheries operate, the catchability of size and age classes of fish associated with different gear types, and the intensity of harvest determine the magnitude of this selective effect. In general, hook-and-line and gillnet fisheries are thought to selectively remove older and larger fish. To a certain extent related to the degree to which age at maturity and growth rate are genetically determined, subsequent generations may composed of fewer older-maturing or faster growing fish. Fishery-related selectivity has been cited as contributing to long-term declines in the average size of harvested fish, and the number of age-5 and age-6 spawners. Older, larger female spawners are believed to produce larger eggs, and dig deeper redds, which improve survival of embryos and fry. .

There is no evidence of long-term or continuing trends in declining size or age at maturity for Puget Sound chinook.. Available data suggest that the fecundity of mature Skagit River summer chinook has not declined from 1973 to the present. (Orrell 1976; SSC 2002). The age composition of Skagit summer / fall chinook harvested in the terminal area has varied widely over the last 30 years, particularly with respect to the proportions of three and four year-old fish, but there is no declining trend in the contribution of five year-olds, which has averaged 15 percent (Henderson and Hayman 2002; R. Hayman, SSC December 9, 2002, pers comm.)

7.5 Amendment of the Harvest Management Plan

The Plan will continue to evolve. Harvest objectives will change in response to change in the status and productivity of chinook populations. It is likely that the assessment tools will evolve to improve estimation of spawning escapement and cohort abundance. Data gaps are identified for each management unit in their profiles (Appendix A). As these new data accumulate, the co-managers will periodically re-assess harvest objectives for all management units. In general this will occur on a five-year cycle, unless information suggests that rapidly changing status demands more frequent attention.

8. Glossary

Abundance - Abundance is the number of individuals comprising a population or a component of the population, at a given life stage. Abundance may be expressed as brood year escapement (spawners of all ages that survive from one brood year) or return year escapement (the individuals maturing and returning to spawn in a single year). Abundance goals are expressed as numeric life stage targets reflective of the capacity of the associated ecosystem.

Adult Equivalent (AEQ) - The adjustment of fishing mortality to account for the potential contribution of fish of a given age to the spawning escapement, in the absence of fishing. Because not all unharvested fish will survive to contribute to spawning escapement, a two-year-old chinook has a lower probability of surviving to spawn, in the absence of fishing, than does a five-year-old.

Catch Ceiling - A fishery catch limitation expressed in numbers of fish. A ceiling fishery is managed so as not to exceed the ceiling. A ceiling is not an entitlement. [see also **catch quota**]

Catch Quota - A fishery catch allocation expressed in numbers of fish. A quota fishery is managed to catch the quota; actual catch may be slightly above or below the quota. [see also **catch ceiling**]

Cohort Analysis - Reconstruction of the abundance of a population or management unit prior to the occurrence of any fishing mortality. The calculation sums spawning escapement, fisheries-related mortality, and adult natural mortality.

Cohort Size (initial) - The total number of fish of a given age and stock at the beginning of a particular year of life.

Coded-Wire Tag (CWT) - Microtags are implanted in juvenile salmon prior to their release from hatcheries. Recovered by sampling catch and escapement, the binary code on the tag provides specific information about the age and origin of the fish.

Low abundance threshold - A spawning escapement level, set intentionally above the point of biological instability, which triggers extraordinary fisheries conservation measures to minimize fishery related impacts and increase spawning escapement.

Diversity - Diversity is the measure of the heterogeneity of the population or the ESU, in terms of the life history, size, timing, and age structure. It is positively correlated with the complexity and connectivity of the habitat.

Drop-off Mortality - The fraction of salmon encountered by a particular gear type that "drop-off" before they are landed, and die from their injuries prior to harvest or spawning.

Escapement – Adult salmon that survive fisheries and natural mortality, and return to spawn.

Evaluation or Test Fishery - A fishery scheduled specifically to obtain technical or management information, e.g. run timing, abundance, and age composition.

Exploitation Rate (ER) - Total mortality in a fishery or aggregate of fisheries expressed as the proportion of the sum of total mortality plus escapement.

Extreme Terminal Fishery – A fishery in freshwater that is assumed to harvest fish from the local management unit.

Fishery – Harvest by a specific gear type in a specific geographical area during a specific period of time.

FRAM - The Fishery Regulation Assessment Model is a simulation model developed to estimate the impacts of Pacific Coast fisheries on chinook and coho stocks.

Gamma Distribution - The gamma distribution is member of the exponential family of distributions. Values of the gamma distribution are positive, ranging from zero to infinity, a property which makes it attractive for modeling variances. Shape and scale parameters describe the distribution.

Harvest Rate (HR) - Total fishing mortality of a given stock expressed as a proportion of the total fish abundance available in a given fishing area at the start of a time period.

Landed Catch – Harvested fish that are taken aboard vessels or shore and retained by fishers. [see also **Nonlanded Mortality**]

Management Period – Based on information about migration timing, the management period is the time interval during which a given species or management unit may be targeted by fishing in a specified area. [see also **Management Unit**]

Management Unit - A stock or group of stocks that are aggregated for the purpose of achieving a management objective.

Maximum Sustainable Harvest (MSH) - The maximum number of fish of a management unit that can be harvested on a sustained basis, that will result in a spawning escapement level that optimizes productivity.

MSH Exploitation Rate – The maximum sustainable harvest (MSH) exploitation rate is the proportion of the stock abundance that could be harvested if long-term yield was to be maximized. The MSH exploitation rate is typically computed assuming stable stock productivity, although annual variability may occur.

Non-landed Mortality – Fish not retained that are otherwise killed as a result of encountering fishing gear. It includes a proportion of sub-legal fish that are captured and released, hook-and line drop-off, and net drop-out mortality. [see **Landed Catch**]

Non-treaty Fisheries - All fisheries that are not treaty Indian fisheries. [see **Treaty Fisheries**]

North of Cape Falcon Forum– A pre-season, management planning process for fisheries in Washington and Oregon, consisting of two public meeting, which occur between the March and April Pacific Fishery Management Council meetings. These meetings provide for an opportunity for discussion, analysis and negotiation among management entities with authority over southern US fisheries.

Parties - The State of Washington and 17 Puget Sound tribes comprise the parties to this plan.

Point of instability - that level of abundance (i.e., spawning escapement) that incurs substantial risk to genetic integrity, or exposes the population to depensatory mortality factors.

Pre-terminal Fishery- A fishery that harvests significant numbers of fish from more than one region of origin.

Productivity - Productivity is the ratio of the abundance of juvenile or adult progeny to the abundance of their parent spawners

Recruitment – Production, quantified at some life stage (e.g. smolts or sub-adults) from a single parent brood year.

Run Size - The number of adult fish in an allocation unit, management unit, stock or any aggregation thereof that is subject to harvest in a given management year.

Shaker Mortality - Nonlanded fishing mortality that results from releasing sub-legal fish, or non-target species. [see **Nonlanded Mortality**]

Southern US Non-Ceiling Index – The index compares the expected AEQ mortalities (assuming base period exploitation rates and current abundance) with the observed AEQ mortalities, by calendar year, over all non-ceiling fisheries in southern US. This index originates from the pass through provision of the Pacific Salmon Treaty.

Stock - a group of fish of the same species that spawns in a particular lake or stream (or portion thereof) at a particular season and which, to a substantial degree, does not interbreed with fish from any other group spawning in a different place or in the same place at a different season.

Terminal Fishery - A fishery, usually operating in an area adjacent to or in the mouth of a river, which harvests primarily fish from the local region of origin, but may include more than one management unit. Non-local stocks may be present, particularly in marine terminal areas.

Treaty Fisheries - Fisheries authorized by tribes possessing rights to do so under the Stevens treaties (see also **Non-treaty Fisheries).**

Tribes - Puget Sound treaty tribes that are parties to this Plan include the: Lummi, Nooksack, Swinomish, Upper Skagit, Sauk-Suiattle, Tulalip, Stillaguamish, Muckleshoot, Suquamish, Puyallup, Nisqually, Squaxin Island, Skokomish, Port Gamble S'Klallam, Jamestown S'Klallam, Lower Elwha Klallam, and Makah.

Viable – In this plan, this term is applied to salmon populations that have a high probability of persistence (i.e. a low probability of extinction) due to threats from demographic variation, local environmental variation, or threats to genetic diversity. This meaning differs from that used in some conservation literature, in which viability is associated with healthy, recovered population status (see McElhany et al. 2000).

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Appendix A: Management Unit Status Profiles

Nooksack River Management Unit Status Profile

Component Stocks

North/Middle Fork Nooksack early chinook
South Fork Nooksack early chinook

Geographic description

The Nooksack River natural chinook management unit is comprised of two early-returning, native chinook stocks that are genetically distinct, geographically separated, and exhibit slightly different migratory and spawning timing. They have been combined into a management unit because their similar migration timing through the fishing areas in the Nooksack River, below the confluence with the South Fork, and Bellingham and Samish Bays.

The North and Middle Forks drain high altitude, glacier-fed streams. Early-timed chinook spawn in the North Fork and Middle Fork from the confluence of the South Fork (RM 36.6) up to Nooksack Falls at RM 65, and in the Middle Fork downstream of the diversion dam, located at RM 7.2. Spawning also occurs in numerous tributaries including Deadhorse, Boyd, Glacier, Thompson, Cornell, Canyon, Boulder, Maple, Kendall, Racehorse, and Canyon Lake creeks. A hatchery-based egg bank and restoration program has operated at the Kendall Creek facility since 1981. Since then up to 2.3 million fingerlings, 142,458 unfed fry and 348,000 yearlings have been released annually into the North Fork, or at various acclimation sites. The yearling release program was discontinued after the 1996 brood because returns showed that survival rates were lower than those of fed fry releases. Since 2001, fingerlings have been released into the Middle Fork, in anticipation of removal of a blocking diversion dam. Beginning in 2003, the Kendall Creek program releases were downsized due to habitat capacity and straying concerns.

The South Fork drains a lower-elevation watershed that is fed primarily by snowmelt and rainfall, not by glaciers. Consequently, river discharges are relatively lower and temperatures relatively higher than the North and Middle forks during mid to late summer and early fall. Some South Fork tributaries have temperature regimes more similar to those in the North and Middle Forks during the late summer and early fall. A hatchery-based egg bank and restoration program operated at the Lummi Skookum Creek facility in brood years 1980 – 1993, but was discontinued when the returns to the hatchery ladder did not occur in significant numbers, and the capture of wild broodstock was not considered appropriate at such low abundances.

Life History Traits

Nooksack early chinook enter the lower Nooksack River from March through July, and migrate upstream over a 30 – 40 day period to holding areas. In the North / Middle Fork spawning occurs in the upper reaches from mid-July through late September, peaking in August. Spawning is currently concentrated in the North Fork, from RM 44 to RM 64, but may not represent the historical spawning distribution. The current distribution may be influenced by station and off-station release locations. Early chinook spawn in the South Fork from its confluence with the North Fork to a cascade at RM 30.4, and in Hutchinson, Skookum, Deer and Plumbago creeks. In the mainstem South Fork spawning is currently concentrated between RM 8 and RM 21. Hutchinson Creek has had the majority of the tributary spawning in recent years. South Fork spawning begins in August, and peak spawning occurs two to three weeks later than in the North / Middle Fork.

The North/Middle Fork Restoration Program utilizes several release strategies from the Kendall Creek Hatchery. Thermal otolith marks are applied to each release group, so their survival and spawning distribution can be evaluated when the fish return as adults. Otolith analysis has shown that strays into the South Fork, while small relative to the total returns of cultured fish to the watershed, can make up to 46% of the early stocks returning to the South Fork.

The release strategy in the of the North/Middle Fork restoration program was changed in 2001 to reduce the on-station release from Kendall Hatchery, which had shown the highest stray rate into the South Fork, from 900,000 fingerlings in 1998 in a series of reductions to 150,000 fingerlings in 2003, the current release goal. At the same time the total off-station release was reduced from 1,700,000 fingerlings in 1999 to 400,000 fingerlings in the North Fork, 200,000 in the Middle Fork, and 50,000 remote site incubator fry in the North Fork in 2003.

Earlier analysis of scales collected from North Fork spawners showed that a large majority (91%) emigrated from freshwater at age-0(WDFW 1995 cited in Myers et al 1998). In contrast, a larger and highly variable (as much as 69 percent) proportion South Fork spawners emigrated as yearling smolts. A more thorough, recent review of the adult scale data collected from natural-origin spawners, for those years when at least 40 samples collected, determined that 29% and 38% of North/Middle and South Fork early chinook, respectively, migrated from the river as yearlings. The number of naturally-produced fingerling and yearling smolts produced by the North / Middle and South forks has not been quantified.

Available information on the age composition of adults returning to the North/Middle forks and the South Fork is presented in Table 1, and indicate a predominance of age-4 returns. Age-5 proportions of these magnitudes are also observed among other Puget Sound spring chinook stocks, e.g. the Suiattle River and White River. Low sample sizes as a result of difficulties in recovering carcasses on the spawning ground require caution in the interpretation of this data.

Table 1. Estimates of the age composition of returning adult early chinook in the North / Middle and South Forks of the Nooksack River.

	Age 2	Age 3	Age 4	Age 5
North/Middle Fork NOR	1%	16%	73%	10%
South Fork NOR	0%	12%	72%	16%

Status

The current status of the Nooksack early chinook stocks is critical. The geometric mean number of natural-origin spawners in the North / Middle Fork, for 1998 – 2002, was 124, though NOR escapement has increased slightly in recent years from very low levels in the late 1990s (Table 2). The number of native, natural-origin spawners in the South Fork remains low, but is also apparently stable. The geometric mean NOR escapement in South Fork, for 1998 – 2002, was 224.

Table 2. Natural-origin escapement of early chinook to the North / Middle Forks and South Fork of the Nooksack River.

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
No/Mid Fork	335	8	171	209	74	37	85	160	264	224
South Fork	235	118	290	203	180	157	166	284	267	289

Total natural spawning escapement has been substantially higher, due to returns from the Kendall Creek Hatchery supplementation program, which is considered essential to the protection and recovery of the North / Middle Fork population. In the North / Middle Fork, escapement has increased markedly since 1998, and exceeded 3,700 in 2002. The number of natural spawners in the South Fork has also increased, and reached 625 in 2002 (Table 3).

Table 3. The total number of natural early chinook spawners (i.e., hatchery- and natural-origin) in the North / Middle and South Forks of the Nooksack River. North / Middle Fork estimates exclude hatchery turnbacks.

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
No Mid Fk	445	45	224	537	574	370	823	1242	2185	3741
South Fk	235	118	290	203	180	157	290	373	420	625

Survey effort has increased to better estimate the abundance and distribution of spawners throughout the Nooksack Basin, but turbidity due to the glacial origin of the North and Middle Forks hampers efforts to enumerate live fish or redds.

North/Middle Fork escapement in the last three years has been more than three times the average for the preceding five-year period (1992-96), while South Fork populations escapement has been stable at about 200 for the last five years. The recent increase in escapement to the North/Middle Fork (Table 4, Figure 1) is attributable in large part to the increase in releases from the Kendall Creek supplementation program, although earlier increases might be related to the reduction of Canadian harvest in the late 1990s. Recruits per natural-origin spawner in the North and Middle Forks have consistently remained below one recruit per pair of spawners. Preliminary estimates of the number of natural origin spawners in the North/Middle Forks, as determined from otolith studies, indicate that the return rate of natural origin spawners for brood years 1992 through 1995 ranged from 0.08 to 0.59 per spawner (Table 5), well below the replacement rate. The large and increasing number of hatchery-origin fish escaping to the North and Middle Forks suggests that harvest in the southern U.S. is not impeding the rebuilding of the abundance of natural origin spawners. The failure of the NORs to show a substantial increase in abundance similar to that of hatchery-origin fish, during the restricted fisheries in the late 1990s, suggests limitations in the ability of existing habitat conditions to support substantial productivity from the increased spawner abundance.

Table 4: Origin of Spawners in the North/Middle Forks of the Nooksack River (Co-Manager unpublished data).

Return Year	Natural Origin	Cultured Origin	Hatchery Turnbacks	Total
1995	171	53		228
1996	209	328		537
1997	74	500		574
1998	37	333		370
1999	85	738		823
2000	160	1082	891	2133
2001	264	1921	4802	6987
2002	224	3517	3731	7472

Figure 1. Natural-origin and total natural escapement to the North / Middle Fork of the Nooksack River, and Kendall Creek Hatchery releases three years prior.

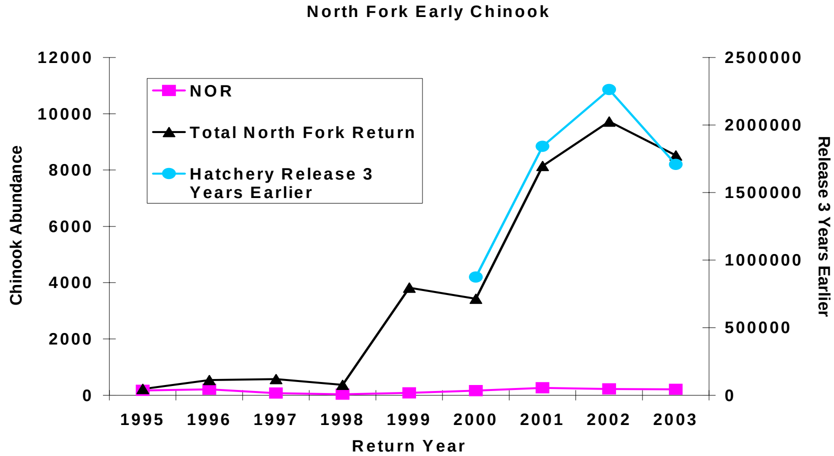


Table 5. Natural origin return per spawner rates for early chinook in the North/Middle Fork of the Nooksack River (Co-Manager unpublished data).

Brood year	Natural spawners	Total age 3 - 6 Returns	Return per Spawner
1992	493	185	0.38
1993	445	76	0.17
1994	45	25	0.56
1995	224	17	0.08
1996	533	247	0.46
1997	574	339	0.59
1998	370	103	0.36
1999*	823	149	0.18

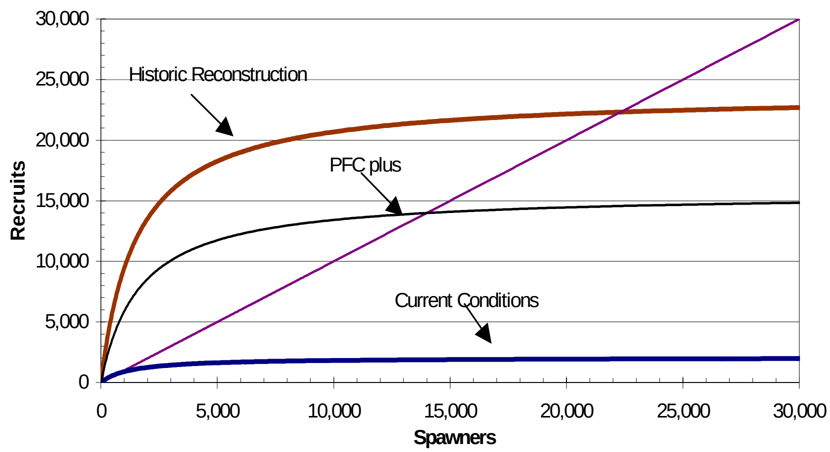
* age 3 and 4 returns only

While there is high variability in the relationship between natural-origin spawners and subsequent returns per spawner for the North / Middle Fork population, and statistical relationship is not significant, the data suggest that the recruitment rate is lower at higher spawner abundance. With the significant increase in natural spawners in recent years, the next four years will provide a clearer picture of the relationship between the number of spawners in the wild and the subsequent recruitment.

The Ecosystem Diagnosis and Treatment (EDT) methodology has produced habitat-based estimates of the productivity and abundance of the Nooksack early populations, under current, historical, and recovered (i.e. 'properly functioning' as identified by the NMFS in the FEMAT process) habitat conditions.

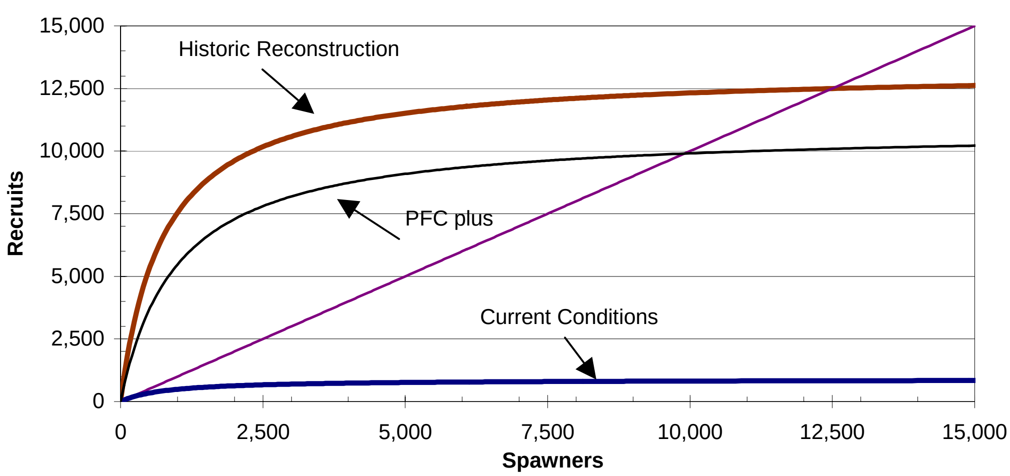
The EDT results for the North/Middle Forks under current conditions estimate capacity at 2,059 adults, equilibrium (i.e. replacement) abundance at 760, and productivity 1.6 adult recruits per spawner, without consideration of fisheries mortality. These results largely agree, but suggest slightly higher productivity than the spawner –recruit relationship derived directly from NOR escapements (Table 4). The EDT analysis indicates that productivity under recovered habitat conditions would be much greater (Figure 2).

Figure 2. Spawner-recruit relationships under current, recovered, and historical habitat conditions in the North / Middle Fork of the Nooksack River, as estimated by EDT analysis.



A similar analysis of the current productivity in the South Fork indicates adult capacity of 885, equilibrium (i.e., replacement) abundance of 80,and a return of 1.1 recruits per spawner. Productivity under recovered conditions would be far in excess of the current level. (Figure 3)

Figure 3. The spawner – recruit functions for South Fork Nooksack early chinook under current, recovered, and historic habitat conditions, as estimated by the EDT method.



The status of the South Fork stock is more difficult to determine in the absence of a reliable brood year return per spawner. The comparison of South Fork early escapement to the early escapement four years later suggest an average spawner replacement rate of 1.21 (Table 6). With the advent of otolith marks for each release strategy in the Kendall Creek Hatchery Program, the North/Middle Fork stock has been identified in the early chinook spawners in the South Fork. Because the 1991 release was the first to be otolith marked and pre-dated the substantial releases of cultured fish in the North and Middle Forks, it is assumed that the straying of North/Middle Fork chinook into the South Fork was low prior to 1995.

Table 6. Origin and replacement rate of early chinook spawners in the South Fork Nooksack River

Brood Year	South Fk Stock (no mark)	North Fk Stock	Stray Other or Unknown	Total	NOR BY+4	Replacement Rate
1991	365			365	290	0.79
1992	103			103	203	1.97
1993	235			235	180	0.77
1994	118			118	157	1.33
1995	166	87	37	290	166	0..57
1996	284	74	14	373	284	1.40
1997	267	138	15	420	267	1.48
1998	289	289	44	625	289	1.84
1999	204	217	148	570	204	0.70
					Average	1.21

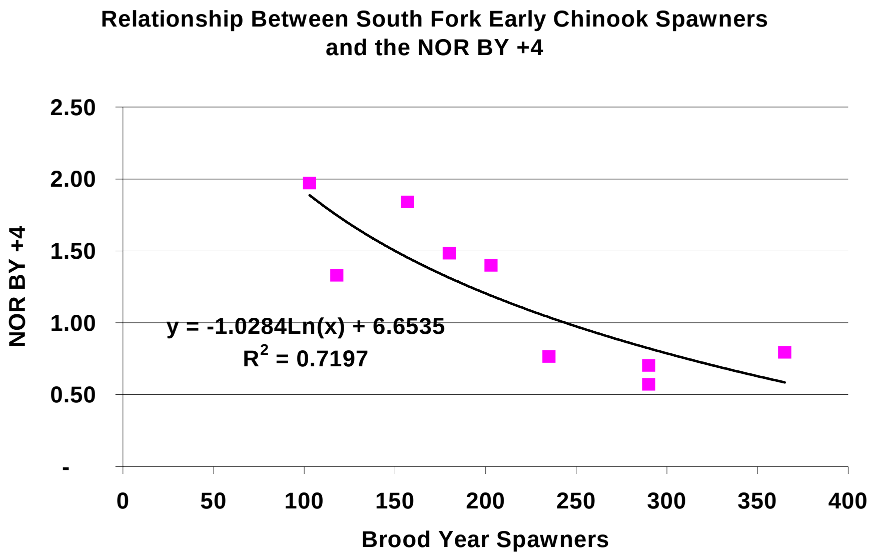
Recent information indicates that as much as 46% of the early chinook spawners in the South Fork have been strays from the Kendall Creek Hatchery program.

Table 7. Estimates of the contributions the native South Fork stock to natural spawning in the South Fork of the Nooksack River, 1999 - 2003.

Return Year	Total Early Number	South Fork Stock	
		Number	Percent
1999	290	166	57%
2000	373	284	76%
2001	420	267	64%
2002	625	289	46%
2003	570	204	36%

The relationship between the number of early chinook spawners in the South Fork and the number of natural origin recruits to the spawning grounds 4 years after the brood year (Figure 4) strongly suggests that habitat conditions constrain productivity in the South Fork. This relationship assumes that the reproductive success of the North Fork and other strays is similar to that of the South Fork population, and that the unmarked fish represent only NORs returning to the South Fork, regardless of the origin of the stock.

Figure 4. The relationship between natural origin early chinook spawners in the South Fork and their replacement rate for spawners four years later.



Harvest distribution

Recoveries of coded-wire tagged North Fork early chinook indicate that a majority of the historic harvest mortality occurs outside of Washington waters, primarily in Georgia Strait and other net and recreational fisheries in British Columbia (Table 8). The principles of abundance-based management of chinook, which were agreed to in the re-negotiated Pacific Salmon Treaty Chinook Annex in 1999, did not constrain harvest of Nooksack early chinook in Georgia Strait, where they comprise less than one percent of the total catch. Conservation measures aimed at reducing spring chinook harvest in the Strait of Juan de Fuca and northern Puget Sound have been in place since the late 1980s. There have been no directed commercial fisheries in Bellingham Bay and the Nooksack River since the late 1970's. Incidental harvest in fisheries directed at fall chinook in Bellingham Bay and the lower Nooksack River was reduced in the late 1980s by severely reducing July fisheries. Since 1997, there has been a very limited subsistence fishery in the lower river in early July. Commercial fisheries in Bellingham Bay that target fall chinook have been delayed until August for tribal fishers, and mid-August for non-treaty fishers. After 1997, the release of summer fall chinook from the Kendall hatchery was moved down to the tidal portion of the river and then to the Maritime Heritage Hatchery on the eastern shore of Bellingham Bay, and then eliminated entirely. Fall chinook production at the Lummi Sea Ponds facility was reduced by about 50% to about 1.0 million fingerlings in 1995. This has shifted the emphasis of the terminal area fishery away from the Nooksack River to the Samish Bay and Lummi Bay areas and reduced the proportion of the tribal harvest taken in the Nooksack River.

Table 8. Average harvest distribution of Nookack early chinook, for management years indicated, as percent of total adult equivalent fishery mortality (CTC 2003).

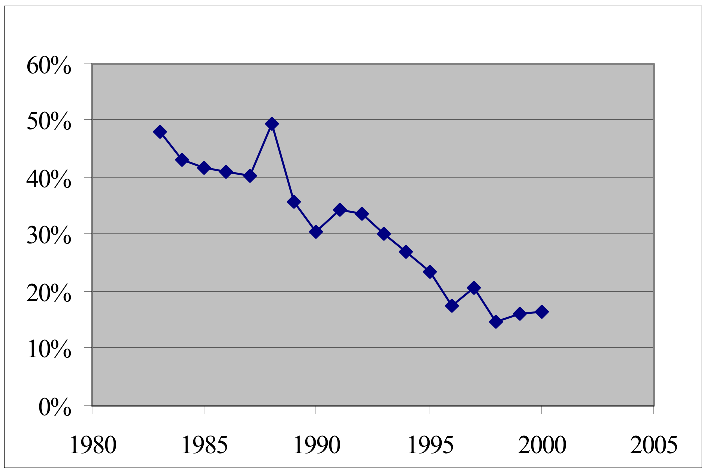
	Alaska	B.C.	Wa troll	PS net	Wa sport
1995-1999 yearlings	0.0%	67.4%	1.9%	6.4%	24.3%
1997-2001 fingerlings	21.5%	65.8%	3.0%	1.5%	8.2%

Coded-wire tag recoveries indicate that, in Washington waters, Nooksack early chinook have been caught in the Strait of Juan de Fuca troll fishery, recreational fisheries in southern and northern Puget Sound, and net fisheries (primarily in Areas 7 and 7A, Bellingham Bay, and the Nooksack River) in northern Puget Sound. The Kendall Creek facility currently releases only fingerling early chinook.

Exploitation rate trends:

The total annual fisheries exploitation rate for Nooksack early chinook, as estimated by post-season FRAM runs, has declined 59 percent, since the 1980s (Figure 1), from levels in excess of 40 percent in 1983 – 1988, to less than 20 percent in the last five years. Some uncertainty is associated with the absolute value of FRAM-based exploitation rates, but they are believed to accurately index the trend in rates. There are no current CWT data to enable a specific computation for the South Fork stock.

Figure 5. Total adult equivalent Exploitation rate of Nooksack early chinook for management years 1983 – 2000, estimated by post-season FRAM runs.



Management Objectives

Management objectives for Nooksack early chinook constrain harvest under co-manager jurisdiction so that it **will not impede recovery**, while allowing for the exercise of treaty-reserved fishing rights and providing non-treaty fishing opportunity on harvestable salmon. The management objective will assure that natural-origin chinook, significantly in excess if MSY escapement levels under current conditions, escape to the spawning grounds to test existing habitat conditions to promote the recovery of the North / Middle and South Fork populations.

The upper management threshold for each Nooksack early population is set at 2,000 NOR spawners. The low abundance threshold for each population is 1,000 NOR spawners. For the next six years it is not expected that the abundance of natural origin spawners of either of the Nooksack early chinook stocks will exceed the low abundance threshold. Under this circumstance, fisheries that impact the escapement of these stocks will be shaped so a critical exploitation rate ceiling of 9% in southern US fisheries is not exceeded; the co-managers' intent is to constrain fisheries so that the projected SUS rate does not exceed 7% in more than once in the next six years.

The low abundance management threshold is currently under review and under current conditions may be significantly less than 1000 spawners. After reviewing the best available information the co-managers in consultation with NMFS may establish more appropriate low abundance management thresholds.

With 87% percent of the total annual harvest mortality occurring in Alaskan and Canadian fisheries (Table 8), the scope for total reducing fisheries impacts in Washington waters is limited. Net, troll, and recreational fisheries in Puget Sound have been shaped to minimize incidental chinook mortality to extent possible while maintaining fishing opportunity on other species such as sockeye and summer/fall chinook. The net fishery directed at Fraser River sockeye, in catch areas 7 and 7A in late July and August, has caught very few Nooksack early chinook.

Table 9. Estimates of the Origin of the Early Chinook Stocks Entering the Nooksack River.

Return Year	North Fk NOR	Total NF w/ Stray to SF	South Fk NOR	Total River Entry	SF+NF NOR	% NOR
1995	171	224	290	514	461	90%
1996	209	537	203	740	412	56%
1997	74	574	180	754	254	34%
1998	37	370	157	527	194	37%
1999	85	3820	166	3986	251	6%
2000	160	3426	284	3710	444	12%
2001	264	8146	267	8413	531	6%
2002	224	9723	289	10012	513	5%
2003	210	8519	204	8723	414	5%

There will be a limited ceremonial and subsistence harvest of Nooksack early chinook in the river, amounting to less than 10 natural origin spawners, and co-migrating cultured stock in excess of spawning requirements, as determined during preseason modeling. In addition, a limited tribal subsistence fishery, targeted at less than 20 natural origin spawners and co-migrating cultured stock in excess of spawning requirement, will occur in early July to meet minimum tribal requirements. These fisheries will occur from Slater Road crossing to the river mouth in the lower Nooksack, and from the Mosquito Lake road crossing down to the SR 9 bridge in the lower North Fork. The projected total harvest of early chinook by in-river tribal ceremonial and subsistence fisheries will be determined, during preseason planning, with reference to forecasted abundance of natural-origin and hatchery returns.

Fisheries in Bellingham Bay and the Nooksack River directed at fall chinook will not open prior to August 1. Subsequent fishing in the Nooksack River occurs in progressively more upstream zones as early chinook clear these areas. Thus the area extending two miles downstream of the confluence of the North and South Forks will not open prior to September 16.

Total exploitation rates projected by the FRAM model for the 2001 – 2003 management years were 18%, 15%, and 20%, respectively. The analysis supporting derivation of a rebuilding exploitation rate (RER) for the Nooksack MU is in progress. It is recognized that tag data do not exist to support a direct analysis of the productivity of the South Fork stock, and given its status, there is ample reason to exert conservative caution in planning fishing regimes.

The co-managers are evaluating the productivity, abundance and diversity of the early chinook runs that could be expected from the Nooksack watershed under properly functioning habitat conditions, as well as those that might have been expected to exist under historical conditions at Treaty time. The calculation of a normal exploitation rate has not be made but at the current escapement goal of 2000 natural origin spawners in each population, and an exploitation rate of 60%, a AEQ recruit abundance of 5,000 in each population would be anticipated. An ambitious and long-term effort to restore and protect habitat, working in concert with appropriate hatchery production and harvest management regimes, is essential to recovery.

Data gaps

Following are the highest priority needs for technical information necessary to understand stock productivity and refine harvest management objectives:

1) Improve estimates of population specific total escapement to the Nooksack basin, with emphasis on North/Middle and South Fork populations, including natural origin fish, and age data on these fish.
    a) Secure resources to read backlog of otoliths collected at the Kendall Creek hatchery to provide a complete evaluation of the contribution of the different release strategies.
    b) Improve the microsatellite DNA stock baselines of all chinook in the Nooksack Basin and conduct analyses to evaluate
        i) the NOR contribution of North/Middle Fork strays to the South Fork that can no longer be identified by otolith marks
        ii) the most appropriate break point to separate early and late chinook spawning in the South Fork
        iii) the relative success of chinook in the South Fork of the different populations as indicated by samples from the South Fork Smolt Trap
        iv) the relative success of North/Middle Fork spawners as indicated by samples collected at the Hovander smolt trap after eliminating the supplementation production identifiable by external mark (Calcein flourescense or fin clip)
    c) Develop alternative spawning ground population estimates that will allow:
        i) Update pre-spawning migration behavior through radio tags or DIDSON technology.
        ii) Increase recovery of carcasses on the spawning ground to improve estimates of the NOR age structure, yearling/sub-yearling contributions, and population composition.

2) Investigate rearing conditions in the river and the estuary and near shore areas to assist in the development of habitat restoration and protection actions.
3) Improve estimates of stock specific natural early chinook smolt outmigration from the North/Middle and South Fork populations and late timed chinook.
4) Develop stock/recruit functions, or other estimates of freshwater survival data to monitor the productivity of the two populations and late timed chinook.
5) Collect information to determine whether the current SUS fishing regime, or the hatchery supplementation program, are exerting deleterious selective effects on the size, sex, or age structure of spawners.

Skagit River Management Unit Status Profiles

Component Stocks

Summer/fall chinook management unit
- Lower Sauk River (summer)
- Upper Skagit River mainstem and tributaries (summer)
- Lower Skagit River mainstem and tributaries (fall)

Spring chinook management unit
- Upper Sauk River
- Suiattle River
- Upper Cascade River

Geographic description

There are two wild chinook management units originating in the Skagit River system - spring and summer/fall chinook. . The co-managers (WDFW and WWIT 1994) identified three spring and three summer/fall populations. The Puget Sound TRT concurred with this delineation in their assessment historical population structure (Currens et al. in prep. 2003).

Summer/fall management unit

The three populations tentatively identified within the summer/fall management unit are: Upper Skagit summers, Lower Sauk summers, and Lower Skagit falls. Upper Skagit summer chinook spawn in the mainstem and certain tributaries (excluding the upper Cascade River), from above the confluence of the Sauk River to Newhalem. Spawning also occurs in Diobsud, Bacon, Falls, Goodell, Illabot, and Clark creeks. Gorge Dam, a hydroelectric facility operated by Seattle City Light, prevents access above river mile (RM) 96, but historical spawning in the high-gradient channel above this point is believed to have been very limited. The lower Sauk summer stock spawns primarily from the mouth of the Sauk to RM 21 - separate from the upper Sauk spring spawning areas above RM 32. The lower mainstem fall stock spawns downsteam of the mouth of the Sauk River, and in the larger tributaries, including Hansen, Alder, Grandy, Jackman, Jones, Nookachamps, Sorenson, Day, and Finney creeks.

Skagit summer/fall stocks are not currently supplemented to a significant extent by hatchery production. A PSC indicator stock program collects summer broodstock (about 40 spawning pairs per year) from the upper river. Eggs and juveniles are reared at the Marblemount Hatchery. The objective of the program is to release 200,000 coded-wire tagged fingerlings for monitoring catch distribution and harvest exploitation rate. Summer chinook fingerlings are acclimated in the Countyline Ponds before they are released. Development of a lower river fall indicator stock was initiated in 1999, with similar production objectives. Production programs for fisheries enhancement of Skagit summer/fall chinook, and plants of fall chinook fingerlings into the Skagit system from the Samish Hatchery have been discontinued.

Spring management unit

The Skagit spring management unit includes stocks originating in the upper Sauk, the Suiattle, and upper Cascade rivers. The upper Sauk stock spawns in the mainstem, primarily above the town of Darrington up to RM 40, the Whitechuck River, and tributary streams. The Suiattle stock spawns in several tributaries including Buck, Downey, Sulphur, Tenas, Lime, Circle, Straight, and Big creeks. Cascade springs spawn in the mainstem above RM 19, and are thus spatially separated from the lower Cascade summer chinook. Spring chinook reared from Suiattle River broodstock are released from the Skagit Hatchery. Annual releases averaged 112,000 yearlings for the period 1982 – 1991 (WDF et al. 1993). Since then, about 250,000 subyearlings have also been released each year. All spring chinook releases are coded-wire tagged.

Life History Traits

The upper mainstem and lower Sauk River and summer stocks spawn from September through early October. Operational constraints imposed by the Federal Energy Regulatory Commission on the Skagit Hydroelectric Project's operation have, to some extent, mitigated the effects of flow fluctuations on spawning and rearing in the upper mainstem, and reduced the impacts of high flood flows by storing runoff from the upper basin. The lower river fall stock enters the river and spawns later than the summer stocks; spawning peaks in October. Age of spawning is primarily 4 years, with significant Age 3 and Age 5 fish. Most summer/fall chinook smolts emigrate from the river as subyearlings, though considerable variability has been observed in the timing of downstream migration and residence in the estuary, prior to entry into marine waters (Hayman et al. 1996).

Spring chinook begin entering freshwater in April, and spawn from late July through early September. Adult spring chinook returning to the Suiattle River are predominantly age-4 and age-5 (WDF et al. 1993 and WDFW 1995 cited in Myers et al. 1998). Glacial turbidity from the Siuattle River and Whitechuck River limit egg survival in the lower Sauk River. Analysis of scales collected from adults on the spawning grounds indicates that the proportion of spawners that outmigrated as yearlings ranged from 20% to 85% in the Suiattle, 35% to 45% in the Upper Sauk, and 10% to 90% in the Upper Cascade system.

Status

Stocks that comprise the summer/fall management unit are depressed. Annual spawning escapement has increased in the last five years (Table 1), but approached the critical threshold of 4,800 in 1997 and 1999. The geometric mean of the last five years' escapement was 12,690, an increase from the geometric mean of 1992-1996, 7,537 (Myers et al. 1998). Recent assessment of freshwater productivity for summer/fall chinook suggests that the current MSY escapement is about 14,500 (see below).

Table 1. Spawning escapement of Skagit River chinook, 1992- 2002.

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Sauk sum	469	205	100	263	1103	295	460	295	576	1103	910
U Skagsum	5548	4654	4565	5948	7989	4168	11761	3586	13092	10084	13815
L Skag fall	1331	942	884	866	1521	409	2388	1043	3262	2606	4866
S/F MU	7348	5801	5549	7077	10613	4872	14609	4924	16930	13793	19591
Cascade sp	205	168	173	226	208	308	323	83	273	625	340
Siuattle sp	201	292	167	440	435	428	473	208	360	688	265
Sauk sp	580	323	130	190	408	305	290	180	388	543	460
Sprg MU	986	783	470	856	1051	1041	1086	471	1021	1856	1065

Spawning escapement for the spring unit has been consistently below 2,000, but has, with the exception of 1994 and 1999, been above the critical abundance threshold of 576. The geometric mean of escapement in 1998 – 2002 was 1,006.

Harvest distribution

Coded-wire tag recovery data for PSC indicator stocks provide a description of the harvest distribution of Skagit chinook, and contrast the differences between summer / fall and spring stocks. Yearling and fingerling releases from Marblemount Hatchery describe the distribution of spring chinook. The Samish Hatchery fall fingerling releases are believed to provide an accurate surrogate for describing the distribution of Skagit summer / fall chinook. Local summer and fall indicator stocks are being developed. Approximately 33 percent of the mortality of summer / fall chinook has occurred in fisheries in British Columbia and Alaska (i.e. outside the jurisdiction of the Washington co-managers). Twelve percent of summer / fall chinook are caught in Washington ocean fisheries. Puget Sound net fisheries and Washington sport fisheries accounted for 54 percent and 11 percent, respectively, of total summer / fall fishing mortality (Table 2). The harvest distribution of yearling and fingerling spring chinook differ, with about 51 and 75 percent of mortality occurring in northern fisheries, respectively. Puget Sound net fisheries account for 4 percent. Washington recreational fisheries account for 43 percent of yearling mortality, and 20 percent of fingerling mortality.

Table 2. Average harvest distribution of Skagit River chinook, for management years 1997 – 2001, as percent of total adult equivalent fishery mortality (CTC 2003 in press)

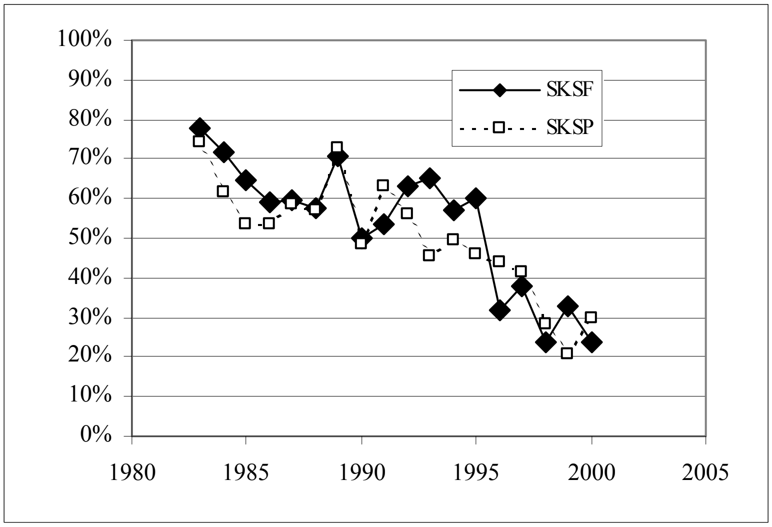
	Alaska	B.C.	Wash. Ocean	Puget Sound Net	Washington sport
Summer Fall	2.6%	30.5%	1.9%	54.1%	11.0%
Spring yrlng	1.1%	50.2%	1.8%	4.2%	42.7%
Spring fing	7.6%	67.6%	0.5%	3.8%	20.5%

Coded wire-tagged Skagit summer and fall indicator stocks, reared from indigenous broodstock at the Marblemount Hatchery, are now being released, and will allow more accurate estimation of harvest distribution and exploitation rates.

Exploitation rate trend:

Annual (management year) exploitation rates for Skagit summer/falls, as estimated by post-season FRAM runs, , have fallen 60 percent, from levels in excess of 60 percent in 1983 – 1987, to an average of 27 percent in 1998 - 2000. Over the same period, exploitation rates for spring chinook have fallen 57 percent, from similar historical levels to a recent average of 26 percent (Figure 1).

Figure 1. Total AEQ fisheries exploitation rate of Skagit summer / fall and spring chinook, estimated from post-season FRAM runs for management years 1983 – 2000.



Management Objectives

Derivation of Upper Management Thresholds

The Puget Sound chinook Evolutionarily Significant Unit (ESU) was listed as "threatened" under the Endangered Species Act in 1999, reflecting the overall poor abundance of the ESU (Myers *et al.* 1998). While the overall abundance of the ESU is poor, and fisheries have been significantly reduced as a result (Puget Sound Indian Tribes and Wash. Dept. Fish and Wildlife 2003), there may exist, from time to time, management units within the ESU that have relatively high abundance, which could support additional harvests. In order to access these harvestable fish, the abundance level that can support additional harvests must first be quantified for each management unit

In the harvest management component of the Puget Sound Comprehensive Chinook Management Plan ("Comprehensive Chinook"), this threshold for harvestable abundance (hereafter, "upper management threshold") is expressed as a spawning escapement level. Under this plan, a management unit has harvestable abundance if, after accounting for expected Alaskan and Canadian catches, and incidental, test, and tribal ceremonial and subsistence catches in southern U.S. fisheries, the spawning escapement is expected to exceed this level, and the unit's projected exploitation rate is expected to be less than its exploitation rate (ER) ceiling. In such cases, additional fisheries, including directed fisheries (fisheries in which this unit comprises the majority of the catch), may be implemented until either the ER ceiling is met, or the expected escapement equals the management threshold (Puget Sound Indian Tribes and Wash. Dept. Fish and Wildlife 2003).

Under the court-ordered Puget Sound Salmon Management Plan, the default threshold that defines harvestable surplus is the level that provides maximum sustained harvest. This objective can, however, be modified by co-manager agreement. For the Skagit summer/fall and spring chinook management units, recognizing the inherent variability in forecasting and recruitment, we define the management threshold as the escapement level that, within the framework of Comprehensive Chinook, is most likely to maximize the long-term catch of that unit. This paper describes the methods used to calculate those thresholds for both Skagit chinook management units.

Methods

Given this definition, the upper management threshold can be calculated analytically. To do this analysis, I wrote a QuickBasic program (CkUBPAge.BAS) (Appendix I) that simulates recruitment, catches, and escapement over a selected period of years, under conditions of uncertainty and error in management, and environmental variation. Because each Skagit chinook management unit is believed to be composed of three separate populations, I wrote this program to simulate up to six populations, each of which can have different productivity and capacity. To mimic current management, the harvest rate is applied on a calendar year basis; thus, each age that matures in a given year experiences the same harvest rate, but each age within a cohort can be harvested at a different rate.

Before doing the modeling, however, it was necessary to resolve three input and modeling questions:

Do we use spawner-recruit parameters that apply to current habitat conditions, or to properly functioning conditions (PFC)?

Because we lack agreed recruitment values for the separate Skagit chinook populations, I used spawner-recruit parameters that had been derived from a habitat-based method, Ecosystem Diagnosis and Treatment (EDT) (Lichatowich *et al.* 1995; Mobrand Biometrics 1999), to get the population-specific spawner-recruit parameters. But because EDT gave Beverton-Holt spawner-recruit parameters under historic conditions and PFC, as well as current conditions, we had a choice to make: which set of parameters should we use for this modeling?

The co-manager policy decision was to use current habitat conditions. The ER ceilings were calculated under assumed current survival rates, so it seemed consistent to assume current conditions when setting the management thresholds. In response to questions about whether this assumption would be responsive to any improvements in habitat, it was noted that these thresholds will be re-evaluated after 5 years, and also that harvest rates would be limited to the current ER ceiling, so if productivity did improve, constraining harvests to the current ER ceiling would allow for escapements to increase above the management threshold. Analyses for Snohomish chinook indicated that, while the calculated MSY escapement under current conditions (approximately 3,000) has been exceeded only 32% of the time in past years, if habitat improved to PFC, and the ER ceiling calculated under current conditions (24%) remained in place, the new MSY escapement (approximately 6,000) would be exceeded 95% of the time, even though the MSY escapement doubled (C. Kraemer, WDFW, *pers. comm.*).

Which point of instability estimates would be used for the summer/fall populations?

For Skagit summer/fall chinook, two sets of point of instability estimates were available: a set derived in 1999 (J. Scott, WDFW, *pers. comm.*), which has been used by NOAA Fisheries for their assessments, and 5% of the EDT-derived historic capacity (5% of capacity is a rule-of-thumb point of instability estimate discussed in Peterman 1977).

Empirical observations indicated that the EDT-derived estimates were too high. In 5 of the last 10 years, Lower Skagit and Lower Sauk escapements were both below the EDT-derived numbers, and in each case, the recruits/spawner rate was well above 1.0 (my program assumes that recruits/spawner averages 1.0 for escapments below the point of instability). During that same time, we did have one Lower Sauk escapement that was also less than its 1999-estimated point of instability, and the recruits/spawner rate for that brood was also well above 1.0, which indicates that that number may also be an overestimate of the point of instability, but, lacking any alternatives, I used the set of estimates derived in 1999 as the points of instability for Skagit summer/falls (Table 1).

Because there were no alternative estimates from earlier years for Skagit springs, and the EDT-derived estimates were the only ones available, I used 5% of the EDT-derived historic capacity as the points of instability for Skagit springs (Table 1). There have been no observed escapements below this point for Suiattle springs, and one near that level for the Upper Cascade population; however, that was in 1999, and the returning brood has not yet fully recruited. For Upper Sauk springs, there have been three observations below its point of instability, two of which have fully recruited, and in both cases the recruits/spawner rate exceeded 1.0.

When modeling a regime that includes a directed fishery, should the denominator used in the calculation of the target ER be the predicted recruitment, or the actual recruitment?

When there is a directed fishery, I modeled the target harvest rate as the harvestable number divided by the recruitment (see Step 8c below). The question was whether the denominator in that calculation should be the predicted recruitment or the actual recruitment. I decided that using the predicted recruitment more accurately simulates our real-world management, in which harvestable numbers are calculated according to predictions; therefore, I used the predicted recruitment in the denominator of that equation.

With these modeling and input questions answered, the steps used to generate the upper management thresholds are as follows:

1. Set the initial inputs. Run-specific inputs are the range of management thresholds that will be tested, the number of runs for each management threshold (each of which starts with a different random number sequence), the number of years for each run, and the populations that will be modeled in the run. Management inputs are the management error distribution, the forecast error distribution, the distribution of freshwater peak flows and marine survival, and the management unit-specific ERs: the ceiling ER, the average ER under incidental fisheries only, the average ER when abundance is critical, the minimum possible ER, and the maximum possible ER. Population-specific inputs are the Beverton-Holt spawner-recruit parameters, point of instability (the escapement level below which the mean recruits/spawner is 1), cohort age composition, initial escapements, and initial recruitments for the ages that precede the recruitments that result from the initial escapements. These inputs are listed in Tables 1 to 5.

2. Set the management threshold.

3. Seed the random number generator

4. Begin each year of a run. Simulate environmental variation that year by multiplying a randomly-chosen freshwater survival factor (Table 4) by the exponential of a cyclically-generated marine survival factor (Table 5). The marine survival factor is of the form:

$$\text{Factor} = A * \sin((\text{Year} / c) + b - 1/c) + \sigma_{sine} * \varepsilon$$

Where A is half the amplitude of the sine curve; b is the starting point on the sine curve, in radians, in Year 1 of the run, with b set at the start of each run to vary randomly between -2π and 2π (i.e., the marine survival cycle can start in Year 1 of each run anywhere from the beginning of the down cycle to the beginning of the up cycle); c * 6 gives the approximate period of the cycle (e.g., c = 4 gives about a 24-year cycle); 1/c is an adjustment I needed to account for starting the run in Year 1, rather than Year 0; σ_{sine} is the standard deviation of the spread around the sine curve; and ε is a normally-distributed error variable with a mean of 0 and standard deviation = 1. A and c were calculated by fitting a sine curve by least squares to the natural logarithms of the 1980-1992 marine survival indices provided by Jim Scott (J. Scott, WDFW, *pers. comm.*) (Table 5; Fig. 1). σ_{sine} is the standard deviation of those indices around that fitted curve.

5. From the spawning escapements that have been initially input or calculated through the program, and the environmental variation factor produced in Step 4, use the Beverton-Holt parameters to generate the population-specific recruitments that will result in 3 to 5 years, and distribute them by age according to the cohort age composition of the population.

6. Sum the age-specific and population-specific recruitments that apply to the current year to calculate the current year's true total recruitment.

7. Multiply the true recruitment by a randomly-chosen forecast error value (Table 2) to calculate the current year's forecasted total recruitment.

8. Using the forecast, generate the current year's target ER. Assume initially that the ER is the average ER under incidental fisheries. If:

   a) The resulting escapement would be less than the sum of the points of instability for all populations modeled, then the critical abundance ER becomes the target;

   b) Otherwise, if the resulting escapement would be less than the management threshold, then the average ER under incidental fisheries remains the target;

   c) Otherwise, the harvestable number is the lesser of the difference between the recruit forecast and the management threshold, and the recruit forecast multipled by the ER ceiling. The target ER becomes the harvestable number divided by the recruit forecast.

9. Divide the target ER by a randomly-chosen management error value (Table 3), to generate the actual ER. Constrain this ER so that it is between the minimum and maximum possible ERs (Table 1).

10. Multiply the actual ER by the true recruitment to generate the catch, and multiply each population-specific and age-specific component of the true recruitment by the complement of the actual ER to get the escapement by population.

11. Go to Step 4 and repeat for 40 years.

12. Increment the random number generator, go to Step 3, and repeat 1000 times.

13. Go to Step 2 and use a different management threshold. Continue until I've identified the management threshold that produces the highest mean catch. That level becomes the management threshold for the Skagit chinook unit being examined.

Results

In preliminary model runs, I tested the sensitivity of the model results to three inputs that are fairly arbitrary: the number of years per run; the number of runs (each started with a different random number seed) for each management threshold tested; and the starting random seed. The results were not affected by the number of runs (the minimum number I tested was 1000 runs) or by the random seed; however, the estimate of the summer/fall chinook management threshold that maximized long-term catch was sensitive to the number of years per run (more years/run gave higher management thresholds). This sensitivity occurred because, as modeled, when abundance drops below the point of instability, it tends to stay there. If this occurs in, e.g., year 20 of a 25-year run, the long-term average catch gets depressed for only 5 years, whereas catch can be depressed for 20 years if this occurs in year 20 of a 40-year run. So there's more of a penalty to falling below the point of instability in longer runs. Since it's more likely that abundance will drop below the point of instability when the management threshold is lower, the runs with more years should favor higher management thresholds.

So I had a subjective decision to make: what should be the number of years per run? I chose 40 years/run (Table 1), feeling that this provided a middle-ground on the penalty for letting abundance fall below a point of instability – more than a 25-year run, and less than a 100-year run (the lengths of the runs were also limited by the amount of time it took to run the program). A 40-year run is about 10 generations of chinook salmon, and approximately 2 marine survival cycles, which I felt provided a sufficient range of variability in the analysis.

Skagit summer/fall chinook:

The maximum mean modeled catch, 13,094, occurred at management thresholds of both 14,000 and 15,000 (Table 6). I therefore split the difference, thereby deriving a Skagit summer/fall chinook management threshold of 14,500. As explained above, I used 40-year runs to derive this threshold. If I had used 25-year runs (which is the time period that was used to establish the ceiling ERs), the maximum mean modeled catch would have occurred at a management threshold of 12,000. With 100-year runs, the maximum mean modeled catch would have occurred at a management threshold of 16,000.

Skagit spring chinook:

The maximum mean modeled catch, 1598, occurred at management thresholds of both 2000 and 2100 (Table 7). Splitting the difference would give a management threshold of 2050. However, while rounding the threshold to the nearest hundred is consistent with other Puget Sound chinook goals, rounding to the nearest ten isn't. So the choice was between 2000 and 2100, and, since the previous Skagit spring chinook goal had been rounded to the nearest thousand (3000), the co-managers agreed to use 2000 as the management threshold for Skagit spring chinook. For springs, the management threshold was not sensitive to the number of years/run; with both 25-year runs and 100-year runs, the management threshold would still have been 2000.

Discussion

It might be argued that there is not much difference between the average catches shown in Tables 6 and 7, and that a different management threshold might be selected with little effect on long-term catch. That may or may not be true (I didn't examine the degree of fluctuation between individual catch years). However, the intent of this exercise was to calculate an answer that had *a* *single solution* that would achieve previously-defined criteria, in order to avoid the conflicts that result from trying to agree on arbitrary buffers or numbers that "look good". In this case, the criterion was maximization of mean catch, no matter how small the difference in mean catch. And, while there was subjectivity involved in some of the inputs (e.g., years/run – see above), it was objective in that the analysis yielded a single solution.

The proposed management thresholds, 14,500 for summer/falls and 2,000 for springs, are considerably higher than the MSY escapement levels that would be calculated analytically, without consideration of management error and environmental variation, from the spawner-recruit parameters listed below. From the parameters listed below, using Ricker's (1975) formulae for computing MSY escapement levels in a Beverton-Holt function, the MSY escapement levels under current conditions would be 7,700 for summer/falls and 900 for springs. Thus, by accounting for observed levels of management error and bias (both the forecasts and the target exploitation rates have tended to be overestimates of the post-season numbers – see Tables 4 and ?), and environmental variation, and by assuming the incidental catch rates observed in recent years under the Comprehensive Chinook framework, the management thresholds that maximize long-term catch are approximately double the MSY escapement levels calculated from formulae that do not account for those factors.

For summer/falls, this management threshold of 14,500 is almost the same as the former spawning escapement goal, 14,900, that was set in 1977. It is somewhat surprising that the two numbers are so close, since the former goal was nothing more than the average escapement calculated for the years 1965-1976 (Ames and Phinney 1977), and no analysis of production relationships was involved in its calculation.

For Skagit springs, on the other hand, the management threshold of 2,000 is considerably lower than the former spawning escapement goal of 3,000, which was set in 1975. This former goal was also calculated only as the average of escapements from an earlier period of years (1959-1973 in this case), rounded to the nearest thousand (Management and Research Division 1975), and the fact that the currently-calculated threshold is significantly different is not a great surprise, especially given that the biologists who now do the spawning escapement estimates have expressed considerable skepticism about the accuracy of the escapement estimates from those earlier years (P. Castle, WDFW, *pers. comm.*). In addition, it has been noted (C. Kraemer, WDFW, *pers. comm.*) that, with exploitation rates on springs slashed by about 70% in recent years, it would be expected that there would be a significant increase in resulting run sizes if there is a lot of unused capacity in the system. The fact that run sizes have instead remained fairly stagnant probably indicates that recent escapement levels (the highest in recent years was about 1900) are not far under the system capacity. By this reasoning, therefore, using directed fisheries to crop off escapement, when the escapement is expected to exceed 2,000, would be unlikely to detract from future production.

In summary, the calculated upper management thresholds for Skagit chinook are:

Skagit summer/fall chinook:	14,500
Skagit spring chinook:	2,000

Table 3. Input values used to generate management thresholds for Skagit summer/fall and spring chinook. See Tables 4 to 6 and Appendix I for data sources.

Run-Specific Inputs:
Number of years/run: 40
Number of runs: 1,000
Initial random seed: -15,000
Increment between seeds: 1

Management and Environmental Inputs:
Forecast Error: (See Table 2)
Exploitation Rate Error: (See Table 3)

ER Inputs:	Summer/Fall Chinook	Spring Chinook
Ceiling ER	52%	42%
Mean ER Under Incidental Fisheries	34%	28%
Mean ER Under Critical Abundance	29%	25%
Minimum Possible ER	15%	6%
Maximum Possible ER	90%	90%

Distribution of Peak Flows: See Table 6
Marine Survival Parameters (see Table 7 for the historic indices):
A (half of amplitude): 0.53
Period: 24 years
c (period/6): 4
σ_{sine}: 0.633
Maximum Deviation Factor from Spawner-Recruit Curve: 5.0
Minimum Deviation Factor from Spawner-Recruit Curve: 0.1

Population-Specific Inputs:

	Up Skagit Summers	Lo Skagit Falls	Lo Sauk Summers	Up Sauk Springs	Suiattle Springs	Up Casc Springs
Bev-Holt a	17,600	10,600	4,500	2,600	500	900
Slope at Origin	9.2	3.3	5.9	8.5	8.2	8.0
Point of Instability	967	251	200	210	40	80
% Age 3	25%	25%	25%	5%	5%	5%
% Age 4	60%	60%	60%	59%	59%	59%
% Age 5	15%	15%	15%	36%	36%	36%
Initial Escapement	9,600	2,300	610	350	430	330
Initial Recruitment	Calculated by age as Initial Escapement/(1-Incidental ER) * Age Comp					
Extinction Level	10	10	10	10	10	10

Table 4. Run size estimation error values used in the program to generate management thresholds for Skagit summer/fall and spring chinook. The in-season update (ISU) error was used, rather than the preseason forecast error, because directed fisheries (which would be conducted if the escapement is predicted to exceed the management threshold) would most likely be managed according to an in-season update.

Year	ISU	Post-Season	Difference	% Error (ISU/Post - 1)
1984	15838	16791	-953	-5.7%
1985	23360	25444	-2084	-8.2%
1986	18583	22500	-3917	-17.4%
1987	17347	13542	3805	28.1%
1988	18992	16229	2763	17.0%
1989	21403	13568	7835	57.7%
1990	16586	20615	-4029	-19.5%
1991	17382	9707	7675	79.1%
1992	17933	11855	6078	51.3%
1993	15150	8255	6895	83.5%
Mean	18257	15851	2407	26.6%
Std Dev	2507	5597	4782	39.4%
SE Mean	793	1770	1512	12.5%

Table 5. Exploitation rate error values used in the program to generate management thresholds for Skagit summer/fall and spring chinook. The error values used in the program are the 1988-93 and 1997-2000 rates listed in the two right-hand columns, under “S/F Ck” and “Spr Ck”. The 1997-2000 values were calculated from the validation (post-season) and FRAM ER Index (preseason) values shown in this table. The 1988-1993 error values were calculated by Gutmann (1998).

	Validation Run		FRAM ER Index		FRAM Preseason U		% Difference (PSF/Validation - 1)		
Year	S/F Ck	Spr Ck	S/F Ck	Spr Ck	S/F Ck	Spr Ck	S/F Ck	Spr Ck	Combined
1988	58%	59%					22.6%	8.1%	
1989	71%	75%					-10.1%	-17.7%	
1990	50%	50%					12.6%	-0.6%	
1991	53%	65%					-7.1%	-16.2%	
1992	63%	57%					-12.7%	-6.9%	
1993	65%	46%					-18.6%	20.8%	
1994	57%	51%							
1995	60%	47%							
1996	30%	45%							
1997	37%	42%	85.0%	80.6%	51.3%	47.3%	38.7%	12.5%	
1998	23%	30%	62.7%	53.6%	37.9%	31.4%	64.6%	4.7%	
1999	33%	23%	74.9%	74.4%	45.2%	43.6%	37.1%	89.6%	
2000	24%	32%	45.2%	39.4%	27.3%	23.1%	13.8%	-27.9%	
2001			62.8%	37.7%	37.9%	22.1%			
2002			40.7%	41.4%	24.6%	24.3%			
2003									
89-93 avg	60.4%	58.6%					-2.2%	-2.1%	-2.2%
97-02 avg	29.3%	31.8%	61.9%	54.5%	37.4%	31.9%	38.5%	19.7%	29.1%
all yrs avg							14.1%	6.6%	10.4%
Std Dev							27.0%	32.8%	29.5%
SE Mean							8.5%	10.4%	6.6%

Table 6. Freshwater flow survival values for Skagit chinook. The values used in the program to compute management thresholds are those in the column labeled "Ratio to Mean". "RI" is flood return interval. Survival rates were calculated from a relation between flood return interval and incubation survival, using survival vs. peak flow data provided by Seiler *et al.* (2002), and converting peak flow to a flood return interval (E. Beamer, Skagit System Cooperative, *pers. comm.*).

Date	Brood Year	Survival	Ratio to Mean	Peak Discharge	RI (yr)
December 26, 1972	1972	17.5%	1.15	53600	1.8
January 16, 1974	1973	16.0%	1.05	77600	4.3
December 21, 1974	1974	17.6%	1.15	51400	1.6
December 4, 1975	1975	6.2%	0.40	130000	30.9
January 19, 1977	1976	17.6%	1.15	52800	1.7
December 3, 1977	1977	16.9%	1.11	65600	2.8
November 8, 1978	1978	18.0%	1.18	40300	1.1
December 19, 1979	1979	10.6%	0.69	112000	15.7
December 27, 1980	1980	10.2%	0.66	114000	17.0
February 16, 1982	1981	17.5%	1.14	55800	1.9
December 4, 1982	1982	16.5%	1.08	71600	3.5
January 5, 1984	1983	14.8%	0.97	88200	6.5
January 0, 1900	1984	18.0%	1.18		1.0
January 19, 1986	1985	16.4%	1.07	72800	3.6
November 24, 1986	1986	16.6%	1.08	70700	3.4
December 10, 1987	1987	18.2%	1.19	32100	0.8
October 17, 1988	1988	17.4%	1.14	56700	2.0
December 5, 1989	1989	13.4%	0.88	97800	9.2
November 25, 1990	1990	1.5%	0.10	152000	70.3
February 1, 1992	1991	18.0%	1.18	40100	1.1
January 26, 1993	1992	18.3%	1.19	27600	0.7
December 11, 1993	1993	18.2%	1.19	32100	0.8
December 28, 1994	1994	17.3%	1.13	58600	2.1
November 30, 1995	1995	3.5%	0.23	141000	46.6
January 20, 1997	1996	17.7%	1.15	50800	1.6
October 5, 1997	1997	17.0%	1.11	64800	2.7
December 14, 1998	1998	17.3%	1.13	58200	2.1
November 13, 1999	1999	16.1%	1.05	76000	4.1
October 21, 2000	2000	18.3%	1.19	26700	0.6
January 8, 2002	2001	16.5%	1.08	71900	3.5
Mean		15.3%	1.000	70441	8.2
Std Dev		4.4%	0.290	33040	
SE Mean		0.81%	0.053	6135	

Table 7. Values used to fit a sine curve to the natural logarithm of the marine survival index for Skagit summer/fall chinook. Period of cycle is approximately 24 years.

Brood Year	Marine S Index	ln(index)	aSin((Yr+b)/c)	Deviation	Dev-squared
80	0.755	-0.2810	0.52832	-0.8094	0.655059
81	4.313	1.4616	0.501463	0.9602	0.921928
82	1.232	0.2086	0.443427	-0.2348	0.055126
83	1.281	0.2476	0.357822	-0.1102	0.01214
84	1.783	0.5783	0.249969	0.3283	0.1078
85	0.413	-0.8843	0.126574	-1.0109	1.021881
86	2.352	0.8553	-0.00469	0.8600	0.739526
87	0.739	-0.3025	-0.13566	-0.1668	0.02782
88	0.775	-0.2549	-0.2582	0.0033	1.1E-05
89	0.801	-0.2219	-0.36469	0.1428	0.02039
90	1.66	0.5068	-0.4485	0.9553	0.912626
91	0.293	-1.2276	-0.50442	-0.7232	0.522962
92	0.374	-0.9835	-0.52898	-0.4545	0.206585
				SSE	5.20385
Mean	1.290077	-0.02288		MSE	0.400
Median	0.801	-0.22189		RMSE	0.63269

a =	0.53
b =	2
c =	4

Figure 2. The best fit sine-curve to Skagit summer/fall chinook marine survival indices for brood years 1980-1992. The period of the curve is about 24 years.

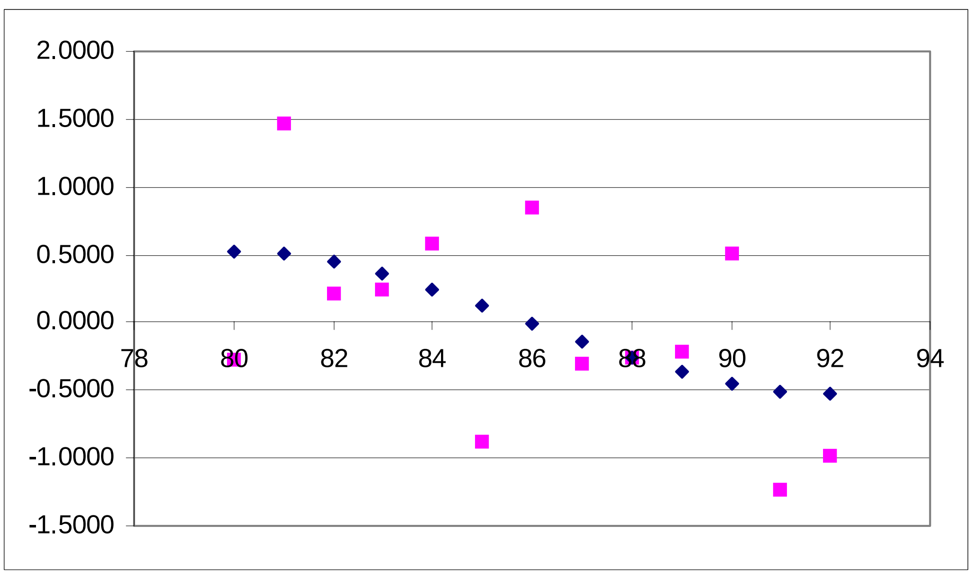


Table 8. Modeled mean annual catch, escapement, number of directed fisheries, and number of population extinctions, in 1,000 runs of 40 years each, at different management thresholds, for Skagit summer/fall chinook. Threshold with maximum catch is bolded.

Skagit Summer/Fall Chinook

Management Threshold	Mean Catch	Mean Escapement	Number of Directed Fisheries	Population Extinctions
10000	12943	9430	29190	7
11000	13003	9706	27435	6
12000	13053	10000	25565	4
13000	13083	10290	24338	4
14000	13094	10579	23167	1
15000	13094	10885	21783	0
16000	13084	11189	20599	0
17000	13066	11484	19480	0
18000	13044	11780	18493	0
19000	13006	12085	17348	0
20000	12961	12386	16243	0

Table 9. Modeled mean annual catch, escapement, number of directed fisheries, and number of population extinctions, in 1,000 runs of 40 years each, at different management thresholds, for Skagit spring chinook. Threshold with maximum catch is bolded.

Skagit Spring Chinook

Management Threshold	Mean Catch	Mean Escapement	Number of Directed Fisheries	Population Extinctions
1500	1569	1664	28056	0
1600	1578	1692	27244	0
1700	1586	1724	26317	0
1800	1592	1755	25323	0
1900	1597	1785	24441	0
2000	1598	1812	23483	0
2100	1598	1838	22558	0
2200	1596	1860	21732	0
2300	1592	1880	20922	0
2400	1587	1898	20145	0
2500	1582	1916	19499	0

Derivation of exploitation rate objectives

Summer / fall chinook

The management objectives for Skagit summer/fall include a recovery exploitation rate that insures, while maintaining fishing opportunity, that harvest will not impede recovery, and low abundance thresholds that guard against abundance falling below the point of instability (Hayman 1999a; 2000a; 2000b). Recovery exploitation rate objectives were developed to meet the following criteria:

1) The percentage of escapements less than the critical abundance (i.e. escapement) threshold increases by less than 5 percentage points relative to the baseline (i.e., in the absence of fishing mortality).

2) Escapements at the end of 25 years exceed the rebuilding escapement threshold at least 80% of the time; **or** the percentage of escapements less than the rebuilding threshold at the end of 25 years differs from the baseline by less than 10 percentage points.

The critical abundance threshold is defined as that which would result in a 5 percent probability that the management unit would become extinct (i.e. fall below 100) at the end of ten years. Since a satisfactory method to calculate critical escapement has not been developed, escapement equal to 5 percent of the stock replacement level was chosen (Hayman 1999a). Replacement escapement is based on the current productivity of the management unit, and therefore incorporates parameters that define the Ricker stock / recruit functions for Skagit units, and recent freshwater and marine survival. For the summer / fall unit, the critical escapement level is 1,165 (Hayman 2000a and 2000b).

The rebuilding escapement threshold is that current level for which there is a 99 percent probability that the run will persist at viable levels. Put another way, if current exploitation rates and freshwater and marine survival conditions were maintained, the probability that the run would go extinct (i.e., fall below 100) at the end of 100 years would fall below one percent. The rebuilding escapement threshold for summer / fall chinook was computed by simulating the population dynamics for 100 years, given a recent average brood year exploitation rate and age composition of escapement, for a range of initial escapement levels. Simulations were replicated 2,000 times, until an initial escapement resulted in extinction in fewer than 1 percent of those replicate runs (Hayman 1999a; 2000b). The rebuilding escapement threshold is 4,700 for the summer/fall unit

With the critical and rebuilding escapement levels established, the population dynamics of the summer / fall Skagit unit was simulated for 25-year periods into the future. The simulation model incorporated the average age composition and age-specific escapement of the units, and randomly or cyclically varying productivity and management error parameters. Each model run used an input exploitation rate, and was replicated 2000 times. The probabilities of exceeding the recovery escapement level, or falling below the critical escapement level, at the end of the simulation period were computed for each run from the 2000 outcomes. A range of exploitation rates, from 0 to 80 percent, were simulated to determine the maximum exploitation rate at which the conservation criteria were met (Hayman 1999a; 2000b). The Washington co-managers have set a rebuilding exploitation rate ceiling of 5 percent for the Skagit summer/fall management unit, as estimated from coded-wire tag recoveries. This management objective was developed from productivity functions characteristic of brood years of Skagit chinook, and was translated into an annual exploitation rate, that is output from the FRAM model, of 50% (Table 4). This exploitation rate objective was set to be 82 percent of the mean rate from fishing years 1989-1993 for summer/fall chinook (Hayman 2000c).

Low abundance thresholds (“crisis escapement levels”) were also established for the summer/fall management unit. These thresholds are defined as the pre-season forecast escapement for which there is a 95 percent probability that the actual escapement will be above the point of instability, given management error and uncertainty about what level the point of instability is (Hayman 1999a;2000b). The derivation of these thresholds takes into account the difference between forecast and observed escapement in previous years, and variance of the spawner-recruit parameters used to calculate the point of instability, thereby reducing the probability of actual escapement falling below the actual point of stock instability. The derivation involved varying the preseason forecast until the area of overlap between the management error distribution curve and the uncertainty curve about the point of instability is less than 5% of the error distribution curve (Hayman 2000b).

In low-abundance years, when projected spawning escapement (from the FRAM model) fall to the lower thresholds, fisheries managers will implement further conservation measures in fisheries to reduce mortality, as described in Section 3 and Appendix C. For the summer/fall management unit, the low abundance threshold is 4,800. For the summer/fall unit, low abundance thresholds have been developed for each component population, so that forecast weakness in any one population may trigger the more conservative harvest regime. The low abundance thresholds for Upper Skagit summers, Lower Sauk summers, and Lower Skagit falls are 2,200, 400, and 900, respectively (Hayman 2000a).

The escapement of individual summer/fall populations may be projected from the aggregate escapement, which is output from the simulation model, in proportion to brood year escapement for each population, or in proportion to estimated age-3 and age-4 adults recruited from their brood-year escapement. Survival rates to compute recruitment will be those implied by the Ricker spawner / recruit function for each population.

Spring chinook

Population	***Modeled CET***	***Modeled RET***	A&P RER	FRAM RER
Suiattle	170	400	50%	41%
Upper Sauk	130	330	46%	38%
Cascade	170	Data insufficient to derive a spawner-recruit analysis. RERs for other Skagit spring populations will be used as surrogate		
Spring MU	470[4]	990	47%	38%

Introduction

The rebuilding exploitation rate (RER) is the highest allowable ("ceiling") exploitation rate for the population under normal conditions of stock abundance. This rate is designed to meet the objective that, compared to a hypothetical situation of zero harvest impact, the impact of harvest at this rate will not significantly impede the opportunity for the population to grow towards the recovery goal. Fisheries are then managed to not exceed the ceiling rate. Recovery will require changes to harvest, hatchery, and habitat management. However, our task involves examining only the impacts of harvest on survival and recovery within the context of actions that are occurring in the other sectors affecting listed salmon. Therefore, we evaluate the RER based on Monte Carlo projections of the near-term (25 years) future performance of the population under current productivity conditions, i.e., assuming that the impact of hatchery and habitat management actions remain as they are now. The RER will be periodically evaluated to see if the actions taken in hatchery and habitat management, or changes in natural environmental

[4] In order to account for management error and uncertainty, the spring chinook LAT in this plan will remain at 576 (Hayman 2000b).

conditions would require revisions of our assumptions about productivity or capacity. The RER is defined as the rate that would result in escapements unlikely to fall below a critical escapement threshold (CET) and likely to rebuild above a rebuilding escapement threshold (RET). All sources of fishing-related mortality are included in the assessment of harvest.

There are two phases to the process of determining an RER for a population. The first, or model fitting phase, involves using recent data from the target population itself, or a representative indicator population, to fit a spawner-recruit relationship representing the performance of the population under current conditions. Population performance is modeled as

$$R = f(S, \mathbf{e}),$$

where S is the number of fish spawning in a single return year, R is the number of adult equivalent recruits[5], and **e** is a vector of environmental, density-independent correlates of annual survival.

Several data sources are necessary for this: a time series of natural spawning escapement, a time series of total recruitment, age distributions for both of these, and time series for the environmental correlates of survival. In addition, one must assume a functional form for f , the spawner-recruit relationship. Given the data, one can numerically estimate the parameters of the assumed spawner-recruit relationship to complete the model fitting phase.

The second, or projection phase, of the analysis involves using the fitted model in a Monte Carlo simulation to project the probability distribution of the near-term future performance of the population assuming that current conditions of productivity continue. Besides the fitted values of the parameters of the spawner-recruit relationships, one needs estimates of the probability distributions of the variables driving the population dynamics, including the process error (including first order autocorrelation) of the spawner-recruit relationship itself and each of the environmental correlates. Also, since fishing-related mortality is modeled in the projection phase, one must estimate the distribution of the deviation of actual fishing-related mortality from the intended ceiling. This is termed “management error” and its distribution, as well as the others are estimated from available recent data.

We used the viability and risk assessment procedure (VRAP)(N. Sands, in prep.) for the projection phase. For a series of target exploitation rates the population is repeatedly projected for 25 years. From the simulation results we computed the fraction of years in all runs where the escapement is less than the CET and the fraction of runs for which the average of the spawning escapements in years 21-25 is greater than the RET. Target exploitation rates for which the first fraction is less than 5% and the second fraction is greater than 80% (or less than 10% than would have occurred without harvest) are considered acceptable for use as ceiling exploitation rates for harvest management. These are the RERs.

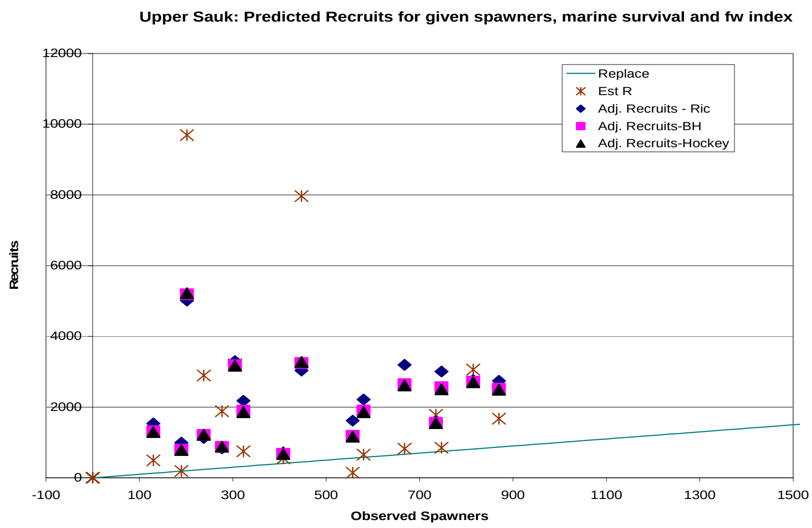
[5] Equivalently, this could be termed “potential spawners” because it represents the number of fish that would return to spawn absent harvest-related mortality.

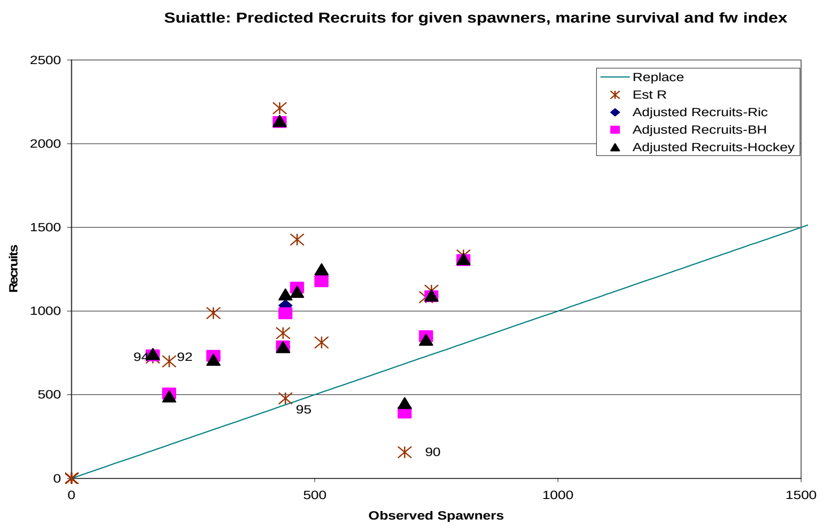
MODEL FITTING PHASE

General

To derive the Suiattle and Upper Sauk spring chinook RERs, we examined the 1981 to 1997 brood years. Uncertainty about data quality of escapement and fishing rates, and residual analyses that indicated a change in system productivity, precluded use of data before 1980. After adjusting for environmental factors, there was no evidence of depensation in the data (Figures 3a and 3b). The 1997 brood year was the last year for which data were available to conduct complete cohort reconstruction.

Figures 3a and 3b. Upper Sauk (1a) and Suiattle (1b) spring chinook recruits adjusted for marine and freshwater environmental conditions





The symbols marked Adj. Recruits (-Bev, -Ric, and –Hoc) in the above figures denote the recruits that would have been produced without the influence of the environmental correlates that drive year to year survival. This allows us to look at the effect of spawners only on the number of recruits produced. We need to remove the effects of other factors, such as the environment, if we want to look for possible depensation which is a function of the number of spawners. Adjusted recruits are calculated for each year as follows:

$$\text{Adjusted recruits} = \frac{\text{Recruits}}{(\text{Annual Environmental Factor}/\text{Average Environmental Factor})}$$

$$\text{Annual Environmental Factor} = (\text{Marine survival index\^{}c})(e^{(d*\text{freshwater flow})})$$

$$\text{Average Environmental Factor} = \sum_{year=1}^{t} Annual\_Environmental\_Factor \Big/ t$$

Where c and d are constants from the spawner-recruit relationship

Escapement estimation methods changed in 1994. Although the two methods result in different escapement estimates in any one year, preliminary comparisons of the two methods do not indicate a consistent difference. There was some concern that because the correlation between the old and new method was weaker for the Upper Sauk than for the Suiattle population, it might preclude use of the data to derive an RER for the Upper Sauk spring population. For the Suiattle, the coefficient of variation of the escapement estimates made before this method change is approximately the same as the coefficient of variation of the estimates since 1994, which indicates comparable measurement accuracy in both time periods; in contrast, the greater coefficient of variation in the Upper Sauk before 1994 indicates that measurement error in the Upper Sauk was probably greater before 1994 than since that time (Table 10).

Table 10. Average number of spawners with standard deviation and coefficient of variation (CV) for three time periods.

	Cascade	Upper Sauk	Suiattle
1952-1974			
average		1225	825
st dev		917	378
Cv		75%	46%
autocorrel		0.35	0.27
1975-1993			
average	192	540	546
st dev	84	384	234
Cv	44%	71%	43%
autocorrel		0.22	0.16
1994-2002			
average	284	309	385
st dev	151	138	158
Cv	53%	45%	41%
autocorrel		0.39	(0.37)

While more variable than those of the Suiattle, the Upper Sauk escapements correlated with independent estimates of marine survival, both before and after the change in escapement estimation methods in 1994. This suggests that the estimates prior to 1994 provide useful information about the behavior of the population. If the data were random, one would not expect any correlation with marine survival, and, in fact, when this assumption was tested, the randomized data had no correlation with any marine survival indices (probability of recruitment fit from random data = 96.2-99.9%)(N. Sands, memo to Skagit RER workgroup, 9/2/03). For the Upper Sauk data, since the information is used to derive the productivity parameter for the spawner-recruit models, we also looked to see if the ratio of recruits/spawner (productivity) was significantly different depending on which escapement estimation method was used. Examination of the 1989-1997 data did not indicate a significant difference in the slopes (t-stat = -1.5; prob = 0.1<x< 0.2) or intercepts (t-stat = 1.34; prob = 0.2) of the relationship between spawners and the natural log of recruits/spawner using the old and new escapement estimates. Therefore, we concluded that we did not have sufficient data to demonstrate that the spawner-recruit relationship for the Upper Sauk spring population would be significantly different depending on the escapement estimation methodology used. Therefore, we used the available escapement data (1981-1993 using peak live and dead counts, 1994-1997 using redd counts) to derive the spawner-recruit parameters for the Upper Sauk population (Table 11). When sufficient data is available using the current method based on cumulative redd counts, the RERs will be revised based on that method.

Table 11. Comparison of R/S values under the escapement estimation methods used before and after 1994. The 1989 brood year would be the first returns affected since they would return as 5 year olds in 1994.

	Spawners		Recruits		R/S estimates		Difference
Brood yr	old	new	old	new	old	new	(oldR/S-newR/S)
1989	668	668	1325	821	2.0	1.2	0.8
1990	557	557	659	146	1.2	0.3	0.9
1991	747	747	4282	852	5.7	1.1	4.6
1992	580	580	844	656	1.5	1.1	0.3
1993	323	323	711	749	2.2	2.3	-0.1
1994	574	130	498	496	0.9	3.8	-2.9
1995	1115	190	191	193	0.2	1.0	-0.8
1996	1079	408	553	551	0.5	1.4	-0.8
1997	264	305	3193	3212	12.1	10.5	1.6
1989-97 geomean	596	379	897	589	1.5	1.6	
1989-97 minimum	264	130	191	146	0.2	0.3	
1989-97 maximum	1,115	747	4,282	3,212	12.1	10.5	
1989-97 st. deviation	293	215	1,407	920	3.8	3.2	

Fishery Rates

Fishery rates for both populations were based on the Skagit spring yearling chinook hatchery indicator stock. Although the stock also has a significant fingerling component (41% and 50% on average for the Suiattle and Upper Sauk, respectively), there are only four years (three consecutive) of available exploitation rate data for the fingerling component; too few to define a spawner-recruit relationship. Preliminary analysis indicates there may be differences between yearling and fingerling exploitation rate patterns, but the data is insufficient to determine with any certainty the direction and magnitude of those differences. We considered using fingerling data from the Nooksack early populations, but that population has a much lower percentage of naturally-occurring yearlings and a different harvest pattern, so there was a great deal of uncertainty about whether the Nooksack population would be representative. A Skagit spring chinook fingerling hatchery indicator stock has been established and the co-managers' are collecting data on fingerling exploitation rate patterns. We will re-examine the data for differences in exploitation rate patterns when several more years of data are available. The hatchery indicator stock is used to represent the natural component also because the natural component is not tagged.

The Pacific Salmon Commission Chinook Technical Committee (CTC) CWT exploitation rate analysis for the Skagit spring indicator stock by age was used for brood years 1981 to 1996, ages 2-4 for brood year 1997 and ages 2-3 for brood year 1998. The 1997 age 5+ fishery rate was based on an average of the 1995-96 rates and the 1998 ages 4-5+ were based on an average of the 1996-1997 rates because the current CTC CWT exploitation rate analysis is not complete for these ages for these brood years. For the purposes of the analysis, fishing rates through brood year 1997 were used since this is the most recent brood year for which we have the most available information. Fishery rates will continue to be updated as data become available.

Maturation Rates

Maturation rates were derived from age data collected from scales from the spawning grounds combined with the age-specific fishing rates described above. Age data taken from scales sampled from the spawning grounds were available for return years 1986-90 and 1992-2001 for the Suiattle, and 1986, 1992-95 and 1997-2001 for the Upper Sauk population (WDFW and SSC data 2002). However, we identified two potential concerns that should be taken into account when using the data: 1) age 2 fish are generally underrepresented in spawning ground samples for several reasons: e.g., carcasses decay faster, the smaller body size makes them more susceptible to being washed downstream, they are less visible to samplers; and 2) only eight years for the Suiattle and five years for the Upper Sauk had a sufficient number of samples to use. The age structure for other years was extrapolated from the average brood year age composition of the years that met the sample size criterion to reconstruct brood year and calendar year escapements by age. The age structure is then adjusted to minimize the difference between both the estimated calendar year escapements and the observed calendar year escapements, and the estimated brood year escapements and the observed brood year escapements for each year for which data are not available. Scale samples collected from areas immediately adjacent to the hatchery were excluded because the presence of hatchery fish was assumed to be substantial. Both yearling and fingerling age data were used in order to represent the full range of life histories present in the basin.

Hatchery Effectiveness/Hatchery Contribution to Natural Spawning

The coded-wire tag indicator stock program is the only hatchery production of Skagit spring chinook in the Skagit basin. Straying of hatchery fish onto the spawning grounds from either inside or outside the basin has been negligible based on spawner survey information (WDF et al. 1993, Skagit RER Workgroup 2003). Therefore, hatchery effectiveness is not considered an issue in the derivation of spawner-recruit parameters for the Skagit spring chinook populations.

Spawner-recruit Models

The data were fitted using three different models for the spawner recruit relationship: the Ricker (Ricker 1954, as referenced in Ricker 1975), Beverton-Holt (Beverton and Holt 1957, as referenced in Ricker 1975), and hockey stick (Barrowman and Meyers 2000). The simple forms of these models were augmented by the inclusion of environmental variables correlated with brood year survival. A wide variety of marine and freshwater covariates were evaluated and the ones with the best correlations to estimated recruits/spawner were chosen for further analysis. For marine survival we tried several indices of survival based on chinook coded-wire tag groups from: several Canadian hatcheries in Georgia Strait; several Washington coastal hatcheries; North Puget Sound hatcheries only; South Puget Sound hatcheries only, an aggregate of groups from throughout Puget Sound; Hood Canal hatcheries only; and an aggregate of Puget Sound spring chinook hatcheries. We also evaluated the spawner-recruit function assuming marine survival does not influence the relationship. The other environmental correlate, associated with survival during the period of freshwater residency, was the maximum daily average October 1-February 28 stream flow during the fall and winter of spawning and incubation from the 1) Sauk River USGS gauge near Sauk (gauge # 12189500), 2) the Whitechuck gauge (gauge # 12186000, which is actually on the Sauk just upstream from the Whitechuck), and 3) the Mount Vernon gauge (gauge # 12200500). For the Upper Sauk, we also evaluated the level of spring releases from the Marblemount Hatchery, and the peak instantaneous flow from October to September at the Sauk River gauge (# 12189500). During the time period that escapement and fishing rates data were available, we evaluated the spawner-recruit relationship for three time periods: 1981-1997, 1984-97 and 1986-1997. The spawner-recruit relationship, after adjusting for environmental conditions, appeared relatively constant based on an analysis of the residuals. The results, detailed in Sands (2003), are summarized in Tables 3 and 4, with parameter estimates shown in Tables 5 and 6. A good fit was defined as one with probability of less than 5% for escapement and less than 20% for recruits of being a random fit.

Equations for the three models are as follows:

$$(\mathbf{R} = \mathbf{aS}\mathrm{e}^{-\mathbf{bS}})(\mathbf{M}^{\mathbf{c}}\mathrm{e}^{\mathbf{dF}}) \quad \text{[Ricker]}$$

$$(\mathbf{R} = \mathbf{S}/[\mathbf{bS} + \mathbf{a}])(\mathbf{M}^{\mathbf{c}}\mathrm{e}^{\mathbf{dF}}) \quad \text{[Beverton-Holt]}$$

$$(\mathbf{R} = min[\mathbf{aS},\mathbf{b}])(\mathbf{M}^{\mathbf{c}}\mathrm{e}^{\mathbf{dF}}) \quad \text{[hockey stick]}$$

In the above, M is the index of marine survival and F is the freshwater correlate.

Table 12. Results of the spawner-recruit relationship fits for various marine and freshwater covariates for the Suiattle spring chinook population. For each run, the best S/R function fit is noted.

Years	Marine Survival Index	Freshwater Discharge	Model Fit (% esc, % recruit)
1981-97	N. Puget Sound cycle	Sauk max daily ave. Oct-Feb	0, 1
	Puget Sound cycle	Sauk max daily ave. Oct-Feb	0, 0
	Puget Sound cycle	Whitechuck max daily ave	Same as Sauk
	Puget Sound cycle	Mt. Vernon max daily ave	Same as Sauk
	Georgia Strait cycle	Sauk max daily ave. Oct-Feb	0, 2
1984-97	N. Puget Sound cycle	Sauk max daily ave. Oct-Feb	2, 4
	Puget Sound cycle	Sauk max daily ave. Oct-Feb	0, 3
	Puget Sound cycle	Whitechuck max daily ave	Same as Sauk
	Puget Sound cycle	Mt. Vernon max daily ave	Same as Sauk
	Georgia Strait cycle	Sauk max daily ave. Oct-Feb	
1986-97	N. Puget Sound cycle	Sauk max daily ave. Oct-Feb	
	Puget Sound cycle	Sauk max daily ave. Oct-Feb	0, 25
	None	**Sauk max daily ave. Oct-Feb**	**0, 11**

Table 13. Results of the spawner-recruit relationship fits for various marine and freshwater covariates for the Upper Sauk spring chinook population. For each run, the best S/R function fit is noted.

Years	Marine Survival Index	Freshwater Discharge	Model Fit (% esc, % recruit)
1981- 97	**Puget Sound cycle**	**Sauk max daily ave. Oct-Feb**	**0,3**
	Puget Sound cycle	Whitechuck max daily ave	Same as Sauk
	Puget Sound cycle	Marblemount spring releases	0,2
	Puget Sound cycle	Instantaneous Sauk Peak Oct-Sep	0,1
	N. Puget Sound cycle	Instantaneous Sauk Peak Oct-Sep	0,1
	Hood Canal ave.	Instantaneous Sauk Peak Oct-Sep	0,15
	Georgia Strait cycle	Sauk max daily ave. Oct-Feb	0,7
1985-97	Puget Sound cycle	Whitechuck max daily ave	0,9
1986-97	Puget Sound cycle	Whitechuck max daily ave	1,16
	Georgia Strait cycle	Sauk max daily ave. Oct-Feb	3,21
	Hood Canal ave.	Instantaneous Sauk Peak Oct-Sep	2,47

The model fits were evaluated based on the size of the predictive error (MSE), probability of the model being fit by random for escapement data and recruits, the ability of the model to estimate productivity at low abundance and the reasonableness of the model's predicted performance at higher escapement levels, relative to our observations. As seen from Tables 12 and 13, most of the model runs met the criteria for a low probability of resulting from random fit.

For the Suiattle population, the model with the lowest probability of a random fit was the model using the Puget Sound cycle for the marine index and the Sauk maximum daily average winter freshwater flow during 1981-97. However this model and several others did a poor job of estimating productivity at low abundance even though the probability of random fit was low. The model for the 1986-97 period assuming no influence from marine survival and using the Sauk maximum daily average winter freshwater flow had the best overall combination of a low predictive error, probability of random fit and estimate of productivity at low abundances compared with the other model runs (Figures 2 and 3, Tables 5a and 5b). In particular, the data points were well distributed along the spawner-recruit curve, both the predicted and observed data fit the curve defined by the spawner-recruit relationship well, and there was little difference among the three spawner-recruit functions (Figure 3). Finally, while both the 1981-97 and 1986-97 relationships estimated capacity at about 800 spawners, the 1981-97 relationship implied considerable redd superimposition between 400 and 800 spawners which has not been observed in the field with escapements in this range.

For the Upper Sauk population, there were two models with the lowest probability of a random fit: the peak Oct-Feb winter freshwater flow combined with 1) the North Puget Sound fall fingerling cycle marine index; and 2) the Puget Sound cycle marine index, during 1981-97. However, the data points for the models for the period 1981-97 using the Puget Sound marine index were better distributed along the spawner-recruit curve (Figures 4 and 5). There was little difference in the fit among the models using the Puget Sound cycle marine index or their estimates of the escapement at maximum sustained yield[6] (Tables 6a and 6b). The model using the Puget Sound cycle for the marine index and the Sauk maximum daily average winter flow for

[6] The Beverton-Holt function did a poor job of describing productivity at low escapement regardless of the model.

the 1981-97 period was used as the representative model of this group for purposes of deriving the RER since it fit well and it matched the freshwater variable used for the Suiattle .

Figure 4. Comparison of observed and predicted recruitment for the Suiattle spring population, brood years 1981-97 data, the Puget Sound cycle marine index and Sauk maximum daily average winter flows, under three different models of the spawner-recruit relationship. The corresponding spawner-recruit parameters are listed in Table 5a.

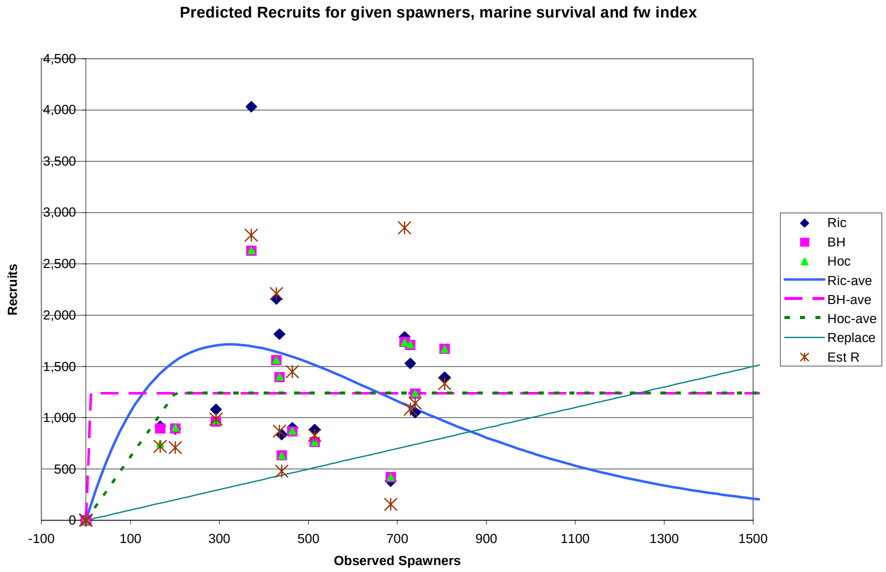


Figure 5. Comparison of observed and predicted recruitment for the Suiattle spring population, brood years1986-97 data, no marine index and Sauk maximum daily average winter flows, under three different models of the spawner-recruit relationship. The corresponding spawner-recruit parameters are listed in Table 5b

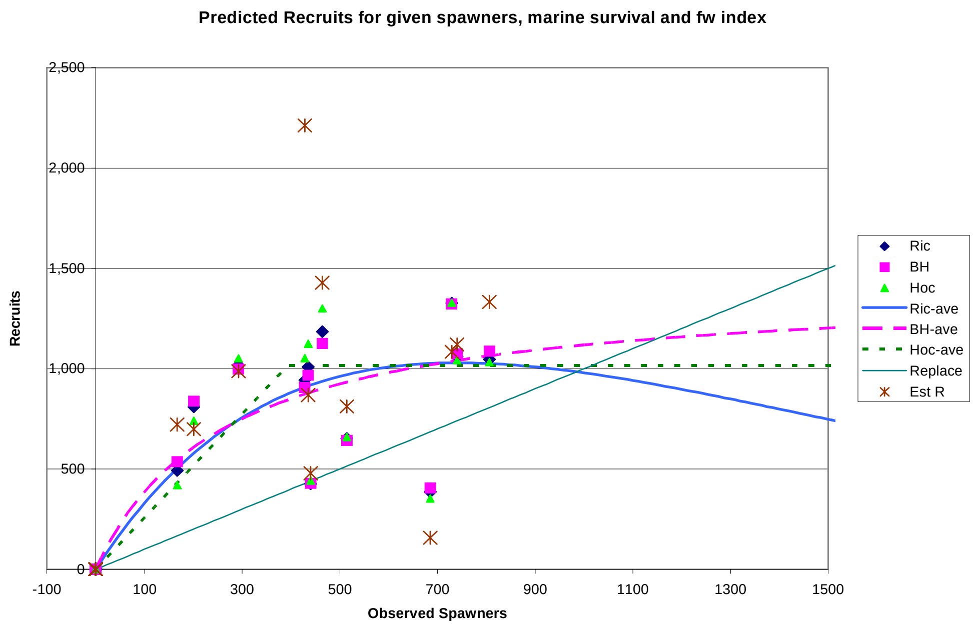


Table 14a (left) and 14b (right). Results of spawner-recruit analysis for the Suiattle using different time periods and environmental covariates.

Marine Index	**Puget Sound cycle**			**none**		
Freshwater variable	**Sauk maximum daily ave. Oct-Feb**			**Sauk maximum daily ave. Oct-F**		
calendar years esc. compared	**1986-1997**			**1991-1997**		
brood years used	**1981-1997**			**1986-1997**		
Parameter Estimates With Smallest S	**Ric**	**Bev**	**Hoc**	**Ric**	**Bev**	**Hoc**
a - productivity	27.8956	0.0000	13.1729	6.5805	0.1112	4.6642
b - Spawners	0.003293	0.000380	2,648	0.001351	0.000417	1,835
c - Marine	0.8132	0.7634	0.7604	0.9800	0.9800	0.9800
d - Freshwater	-0.000012	-0.000017	-0.000017	-0.000022	-0.000021	-0.000024
SSE	0.287	0.707	0.705	0.019	0.024	0.016
MSE (esc)	0.036	0.088	0.088	0.005	0.006	0.004
autocorrelation in error	0.090	0.018	0.027	-0.034	-0.147	0.040
R - esc	0.949	0.866	0.867	0.992	0.989	0.993
F(3,8)	24.122	8.035	8.063	118.032	93.600	138.566
PROBABLITIY	0.0%	0.8%	0.8%	0.0%	0.0%	0.0%
MSE (recruits)	0.272	0.274	0.270	0.215	0.227	0.195
autocorrelation in error	0.028	-0.068	-0.059	-0.163	-0.127	-0.220
R - recruits	0.822	0.750	0.748	0.636	0.614	0.684
F(3,13)	9.014	5.579	5.506	3.060	2.728	3.959
PROBABLITIY	0.6%	2.3%	2.4%	15.6%	17.9%	11.3%
Ave.Pred. Error	1020	1218	1219	469	480	440

	Ric	**Bev**	**Hoc**	**Ric**	**Bev**	**Hoc**
slope at origin, intrinsic prod.	27.90	1000.00	13.17	6.58	9.00	4.66
average MS*FW factor	0.75	0.66	0.65	0.57	0.59	0.55
cv MS/FW	61/17	57/23	57/24	0/34	0/32	0/36
adjusted productivity at origin	20.79	657.36	8.61	3.78	5.31	2.58
replacement level	920	1,730	1,730	980	1,160	1,020
capacity = spawners for max recruits	300	1,730	200	740	1,420	400
max recruits	2,320	1,730	1,730	1,030	1,420	1,020
MSY spawners	260	10	210	410	350	400
MSY recruits	2,300	1,730	1,730	890	810	1,020
MSY ER	0.89	0.99	0.88	0.54	0.57	0.61
ave ER last 3yrs	0.72	0.72	0.72	0.69	0.69	0.69

Figure 6. Comparison of observed and predicted recruitment for the Upper Sauk spring population, brood years 1981-97 data, the North Puget Sound cycle marine index and peak instantaneous Oct-Sep flow at the Sauk gauge, under three different models of the spawner-recruit relationship.

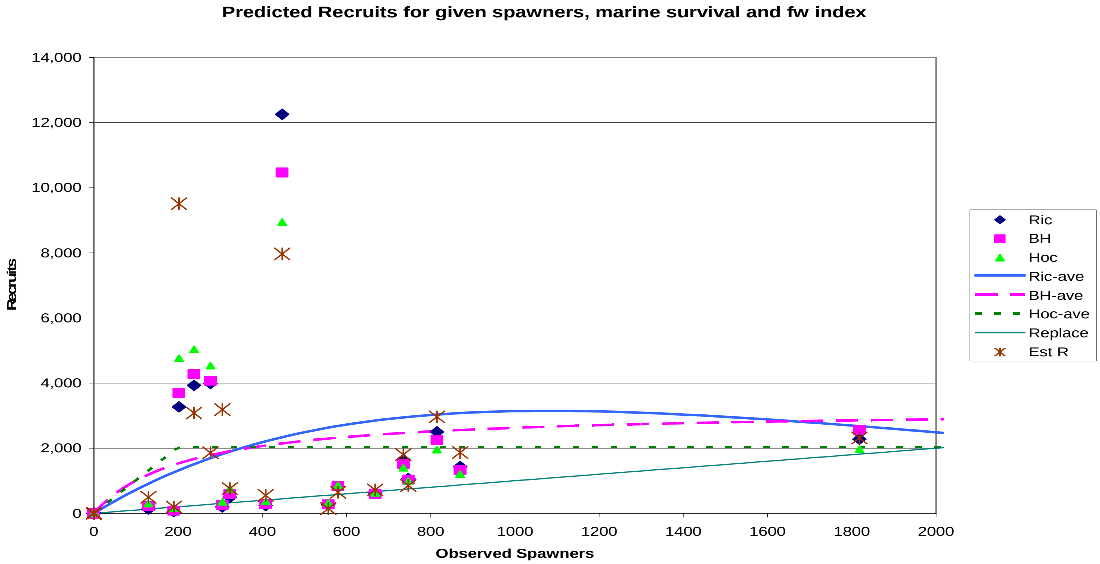


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Figure 7. Comparison of observed and predicted recruitment for the Upper Sauk spring population, brood years1981-97 data, the Puget Sound cycle marine index and peak instantaneous Oct-Sep flow at the Sauk gauge, under three different models of the spawner-recruit relationship. The corresponding spawner-recruit parameters are listed in Table 6a.

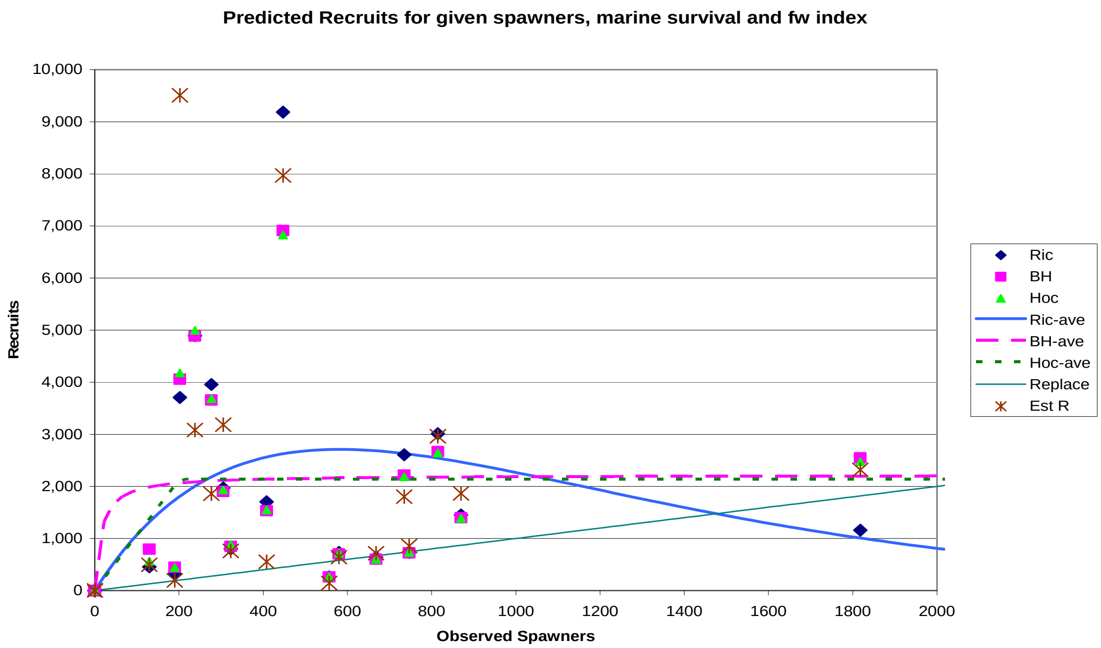


Table 15a (left) and 15b (right). Results of spawner-recruit analysis for the Upper Sauk using different freshwater environmental covariates.

marine index	**Puget Sound cycle**			**Puget Sound cycle**		
freshwater index	**inst. peak Oct-Sep. winter flow**			**Sauk maximum daily average winter flow (Oct-Feb)**		
= calendar years esc. compared	**1986-1997**			**1986-1997**		
= brood years used	**1981-1997**			**1981-1997**		
	Ric	**Bev**	**Hoc**	**Ric**	**Bev**	**Hoc**
a - productivity	24.5562	0.0035	20.7467	21.3694	0.0037	17.1128
b - Spawners	0.001721	0.000232	4,191	0.001745	0.000282	3,457
c - Marine	1.2134	1.0926	1.0766	1.1330	1.0135	0.9991
d - Freshwater	-0.000021	-0.000020	-0.000020	-0.000026	-0.000022	-0.000022
SSE	0.216	0.253	0.238	0.119	0.259	0.245
MSE (esc)	0.027	0.032	0.030	0.015	0.032	0.031
autocorrelation in error	0.736	-0.362	-0.276	0.481	-0.184	-0.166
R - esc	0.974	0.969	0.971	0.986	0.969	0.970
F(3,8)	48.666	41.413	44.111	90.778	40.732	42.923
PROBABLITIY	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
MSE (recruits)	0.350	0.325	0.308	0.418	0.401	0.388
autocorrelation in error	0.147	0.429	0.375	0.163	0.410	0.372
R - recruits	0.763	0.808	0.812	0.693	0.721	0.723
F(3,13)	6.040	8.131	8.385	4.002	4.700	4.749
PROBABLITIY	1.9%	0.8%	0.7%	5.2%	3.6%	3.5%
Ave.Pred. Error	1919	1769	1752	2145	2094	2087

	Ric	Bev	Hoc	Ric	Bev	Hoc
slope at origin, intrinsic prod.	24.56	286.46	20.75	21.37	268.20	17.11
average MS*FW factor	0.52	0.51	0.51	0.59	0.61	0.61
cv MS/FW	87/36	79/35	78/35	82/33	74/30	73/30
adjusted productivity at origin	12.68	147.43	10.60	12.57	163.52	10.39
replacement level	1,480	2,200	2,140	1,450	2,160	2,100
capacity = spawners for max recruits	580	2,220	200	570	2,160	200
max recruits	2,710	2,220	2,140	2,650	2,160	2,100
MSY spawners	480	180	220	460	150	220
MSY recruits	2,670	2,040	2,140	2,590	1,990	2,100
MSY ER	0.82	0.91	0.90	0.82	0.92	0.90
ave ER last 3yrs	0.72	0.72	0.72	0.72	0.72	0.72
set survival	0.16	0.18	0.19	0.19	0.23	0.23
adj MSY sp	330	90	200	330	90	200
adj MSY recruits	730	670	760	760	710	790
adj MSY ER	0.55	0.87	0.74	0.57	0.87	0.75

Critical Abundance Threshold

The critical abundance threshold (CAT) represents a boundary below which uncertainties about population dynamics increase substantially. If sufficient stock-specific information is available, we can use the population dynamics relationship to define this point. Otherwise, we use alternative population-specific data, or general literature-based guidance. In this case, the CAT is 170 and 130 for the Suiattle and Upper Sauk spring chinook populations, respectively, and 470 for the spring MU, using the smallest previously observed escapement from which there was a greater than 1:1 return per spawner. Other escapements in this range have also generated returns per spawner of greater than one (Skagit RER Workgroup 2003). NOAA Fisheries has also provided some guidance on the range of critical thresholds in its document, *Viable Salmonid Populations* (McElhaney et al. 2000). The VSP guidance suggests that effective population sizes of less than 500 to 5,000 per generation, or 125 to 1,250 per annual escapement, are at increased risk. The CATs of 130 and 170 fall within the lower end of this range, reasonable for a small population (Upper Sauk: 1980-2002 range = 130-1,818, average = 459; Suiattle: 1980-2002 range = 167-1094, average =503).

It is important to distinguish between the CAT used in this RER calculation, and the LAT used in this harvest management plan. Although the Suiattle and Upper Sauk modeled CET numbers are the same as their LATs (see Tables 1 and 3 of the harvest management plan), they don't represent the same thing. The modeled CAT is an assumed point of instability; however, because the CAT's used in the RER calculation are escapement levels from which the observed return per spawner was greater than 1:1, it is likely that these modeled CAT levels are in fact well above the true points of instability, a bias that will build conservatism into the calculated RER. The LAT, on the other hand, is a trigger point below which additional management actions are taken to prevent escapement from falling below the true CAT. The LATs that were used for the Skagit summer/fall populations and the spring management unit during the last 3 years were calculated as the preseason escapement forecasts for which there is a 5% probability that the post-season escapement number will be less than the point of instability (Hayman 2000a; Hayman 2000b). Interestingly, using the spawner-recruit parameters derived from this RER analysis, the LAT for Suiattle chinook was calculated as 170 (assuming a quasi-extinction threshold of 63), which is the same as the modeled CAT number that was derived using the 1:1 return rate as the criterion. The calculated LAT for Upper Sauk chinook would be 250, which is higher than the number calculated from the 1:1 return rate criterion; however, because of the greater variance about the Upper Sauk spawner-recruit relation, the estimated probability that an escapement of 130 would be below the point of instability was unrealistically high, given that we have observations that indicate that it in fact is not below this point. Thus, for Upper Sauk chinook, we set the LAT at the same value as the modeled CAT (130). Assuming that the Upper Sauk point of instability is 72 (as calculated from the spawner-recruit parameters), and the past observed range of management error, the probability that a forecasted escapement of 130 would result in an observed escapement below the point of instability was only 0.2%. For the Skagit spring MU, the calculated LAT was 576 (Hayman 2000b), which is over 100 chinook higher than the CET assumed in this analysis (470). Because there is nothing in the LAT calculation that appears to contradict our observations (e.g., there is a very low probability that an escapement of 470, the lowest observed escapement with a return rate greater than 1:1, is below the point of instability), we retained 576 as the LAT in this harvest management plan.

Rebuilding Escapement Threshold

The RET represents a higher abundance level that would generally indicate recovery or a point beyond which ESA type protections are no longer required. Again, because we are isolating the effects of harvest, the RET in this context represents an escapement level consistent with estimates of the current productivity and capacity of the Upper Sauk and Suiattle spring chinook populations. The RET is the smallest escapement level such that the addition of one additional spawner would be expected to produce less than one additional future recruit under current conditions of productivity[7]. This level is also known as the maximum sustainable yield (MSY) escapement. The rebuilding threshold varies with the assumed freshwater covariate and also with the particular form of the spawner-recruit relationship.

For the Suiattle, using the maximum daily flow in the Sauk River from October through February, we derived the RET for each spawner-recruit function. These values were: 410 – Ricker, 350 – Beverton-Holt, and 400 – hockey stick (Table 5a). Since all three models performed similarly (Table 2), we propose to use the average of these estimates as the RET. This average is 400 natural origin spawners (rounding to the nearest 100 spawners).

For the Upper Sauk, using the maximum daily flow in the Sauk River from October through February and the Puget Sound cycle marine index, we derived the RET for each spawner-recruit function. These values were: 460 – Ricker and 220 – hockey stick, under the 1981-97 marine survival rates. However, in our VRAP runs (see next section) we assumed that marine survival in the near future would be more similar to the generally lower rates estimated for 1988-95, for which the RET values were: 330 – Ricker and 200 – hockey stick (Table 6b). For reasons explained in the next section, we discarded the hockey stick analysis and used the Ricker value, 330, as the RET for Upper Sauk. The Beverton-Holt spawner-recruit function did a poor job of estimating productivity at low abundance and, therefore, was not used to estimate a RET.

It is extremely important to recognize that the RET is not an escapement goal but rather a level that is expected to be exceeded most of the time ($\geq$ 80%) under the RER. It is also the case that, should the productivity conditions for the population improve, the RET and the corresponding RER will increase under improved conditions. However, since we will not be able to detect these changes immediately, the RER under current conditions provides a conservative approach because it assumes conditions are poorer than may actually exist. Should conditions improve, the probability of exceeding the RET using the RER computed for current conditions will also increase over the probability computed under current conditions. Thus the RET serves as a step in the progression to recovery which will occur as the contributions from all sectors are realized.

Rebuilding Exploitation Rate Derivation

We projected the performance of the Suiattle and Upper Sauk spring population at target exploitation rates in the range of 0 to 0.80 at intervals of 0.02 using the fitted values of a, b, c, and d (see model equations above) for the Upper Sauk spawner-recruit models, and using the fitted values of a, b, and d for the 3 Suiattle models (which had no marine survival parameter; hence, no c value). As described above, for the Suiattle, we used the 1986-97 brood year model run using the Sauk monthly maximum average flow during the winter, and no marine survival parameter. For the Upper Sauk, we used the 1981-97 brood year model run using the Puget Sound marine cycle index and the Sauk maximum daily average flow during the winter. The freshwater environmental correlate (maximum daily average flow) was projected using the average and

[7] An alternative definition of RET, i.e., the initial escapement level from which there is less than 1% probability that the unit will go extinct in 100 years, was used to set the RER for the Skagit summer/fall and spring management units during the last 3 years (Hayman 1999; Hayman 2000a; Puget Sound Indian Tribes and WDFW 2001; Puget Sound Indian Tribes and WDFW 2003). However, the programming necessary to use this definition for the Skagit spring populations has not been completed, so RETs that use this definition for the Skagit spring populations were not calculated.

variance observed for the 1981-1997 period. For the Upper Sauk, the marine survival environmental correlate (Puget Sound cycle) was projected using the average and variance observed for the 1988-95 period, a period of low marine survival. West coast salmon have been experiencing a period of low marine survival. Although there are preliminary indications that marine conditions are improving, it has not yet been confirmed for Puget Sound. The CETs were 170 and 130 for the Suiattle and Upper Sauk, respectively, derived as described above. The RETs were the MSY escapement levels (also described above) adjusted for environmental conditions. When adjusted for projected environmental conditions the RETs for the Upper Sauk population were: 330 – Ricker and 200 – hockey stick. Since marine survival did not influence the spawner-recruit relationship, no adjustment for environmental conditions to the RET was required for the Suiattle population.

For each combination of spawner-recruit relationship and exploitation rate we ran 1000 25-year projections. Estimated probabilities of exceeding the RET were based on the number of simulations for which the average of the spawning escapements in years 21-25 exceeded the RET. Estimated probabilities of falling below the CET were based on the number of years (out of the total of 25,000 individual years projected for each target exploitation rate for a particular spawner-recruit relationship) that the spawning escapement fell below the CET. For each spawner-recruit relationship the sequence of Monte Carlo projection running through the target exploitation rate range from 0 to 0.80 started with the same random number seed so that the results for the different spawner-recruit models would be comparable.

Detailed results of these projections are in Tables 18 to 21, and summarized results are in Tables 16 and 17. For the Suiattle, the indicated target exploitation rates are 0.48 – Ricker, 0.52 – Beverton-Holt, and 0.51 – hockey stick. Since all three models performed similarly, we propose to use the average of these values as the target rebuilding exploitation rate. This average is 0.50, rounding down to the nearest whole percentage exploitation rate.
For the Upper Sauk, the target exploitation rates that meet the RER criteria are 0.46 – Ricker and 0.62 – hockey stick. A comparison of the habitat in the areas used by the three Skagit spring populations indicated the productivities of the three Skagit spring populations should be similar based on habitat characteristics and land use (B. Hayman, memo to Skagit RER workgroup, 7/15/03). In addition, a VRAP analysis of the Skagit spring management unit (all three spring populations combined) indicated an RER of 0.47 (Tables 18 - 21; N. Sands memo to Skagit RER workgroup, Summary of Skagit springs results, 7/15/03). Since the Ricker target exploitation rate of 0.46 was more similar to the RER for the Suiattle (0.50) and to the Skagit management unit, it was chosen as the RER for the Upper Sauk spring chinook population.

To make the RER compatible with the fishery model used in fishery planning (the FRAM model), the RERs derived from data in the A&P tables were converted to a FRAM equivalent RER using a simple regression between the exploitation rate estimates from the A&P table and post season exploitation rate estimates derived from FRAM. Using this conversion, the FRAM RERs used for annual preseason fishery planning purposes were 0.41 and 0.38 for the Suiattle and Upper Sauk, respectively.

Table 16. Results of the VRAP projections of the Suiattle chinook stock under current conditions showing the indicated target exploitation rate for each form of the spawner-recruit relationship.

Model	Target ER	#fish Mort.	%runs extinct	%yrs <critical	%runs end>rebuilding	1st Year	LastYrs Ave.
Ricker	0.48	577	0	0.3	82.3	474	578
Beverton-Holt	0.52	601	0	0.7	80.9	451	500
Hockey-Stick	0.51	635	0	0.4	81.0	460	552

Table 17. Results of the VRAP projections of the Upper Sauk chinook stock under current conditions showing the indicated target exploitation rate for each form of the spawner-recruit relationship.

Model	Target ER	#fish Mort.	%runs extinct	%yrs <critical	%runs end>rebuilding	1st Year	LastYrs Ave.
Ricker	0.46	516	0.2	0.5	80.5	620	505
Hockey-Stick	0.62	646	0.9	3.7	85.0	432	327

Table 18**.** Summary of projections of the Suiattle spring chinook population at different target exploitation rates for three different forms of the spawner-recruit relationship.

	Pr (final esc > rebuilding threshold) %				Pr (annual esc < critical threshold) %		
Target ER	**B-H**	**Ricker**	**Hockey-St**		**B-H**	**Ricker**	**Hockey-St**
0.00	100	99.7	100		0	0.1	0
0.02	100	99.8	100		0	0.1	0
0.04	100	99.9	100		0	0	0
0.06	100	99.5	100		0	0	0
0.08	100	99.8	100		0	0.1	0
0.10	100	99.8	100		0	0	0
0.12	100	99.9	100		0	0	0
0.14	100	99.8	100		0	0	0
0.16	100	99.8	100		0	0	0
0.18	100	99.7	100		0	0	0
0.20	100	99.8	100		0	0	0
0.22	100	99.5	99.9		0	0.1	0
0.24	100	99.7	100		0	0	0
0.26	100	99.5	99.9		0	0	0
0.28	100	99.6	99.9		0	0	0
0.30	100	99	99.9		0	0.1	0
0.32	100	98.7	99.3		0	0	0
0.34	99.7	98.9	99		0	0	0
0.36	99.7	97.4	99		0	0	0
0.38	99.7	96.5	98.2		0	0	0
0.40	99.6	95.8	96.5		0	0.1	0
0.42	97.9	92.4	97.1		0.1	0.1	0
0.44	96	87.6	96.1		0.1	0.1	0
0.46	94.5	87.5	93.7		0.1	0.1	0.1
0.48	91.8	**82.3**	90.1		0.2	0.3	0.1
0.50	87.8	74.7	**84.3**		0.4	0.4	0.3
0.52	**80.9**	66.7	**78.7**		0.7	0.8	0.5
0.54	73.3	56	71		1.3	1.3	0.8
0.56	65.7	46.8	57.5		1.9	1.7	2
0.60	53.5	35.4	47.6		3.2	3.2	2.9
0.62	38	23.3	34		**5.6**	**5.6**	**5.4**
0.64	27.3	14.1	22.1		9.1	9.6	9.8
0.66	16.6	5.8	10.9		13.6	15.3	16.8
0.68	9.4	4.1	3.7		21	23.7	28.4

Table 19. Summary of projections of the Upper Sauk spring chinook population at different target exploitation rates for three different forms of the spawner-recruit relationship.

	Pr(final esc > rebuilding threshold)%		Pr(ann. Esc. < critical threshold) %	
Target ER	**Ricker**	**Hockey-St**	**Ricker**	**Hockey-St**
0.00	98.5	100.0	0.3	0.0
0.02	99.2	100.0	0.3	0.0
0.04	97.8	100.0	0.3	0.0
0.06	97.5	100.0	0.2	0.0
0.08	99.3	100.0	0.2	0.0
0.10	98.3	100.0	0.2	0.0
0.12	98.7	100.0	0.2	0.0
0.14	98.1	100.0	0.3	0.0
0.16	98.8	100.0	0.1	0.0
0.18	97.5	100.0	0.2	0.0
0.20	97.5	100.0	0.2	0.0
0.22	96.9	100.0	0.2	0.0
0.24	96.9	100.0	0.1	0.0
0.26	96.2	100.0	0.1	0.0
0.28	96.1	100.0	0.2	0.0
0.30	96.0	100.0	0.1	0.0
0.32	94.7	100.0	0.2	0.0
0.34	95.0	100.0	0.2	0.0
0.36	93.3	100.0	0.2	0.0
0.38	92.2	100.0	0.3	0.0
0.40	92.4	99.7	0.2	0.0
0.42	88.9	99.9	0.3	0.0
0.44	86.1	99.8	0.3	0.0
0.46	**80.5**	99.7	0.5	0.0
0.48	76.7	99.4	0.7	0.0
0.50	74.2	99.0	0.7	0.0
0.52	69.4	97.6	1.1	0.0
0.54	62.9	96.5	1.6	0.1
0.56	55.5	95.9	2.3	0
0.58	48.9	95.4	**3.4**	0
0.60	35.9	89.8	5.6	0.4
0.62	27.8	**85.0**	8.1	0.9
0.64	21.4	78.5	11.4	**2.6**
0.66	12.0	65.4	16.9	6.5

Table 20. Results of spawner-recruit analysis for the Skagit spring management unit using different freshwater environmental covariates.

calendar years esc. compared **1989-1997**
brood years used **1984-1997**

Parameter Estimates With Smallest SSE

	Ric	Bev	Hoc
a - productivity	9.6393	0.0255	5.7893
b - Spawners	0.000759	0.000220	4,185
c - Marine	0.6669	0.5731	0.5839
d - Freshwater	-0.000009	-0.000009	-0.000008
SSE	0.126	0.108	0.107
MSE (esc)	0.025	0.022	0.021
autocorrelation in error	-0.189	-0.060	0.036
R - esc	0.942	0.951	0.951
F(3,5)	13.108	15.642	15.776
PROBABLITIY	1%	1%	1%
MSE (recruits)	0.463	0.426	0.429
autocorrelation in error	0.372	0.428	0.332
R - recruits	0.746	0.764	0.765
F(3,10)	4.175	4.663	4.708
PROBABLITIY	8%	7%	6%
Ave.Pred. Error	2054	2026	1996

	Ric	Bev	Hoc
slope at origin, intrinsic prod.	9.64	39.25	5.79
average MS*FW factor	0.87	0.85	0.87
cv MS/FW	48/15	42/15	43/14
adjusted productivity at origin	8.41	33.54	5.01
replacement level	2,810	3,780	3,620
capacity = spawners for max recruits	1,320	3,880	720
max recruits	4,080	3,880	3,620
MSY spawners	990	540	720
MSY recruits	3,930	3,200	3,610
MSY ER	0.75	0.83	0.80
ave ER last 3yrs	0.73	0.73	0.73

Table 21. Summary of projections of the Skagit spring chinook management unit at different target exploitation rates for the Ricker spawner-recruit relationship.

Target ER	Pr(final esc > rebuilding threshold)%	Pr(ann. Esc. < critical threshold) %
0.00	98.20	0.7
0.02	98.00	0.5
0.04	98.2	0.6
0.06	97.90	0.5
0.08	98.80	0.5
0.10	97.70	0.5
0.12	97.70	0.4
0.14	98.00	0.4
0.16	97.60	0.5
0.18	98.00	0.4
0.20	97.40	0.4
0.22	96.90	0.4
0.24	97.90	0.3
0.26	97.40	0.3
0.28	95.60	0.4
0.30	96.10	0.4
0.32	95.60	0.4
0.34	95.00	0.3
0.36	92.10	0.3
0.38	92.70	0.4
0.40	91.60	0.4
0.42	88.50	0.4
0.44	88.20	0.6
0.46	**83.60**	0.6
0.48	**78.30**	0.7
0.50	76.20	1.0
0.52	71.60	1.3
0.54	66.20	1.8
0.56	58.10	1.7
0.60	51.90	2.5
0.62	39.90	3.3
0.64	36.30	**5.3**
0.66	25.10	7.9
0.68	15.70	12.2

The ceiling exploitation rates defined in this plan, which are intended to maximize long-term harvestable numbers and prevent extinction for the Skagit spring and summer/fall management units separately, are consistent with a "no jeopardy" ruling. The jeopardy standards themselves were explicitly used to calculate those rates, and the calculated ceiling rates are comparable to the rates on Skagit summer/fall chinook that were evaluated and approved in the Northern Fisheries Biological Opinion (NMFS 2000), which, depending on abundance, ranged from about 50 to 70 percent. Additional conservatism, beyond that evaluated in the Northern BO, is also provided. Critical abundance threshold escapement levels, below which additional actions would be required, are established for both the spring and summer/fall chinook management units separately, and for each of the three summer/fall populations proposed in WDFW & WWTIT (1994). The intent of this Plan is to take actions that prevent extinction of individual populations, while maximizing long-term harvestable numbers and achieving ESA jeopardy standards for the two Skagit wild chinook management units

During pre-season fishery planning, the impacts from a proposed fisheries management regime will be simulated, and escapement projected, based on the forecast abundance of all contributing chinook units (including those from British Columbia, the Washington coast, and the Columbia River, as well as those from Puget Sound). If the projected escapement of either management unit, or of any Skagit summer/fall or spring population falls below their low abundance threshold, further management actions will be triggered to reduce fishing mortality, as described in Chapter 5 and Appendix C. The FRAM fisheries simulation model, which is currently in use, estimates escapement for the Skagit summer/fall management unit, but that management unit total may be resolved into component stocks in proportion to their forecasted total abundance.

An analysis of how this regime would have functioned if it had been applied in previous years indicates that the exploitation rates would generally have been significantly lower than observed, and that the management response to critical status would have been triggered in two of the recent years (R. Hayman, Skagit System Cooperative pers comm.)

Data gaps

Priorities for filling data gaps to improve understanding of stock / recruit functions or population dynamics simulations necessary to testing and refining harvest management objectives include:

- Consistent release of coded-wire tagged fingerling summer and fall chinook to enable direct assessment of harvest distribution, and estimation of harvest exploitation rates and marine survival rates;.
- Estimates of natural-origin smolt abundance from spring chinook production areas.
- Estimates of estuarine and early-marine survival for fingerling and yearling smolts.
- Limiting factors on yearling chinook abundance

Stillaguamish River Management Unit Status Profile

Component Stocks

Stillaguamish summer chinook
Stillaguamish fall chinook

Geographic description

The Stillaguamish River management unit includes summer and fall stocks which are distinguished by differences in their spawning distribution, migration and spawning timing, and genetic characteristics. The summer stock, a composite of natural and hatchery-origin supplemental production, spawns in the North Fork, as far upstream as RM 34.4 but primarily between RM 14.3 and 30.0, and in the lower Boulder River and Squire Creek. Spawning also occurs in French, Deer, and Grant creeks, particularly when flows are high. The fall stock, which is not enhanced or supplemented by hatchery production, spawns throughout the South Fork and the mainstem of the Stillaguamish River (WDF et al. 1993), and in Jim Creek, Pilchuck Creek, and lower Canyon Creek. Despite the small overlap in spawning distribution, it is likely that the two stocks are genetically distinct.

Allozmye analysis of the summer stock show it to be most closely related to spring and summer chinook stocks from North Puget Sound, and the the Skagit River summer stocks in particular. The fall stocks align most closely with South Sound MAL, which includes Green River falls and Snohomish River summer and falls.

Life History Traits

Summer run adult enter the river from May through August. Spawning begins in late August, peaks in mid-September, and continues past mid-October. Fall chinook enter the river much later – in August and September. The peak of spawning of the fall stock occurs in early to mid-October, about three weeks later than the peak for the summer stock. The age composition of mature Stillaguamish River summer chinook, based on scales collected from 1985 – 1991 was as follows: 4.9% age-2, 31.9% age-3, 54.7% age-4, and 8.5% age-6 (WDF 1993 cited in HGMP). Juvenile summer chinook produced in the Stillaguamish River primarily (95%) emigrate as sub-yearlings (WDF 1993 cited in HGMP).

Status

WDF et al. (1993) classified both the summer and fall stocks as depressed, due to chronically low escapement. Degraded spawning and rearing habitat currently limit the productivity of chinook in the Stillaguamish River system (PFMC 1997). After analyzing the trends in spawning escapement through 1996, the PSC Chinook Technical Committee concluded that the stock was not rebuilding toward its escapement objective (CTC 1999).

Aggregate spawning escapement for Stillaguamish summer/fall chinook has averaged 1,341 (geometric mean) over the period 1997 – 2001. From 1988 through 1995 escapement ranged from 700 to 950 (except 1991), and since 1995 has ranged from 1100 to over 1600. The geometric mean of escapement in the last five years (1998 - -2002) was 1429, which was higher than the mean of 1009 from the preceding five years (Myers et al. 1998). From 1985 – 1991 the average escapements of summer and fall chinook were 879 and 145, respectively (WDF et al.

1993). In the last five years (1998-2002) escapement to the South Fork ranged from 226 – 335), while escapement to the North Fork ranged from 845 to 1403 . Escapement to the North Fork has comprised an average of 81% of total escapement since 1997 (K. Rawson, Tulalip DNR, pers comm., February 10, 2003).

Table 1. Spawning escapement of Stillaguamish summer/fall chinook, 1993-2002.

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
North Fork	583	667	599	993	930	1292	845	1403	1066	1253
South Fork	345	287	223	251	226	248	253	243	283	335
Total	928	954	822	1244	1156	1540	1098	1646	1349	1588

The total annual abundance of Stillaguamish summer/fall chinook for the period 1979 – 1995, estimated as potential escapement (i.e. the number of chinook that would have escaped to spawn absent fishing mortality), ranged from 1,300 to 2,500 without showing a clear positive or negative trend (PSSSRG 1997). However, the productivity, as indexed by the trend in MSY exploitation rate, declined substantially through this period.

The summer chinook supplementation program, which collects broodstock from the North Fork return, was initiated in 1986 as a Pacific salmon Treaty indicator stock program, and its current objective is to release 200,000 tagged fingerling smolts per year. Most releases are into the North Fork, via acclimation sites; relatively small numbers of smolts have been released into the South Fork. This supplementation program is considered essential to the recovery of the stock, so these fish are included in the listed ESU. The program contributes substantially to spawning escapement in the North Fork.

Harvest distribution

Recoveries of coded-wire tagged North Fork Stillaguamish summer chinook provide an accurate description of recent harvest distribution. Northern fisheries in Alaska and British Columbia account for 73 percent of total harvest mortality (Table 2). Washington ocean fisheries account for 4 percent. Washington sport fisheries account for 24 percent of total fisheries mortality.

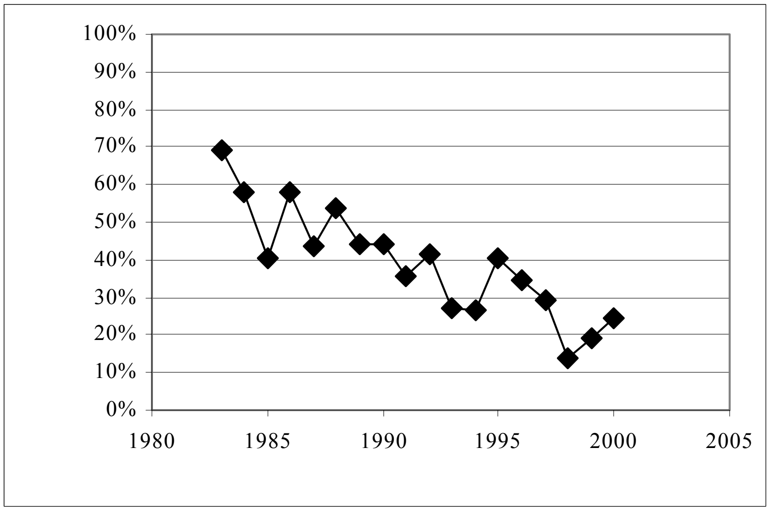
Table 2. The harvest distribution of Stillaguamish River summer chinook, expressed as an average proportion of annual adult equivalent harvest mortality for 1996 - 2000 (CTC03-1 in press)). Update with 2001??

Alaska	B.C.	WashingtonTroll	Puget Sound Net	Washington sport
26.7%	46.3%	0.5%	2.8%	23.8%

Exploitation rate trends:

Post-season FRAM runs, incorporating actual catch in all fisheries and actual abundance, indicate that total fishery-related, adult equivalent, exploitation rates for Stillaguamish chinook have fallen 64 percent, from 1983 – 1987 to 1998 – 2000.

Figure 1. Total adult equivalent fishery exploitation rate of Stillaguamish chinook from 1983 – 2000, estimated by post-season FRAM runs.



Management Objectives

The management guidelines for Stillaguamish chinook include an exploitation rate objective and a critical escapement threshold. The exploitation rate objective is the maximum fraction of the production from any brood year that is allowed to be removed by all sources of fishery-related mortality, including direct take, incidental take, and non-landed mortality. The exploitation rate is expressed as an adult equivalent rate, in which the mortality of immature chinook is discounted relative to their potential survival to maturity.

Analysis specific to Stillaguamish summer chinook was completed to develop the exploitation rate objective to reflect, to the extent possible, the current productivity of the stock. Brood year recruitment (i.e., number of recruits per spawner) was estimated, for brood years 1986 through 1993, by reconstructing the total abundance of natural origin chinook that were harvested or otherwise killed by fisheries, or escaped to spawn. The resulting brood year recruitment rates were partitioned into freshwater and marine survival rates. The future abundance (i.e. catch and escapement) of the stock was simulated for 25 years, using a simple population dynamics model, under total fishery exploitation rates that ranged from 5 percent to 60 percent. In the model, production from each year's escapement was subjected to randomly selected levels of freshwater and marine survival, and randomly selected levels of management error. Each model run (i.e. for each level of exploitation rate) was replicated one thousand times, and the set of projected population abundances analyzed to determine the probability of achieving the management objectives. The simulation for Stillaguamish summer chinook, across a range of exploitation rates (Table 3), indicated that total exploitation rates below 0.35 met the recovery criteria.

Table 3. Summary of results of 1,000 runs of the simulation model at each exploitation rate.

Exploitation Rate	Probability of Falling below critical	Probability of recovery	Median Escapement ratio	Median Escapement
0.00	1%	96%	2.75	3,597
0.05	1%	96%	2.81	3,377
0.10	1%	96%	2.76	3,165
0.15	2%	95%	2.66	2,964
0.20	2%	95%	2.56	2,758
0.25	3%	93%	2.57	2,418
0.30	4%	92%	2.48	2,210
0.35	6%	92%	2.46	1,920
0.40	7%	91%	2.29	1,686
0.45	11%	87%	2.14	1,444
0.50	17%	80%	1.92	1,180
0.60	41%	52%	1.04	648
0.70	73%	12%	0.27	259
0.80	94%	0%	0.02	55

The fishery management objectives for the 2000 management year was to realize an exploitation rate that, if imposed consistently over a future time interval

- would not increase the probability that the stock abundance would fall below the critical escapement threshold, after 25 years, by more than five percentage points higher than were no fishing mortality to occur; and

- would result in at least an 80 percent of greater probability of the stock recovering (i.e. escapement exceeding the current level) after 25 years.

Stock recovery, for this analysis, was defined as the average spawning escapement for the final three years in the simulation period exceeding the average for the first three years in the simulation period (Rawson 2000).

At the present time, there is very little information concerning the productivity of the Stillaguamish fall stock other than the fact that the average abundance of this stock has been approximately 50% of the Stillaguamish summer stock based on relative escapement. Incorporating this lower estimate of abundance, and assuming the same productivity (i.e. recruitment rates), the simulation model predicted that exploitation rates below 35% met the first management objective. The probability of rebuilding at this exploitation rate was 96%. This analysis indicates that a target exploitation rate of 0.35 would also be appropriate for the Stillaguamish fall stock.

The Washington co-managers have set an exploitation rate guideline of 0.25, as estimated by the FRAM simulation model, for the Stillaguamish chinook management unit. According to the simulation model this level of exploitation results in a 4 percent risk of the stocks falling below the critical escapement threshold of 500, and affords a 92 percent probability of recovery (i.e., that spawning escapement will exceed the current average level).

The low abundance threshold for North Fork Stillaguamish chinook is 500 natural-origin spawners. Reconstruction of the total brood abundance of adult Stillaguamish chinook suggests that escapements of 500 (+/- 50) can result in recruitment rates ranging from two to five adults per spawner (Rawson 2000). The genetic integrity of the stock may be at risk and depensatory mortality factors may affect the stock when annual escapement falls below this threshold to 200 (NMFS BO 2000). The critical threshold for South Fork Stillaguamish chinook is undetermined pending further analysis of data. The low abundance threshold for the Stillaguamish management unit is based on the 1996-2002 average fraction of the natural escapement for the years 1996-2002 that was in the North Fork. This average was .813 (range: .770 - .852). Thus a management unit escapement of 500/.813 = 615 would, on average, include 500 North Fork fish. The range of management unit escapement thresholds computed this way is 586 to 649. Based on this, we have selected a low abundance threshold of 650 for the Stillaguamishmanagement unit. Whenever spawning escapement is projected to be below this level, fisheries will be managed to either achieve the critical exploitation rate ceiling , or exceed the low abundance threshold .

Data gaps

Priorities for filling data gaps to improve understanding of stock / recruit functions or population dynamics simulations necessary to testing and refining harvest management objectives include:

- Spawning escapement estimates that include variance for summer and fall stocks
- Estimates of natural-origin smolt production (freshwater survival to the estuary)

Snohomish River Management Unit Status Profile

Component Stocks

The stock structure of summer/fall chinook in the Snohomish basin is based on the report of the Puget Sound TRT (2001) suggesting that there are two populations of summer/fall chinook in the Snohomish basin. The comanagers have reviewed this report along with additional information, and have tentatively concluded that the former four-stock structure of Snohomish chinook should be revised to conform to the TRT's population structure.

Summer/fall chinook management unit

Skykomish
Snoqualmie

Geographic description

Skykomish chinook spawn in the mainstem of the Skykomish River, and its tributaries including the Wallace and Sultan Rivers, in Bridal Veil Creek, the South Fork of the Skykomish between RM 49.6 and RM 51.1 and above Sunset Falls (fish have been transported around the falls since 1958), and the North Fork up to Bear Creek Falls (RM 13.1). Relative to spawning distribution in the 1950's, a much larger proportion of summer chinook currently spawn higher in the drainage, between Sultan and the forks of the Skykomish (Snohomish Basin Salmonid Recovery Technical Committee (SBSRTC) 1999). There is some indication that spawning in the North Fork has declined over the last twenty years (Snohomish Basin Salmonid Recovery Technical Committee (SBSRTC) 1999). Fish spawning in Snohomish mainstem and the Pilchuck River are currently considered to be part of the Skykomish stock pending further collection of genetic stock identification data.

Snoqualmie chinook spawn in the Snoqualmie River and its tributaries, including the Tolt River, Raging River, and Tokul Creek.

There is some uncertainty whether a spring chinook stock once existed in the Snohomish system. Suitable habitat may still exist in the upper North Fork, above Bear Creek Falls.

Life History Traits

Summer chinook enter freshwater from May through July, and spawn, primarily, in September, while fall chinook spawn from late September through October. However, fall chinook spawning in the Snoqualmie River continues through November. The peak of spawning in Bridal Veil creek is in the second week of October (i.e. slightly later than the peak for fish spawning in the mainstem of the Skykomish. Natural spawning in the Wallace River occurs throughout September and October (Washington (State). Dept. of Fisheries. et al. 1993).

The age composition of returning Snoqualmie River fall chinook showed a relatively strong age-5 component (28 percent), relative to other Puget Sound fall stocks. Age-3 and age-4 fish comprised 20 and 46 percent, respectively, of returns in 1993 – 1994 (Myers et al. 1998).

Most Snohomish summer and fall chinook smolts emigrate as subyearlings, but, based on scale data, an annually variable, but relatively large, proportion of smolts are yearlings. Of the summer chinook smolts sampled in 1993 and 1994, 33 percent were yearlings (Myers et al. 1998). Based on scale data, 25 to 30 percent of returning fall chinook also showed a stream-type life history (Snohomish Basin Salmonid Recovery Technical Committee (SBSRTC) 1999). No other summer or fall chinook stocks in Puget Sound produces this high a proportion of yearling smolts. Rearing habitat to support yearling smolt life history is vitally important to the recovery of these stocks.

Management Unit / Stock Status

Total natural spawning escapement of Snohomish summer/fall stocks has ranged between 2,700 and 8,200 since 1990, and has exceeded the 1968-1979 average of 5,237 only four times since 1980: in 1998, 2000, 2001, and 2002 (Table 1). However, due in part to reduced exploitation rate, escapement has rebounded from the levels observed in the early 1990s.

Table 1. Natural spawning escapement of Snohomish summer/fall chinook salmon, 1990-2002. Total estimates of natural spawning escapement were provided by WDFW using the escapement estimation method described by Smith and Castle (Smith and Castle 1994). Estimates of the natural origin fraction of the natural escapement are based on recoveries of thermally marked otoliths (Rawson et al. 2001)

Year	Snoqualmie	Skykomish	Total	Nat. Origin
1990	1277	2932	4209	
1991	628	2192	2820	
1992	706	2002	2708	
1993	2366	1653	4019	
1994	728	2898	3626	
1995	385	2791	3176	
1996	1032	3819	4851	
1997	1937	2355	4292	3525
1998	1892	4412	6304	2856
1999	1344	3455	4799	2436
2000	1427	4665	6092	3024
2001	3589	4575	8164	6336
2002	2895	4325	7220	
average	1443	3146	4791	
average %	31.4%	68.6%		

A portion of the natural spawning fish are the survivors of releases from the Wallace River and Bernie Kai-Kai Gobin (Tulalip) facilities. Since 1997 it has been possible to estimate the natural origin portion of the natural escapement because all chinook production at the Bernie Kai-Kai Gobin and Wallace River hatcheries has been thermally mass-marked and there has been comprehensive sampling of natural spawning areas for otoliths (Rawson et al. 2001). In most years the natural origin component of the natural escapement is significantly smaller than the total natural escapement estimate, although in 2001 the natural origin portion alone of the natural escapement was higher than the total natural escapement in any prior year since at least 1980 (Table 1 and state/tribal chinook escapement database).

Harvest distribution and exploitation rate trends:

Assessment of exploitation rate trends for Snohomish summer/fall chinook is difficult because there has been no coded-wire tagged indicator stock representing the management unit. Post-season runs of the FRAM model show a clearly declining trend in annual fishing year exploitation rate over the past two decades (Table 2). These validation runs use the same projection model used in preseason planning, but use post-season estimates of spawning escapement and fishery harvest and non-catch mortality instead of preseason abundance and fishing level predictions. Thus, these runs adjust for observed abundances and fishing levels, but they assume the stock composition of fisheries is the same as the base period stock composition used in the FRAM model.

Table 2. Adult equivalent (AEQ) exploitation rates (ER) by fishing year for the Snohomish summer/fall chinook management unit from post-season runs of the FRAM model for 1983-2000 (April 2003 revision of FRAM validation runs, personal communication, Andy Rankis, NWIFC, and Larrie LaVoy, WDFW) and from pre-season FRAM model predictions for 1999-2003[8]. The ceiling exploitation rate column is the maximum allowable annual AEQ exploitation rate from the management plan that was in effect for the year[9].

	AEQ ER		
Fishing Year	**Postseason**	**Preseason**	**Ceiling ER**
1983	73%		
1984	64%		
1985	55%		
1986	60%		
1987	48%		
1988	66%		
1989	52%		
1990	49%		
1991	52%		
1992	61%		
1993	62%		
1994	50%		
1995	65%		
1996	44%		
1997	29%		
1998	25%		
1999	31%	31%	38%
2000	26%	20%	35%
2001		21%	32%
2002		18%	32%
2003		19%	24%

[8] FRAM runs 99NP, 00NP, 01NP, 02NP, and 03NP.
[9] These are documented in the annual Stillaguamish/Snohomish regional status reports available from Tulalip Fisheries, 7615 Totem Beach Rd., Marysville, WA 98271. Management objectives that were in effect for years before 1999 are also documented in regional status reports for those years.

Table 3. Brood year exploitation rates reported in the Puget Sound Technical Recovery Team's Abundance and Productivity tables for the Skykomish and Snoqualmie chinook populations.

Brood Year	Skykomish	Snoqualmie
1980	86%	86%
1981	88%	87%
1982	84%	77%
1983	68%	67%
1984	82%	83%
1985	75%	74%
1986	76%	74%
1987	70%	69%
1988	76%	78%
1989	74%	75%
1990	67%	59%
1991	54%	39%
1992	56%	61%
1993	61%	64%
1994	54%	54%
1995	46%	38%
1996	51%	44%
1997	46%	43%
1998	48%	46%

Management Objectives

Management objectives for Snohomish summer/fall chinook include an upper limit on total exploitation rate, to insure that harvest does not impede the recovery of the component stocks, and a low abundance threshold (LAT) for spawning escapement to trigger reduced fishing effort under low returns to maintain the viability of the stocks. Fisheries will be managed to achieve a total adult equivalent exploitation rate, associated with all salmon fisheries, not to exceed 24 percent. These impacts include all mortalities related to fisheries, including direct take, incidental take, release mortality, and drop-off mortality.

Lacking direct information on the extent to which the current fisheries regime may disproportionately harvest any single stock, the spawning escapement of each stock will be carefully monitored for indications of differential harvest impact. Average escapement during the period of 1965 – 1976 will be the benchmark for this monitoring (Snohomish Basin Salmonid Recovery Technical Committee (SBSRTC) 1999).

The Puget Sound Salmon Management Plan mandates that fisheries will be managed to achieve maximum sustainable harvest (MSH) for all primary[10] natural management units. The recovery exploitation rate is likely to be lower than the rate associated with MSH under current conditions of productivity, as in the case where recovery involves increasing the current level of productivity. The conservatism implied by the recovery exploitation rate imbues caution against the potential size and age selectivity of fisheries, and the effects of that selectivity on reproductive potential, and potential uncertainty and error in management.

[10] A primary management unit is one for which fisheries are directly management to achieve a particular escapement goal or exploitation rate.

LOW ABUNDANCE THRESHOLD FOR MANAGEMENT

A low abundance threshold of 2,800 spawners (natural origin, naturally spawning fish) for the Snohomish management unit is established (see estimation procedure below) as a reference for pre-season harvest planning. If escapement is projected to fall below this threshold under a proposed fishing regime, extraordinary measures will be adopted to minimize harvest mortality. Directed harvest of Snohomish natural origin chinook stocks, (net and sport fisheries in the Snohomish terminal area or in the river) has already been eliminated. Further constraint, thus, depends on measures that reduce incidental take.

The low abundance threshold for the management unit was derived from critical escapement thresholds for each of the Snoqualmie, and Skykomish populations in a two-step process. Critical escapement thresholds are levels that we don't want to go below under any circumstances. For each population, the critical escapement threshold was determined and then expanded to an adjusted level for management use according to the following formula:

$$E_{man,p} = E_{crit,p} / [(R/S)_{low,p} * (1-RER_{mu})] \qquad [1]$$

Where $E_{man,p}$ is the lower management threshold for population ***p;***

$E_{crit,p}$ is the critical threshold for population ***p;***

$R/S_{low,p}$ is the average of recruits/spawner for population ***p*** under low survival conditions; and

RER_{mu} is the RER established for the management unit

The following describes the $\boldsymbol{E_{man,p}}$ for the Snoqualmie and Skykomish stocks within the Snohomish management unit. The following analysis is based on estimates of natural spawning escapement to the Snohomish system, by population, for the most recent twelve years (Table 1) .

Maximum Exploitation Rate Guideline

INTRODUCTION

The rebuilding exploitation rate (RER) is the highest allowable ("ceiling") exploitation rate for a population under recovery given current habitat conditions , which define the current productivity and capacity of the population. This rate is designed to meet the objective that, compared to a hypothetical situation of zero harvest impact, the impact of harvest under this Plan will not significantly impede the opportunity for the population to grow towards the recovery goal. Since recovery will require changes to harvest, hatchery, and habitat management and since this Plan only addresses harvest management, we cannot directly evaluate the likelihood of this plan's achieving its objective. Therefore, we evaluate the RER based on Monte Carlo projections of the near-term future performance of the population under current productivity conditions, in other words, assuming that hatchery and habitat management remain as they are now and that survival from environmental effects remain as they are now.

We choose the RER such that the population is unlikely to fall below a critical threshhold[11] (CT) and likely to grow to or above a rebuilding escapement threshold (RET). The CT is chosen as the smallest previously-observed escapement from which there was a greater than 1:1 return per

[11] Note that, there are other provisions of this plan that call for further reduction of the exploitation rate ceiling should the abundance be observed or expected to be near the lower threshold. This will provide additional protection against falling below the lower threshold that is not considered in this section, which address only the conditions under which the RER would apply.

spawner, while the RET is chosen as the smallest escapement level such that the addition of one additional spawner would be expected to produce less than one additional future recruit under current conditions of productivity. This level is also known as the maximum sustainable harvest (MSH) escapement. It is extremely important to recognize, though, that under this Plan the RET is not an escapement goal but rather a level that is expected to be exceeded most of the time. It is also the case that, when the productivity conditions for the population improve due to recovery actions, the RET will usually increase (MSH escapement does not increase in the Hockey stick model if productivity and capacity increase together as in eq. 5) and the probability of exceeding the RET using the RER computed for current conditions will also increase over the probability computed under current conditions. Thus the RET serves as a proxy for the true goal of the plan, which can only be evaluated once we have information on likely future conditions of habitat that will result from recovery actions, and hatchery as well as harvest management.

It also follows from the above, given that the likely chance of achieving the RET is greater than 50%, that the actual harvest from the population under this Plan will be less than the maximum sustainable harvest, the amount less being dependent on the likelihood (%) of achieving the RET. All sources of fishing-related mortality are included in the assessment of harvest, and nearly 100% of the fishing-related mortality will be due to non-retention or incidental mortality; only a very small fraction is due to directed fishing on Snohomish populations.

There are two phases to the process of determining an RER for a population. The first, or model fitting phase, involves using recent data from the target population itself, or a representative indicator population, to fit a spawner-recruit relationship representing the performance of the population under current conditions. Population performance is modeled as

$$R = f(S, \mathbf{e}),$$

where S is the number of fish spawning in a single return year, R is the number of adult equivalent recruits[12], and **e** is a vector of environmental, density-independent correlates of annual survival. The purpose of this phase is to be able to predict the recruits from spawners and environmental covariates into the future. What is important here is to simulate a pattern of returns into the future, not predict returns for specific years.

Several data sources are necessary for this analysis: a time series of natural spawning escapement, a time series of total recruitment (obtained from run reconstruction based on harvest and escapement data), age distributions for both of these, and time series for the environmental correlates of survival. In addition, one must assume a functional form for f , the spawner-recruit relationship; in our case three different forms were examined. Given the data, one can numerically estimate the parameters of the assumed spawner-recruit relationship to complete the model fitting phase.

The second, or projection phase, of the analysis involves using the fitted model in a Monte Carlo simulation to predict the probability distribution of the near-term future performance of the population assuming that current conditions of productivity continue. Besides the fitted values of the parameters of the spawner-recruit relationships, one needs estimates of the probability distributions of the variables driving the population dynamics, including the process error (including first order autocorrelation) of the spawner-recruit relationship itself and each of the environmental correlates. Also, since fishing-related mortality is modeled in the projection

[12] Equivalently, this could be termed “potential spawners” because it represents the number of fish that would return to spawn absent harvest-related mortality.

phase, one must estimate the distribution of the deviation of actual fishing-related mortality from the intended ceiling. This is termed “management error” and its distribution, as well as the others are estimated from available recent data.

We used the viability and risk assessment procedure (VRAP, N J Sands, in prep.) for the projection phase. For each trial RER value, the population is repeatedly projected for 25 years. From the simulation results we computed the fraction of years in all runs where the escapement is less than the LAT and the fraction of runs for which the final year’s escapement (average of last 3 years) is greater than the UAT. Trial RERs for which the first fraction is less than 5% and the second fraction is greater than 80% are considered acceptable for use as ceiling exploitation rates for management under this plan.

MODEL FITTING PHASE

General

The model used to estimate the spawner recruit parameters uses fishing rate and maturation rate estimates along with the spawning estimates to determine the time series of total recruitment needed.

Preterminal Fishery Rates

Fishery rates were based on an aggregate of Puget Sound summer/fall chinook hatchery indicator stock populations (Stillaguamish, Green, Grovers, George Adams, Nisqually, Samish). Although a new indicator stock tagging program has been implemented to represent Skykomish wild chinook, there is currently no coded-wire-tag (CWT) recovery data available that is directly representative of the Snohomish populations and no direct measure of fishery exploitation on the wild populations. We evaluated two options for estimating fishery rates on the Snohomish populations: 1) an aggregate of Puget Sound summer/fall chinook hatchery coded-wire-tag (CWT) indicator stocks using the Pacific Salmon Commission Chinook Technical Committee (CTC) exploitation rate indicator stock analysis (CTC 1999 for method, Dell Simmons pers. Comm. for most recent data); and 2) estimates from the CTC chinook model (CTC 1999).

Option 1 relies on CWT recoveries from individual years to reconstruct the fishery rates for that year, but is dependent on a consistently high rate of catch and escapement sampling to make precise estimates. After further evaluation, we determined that catch and escapement sampling for most of the populations within the aggregate meet or exceed their target sampling rates in most years. Snohomish populations may not have the same distribution as the populations within the aggregate. Puget Sound summer/fall chinook populations show some similarity in the general trend over time of exploitation in preterminal fisheries. Although it is logical to assume that Snohomish summer/fall populations follow a similar trend with respect to the change over time in the rate of preterminal exploitation, concern remains that the aggregate Puget Sound indicator stocks may not accurately reflect the true exploitation rates of Snohomish populations. Also, the indicator stocks that comprise the aggregate are not likely to represent harvest patterns of yearling outmigrant or “stream type” (Healy 1991). Scale pattern analysis of Snohomish Chinook shows that a significant portion of the return is stream type from both fingerling and yearling populations.

Under Option 2, the CTC model uses CWT recoveries from the Stillaguamish indicator stock during the 1979-1982 base period to estimate fishery exploitation on the Snohomish population in subsequent years so estimates are less subject to year-year variability in sampling rates. The CTC model appears to best reflect the pattern of reduced overall exploitation they expected to see in the early 1990s in response to more restrictive fishing regimes. Again, it is possible that the distribution and exploitation of the Stillaguamish and Snohomish populations are different.

We chose Option 1 because we determined that, for the purposes of deriving an RER, year specific fishery rates would be better than estimates derived from a base period based on a limited number of Stillaguamish CWT recoveries. Option 1, by using an aggregate set of populations, maximizes the use of the available data and smoothes differences in any one year associated with a particular population. Also, we were able to address most of the concerns we had with Option 1. In addition, Therefore, the aggregate was used as a surrogate to represent the Snohomish populations in preterminal fisheries. Fishery rates were derived from the CTC CWT exploitation rate analysis for each population in the aggregate and averaged across all populations for each year for which data were available.

The average CTC CWT exploitation rate analysis for fall indicator stocks by age was used for brood year 1979 to 1994, ages 2-4 for brood year 1995 and ages 2-3 for brood year 1996. The 1995 age 5+ fishery rate was based on an average of the 1993-94 rates. The 1996 ages 4-5+ were based on an average of the 1994-1995 rates because the current CTC CWT exploitation rate analysis is not complete for these ages for these brood years. However, available data for ages 2 and 3 indicate fishery rates were similar in 1994-1996. Fishery rates will continue to be updated as data become available.

Terminal Fishery Rates

Terminal area fisheries include mature chinook harvested in net fisheries throughout Puget Sound and in recreational fisheries in the Snohomish River system and Area 8D. The in-river recreational fishery harvest is partitioned into natural and hatchery-produced components based on the relative magnitudes of the escapement to natural areas and to the Wallace River Hatchery.

The stock composition of the Area 8D recreational and net harvest is estimated using results of recoveries of thermally-marked otoliths from Tulalip hatchery. The otolith recoveries are used to estimate the Tulalip hatchery contribution to this fishery for the brood years from 1997 on (Rawson et al. 2001), which is subtracted from the total catch. The remaining catch is partitioned into components based upon the relative run strengths of the Stillaguamish and Snohomish chinook returns to their rivers. In particular, the Snohomish natural fraction is estimated as the Snohomish natural escapement plus the Snohmish natural portion of the in-river recreational harvest divided by the sum of the escapements to the Stillaguamish and Snohomish Rivers and the in-river harvests of chinook in those rivers. For years before 1997 the procedure is the same, except that the proportional contribution of Tulalip hatchery fish to Area 8D is assumed to be the average of the values measured for 1997-2001.

The stock composition of the Area 8A net harvest is estimated using the relative proportions of all the Stillaguamish/Snohomish stocks passing through Area 8A. Only chinook harvested during the so-called “adult accounting period” of July1 through September 30 are included in this analysis. Other chinook harvested in Area 8A are part of the preterminal fishing rate. In particular, the Snohomish natural fraction is the sum of the Snohomish natural escapement, the Snohomish natural fraction of the in-river harvest, and the Snohomish natural fraction of the 8D harvest, divided by the sum of the total escapement and harvest in both rivers plus the Area 8D harvest and escapement to Tulalip hatchery.

To the three harvest components computed above (in-river, 8D, and 8A) the harvest of mature Snohomish natural chinook in Puget Sound net fisheries outside of Area 8A must be added. This computation was completed using coded-wire tag recoveries by Jim Scott and Dell Simmons of the CTC. The terminal, or mature fishery, fishing rate is then the sum of the harvest in the four components divided by the numerator plus the Snohomish natural escapement.

Maturation Rates

We also considered two options for the maturation rates (the fraction of each cohort that leaves the ocean to return to spawn during the year): 1) maturation rates derived from age data collected from scales and otoliths from the spawning grounds combined with the age-specific fishing rates described above; 2) estimates derived from the CTC model for the Snohomish model population. In general, fish matured at older ages under option 1 than option 2, and no fish matured as two year olds. We decided to use option 1 because it is a more direct measure of the age structure of the spawners and relies on age specific data for the populations.

However, we identified two potential concerns that should be taken into account when using the data: 1) age 2 fish are generally underrepresented in spawning ground samples for several reasons: e.g., carcasses decay faster, the smaller body size makes them more susceptible to being washed downstream, they are less visible to samplers; and 2) only one year, 1989, had a sufficient number of samples to use. The age structure for other years was extrapolated from 1989 by using the 1989 age composition to reconstruct brood year and calendar year escapements by age. The age structure is then adjusted to minimize the difference between the estimated calendar year escapements and the observed calendar year escapements for each year for which data are not available.

Hatchery Effectiveness

No adjustments were made for the relative fecundity of naturally-spawning hatchery-produced fish as compared with natural-origin fish, since there is no available data for the effectiveness of hatchery spawners in the wild when compared with their natural origin counterparts for Puget Sound chinook. For the RER analysis, we assumed all spawners were equally fecund regardless of their origin. This is a conservative assumption since it would tend to underestimate productivity (assuming hatchery fish are less effective) and, therefore, the resulting RER, minimizing the possibility of adopting a harvest objective that was too high (Table 4.)

Table 4. Intrinsic Productivity (MSY Exploitation Rate) by Production Function for the Skykomish chinook population.

Hatchery Effectiveness	Ricker	Beverton-Holt	Hockey Stick
Not Effective	7.58 (49%)	14.14 (65%)	8.07 (77%)
Half as Effective	6.26 (52%)	8.34 (65%)	4.55 (63%)
Equal Effectiveness	5.49 (47%)	6.51 (53%)	3.66 (51%)

Spawner-recruit Models

The data were fitted using three different models for the spawner recruit relationship: the Ricker (Ricker 1975), Beverton-Holt (Ricker 1975), and hockey stick (Barrowman and Myers 2000). The simple forms of these models were augmented by the inclusion of environmental variables correlated with brood year survival. For marine survival we used an index based on the common signal from a several chinook coded-wire tag groups released from Puget Sound hatcheries (J Scott, Washington Department of Fish and Wildlife, personal communication). We tried two indices: one (PS6) used tag groups from throughout Puget Sound; the other (NPS2) used coded wire tags from North Puget Sound hatcheries only. The other environmental correlate, associated with survival during the period of freshwater residency, was the September-March peak daily mean stream flow during the fall and winter of spawning and incubation.

Equations for the three models are as follows:

$$(\mathbf{R} = \mathbf{aS}e^{-\mathbf{bS}})(\mathbf{M}^{\mathbf{c}}e^{\mathbf{dF}})$$ [Ricker]

$$(\mathbf{R} = \mathbf{S}/[\mathbf{bS} + \mathbf{a}])(\mathbf{M}^{\mathbf{c}}e^{\mathbf{dF}})$$ [Beverton-Holt]

$$(\mathbf{R} = min[\mathbf{aS},\mathbf{b}])(\mathbf{M}^{\mathbf{c}}e^{\mathbf{dF}})$$ [hockey stick]

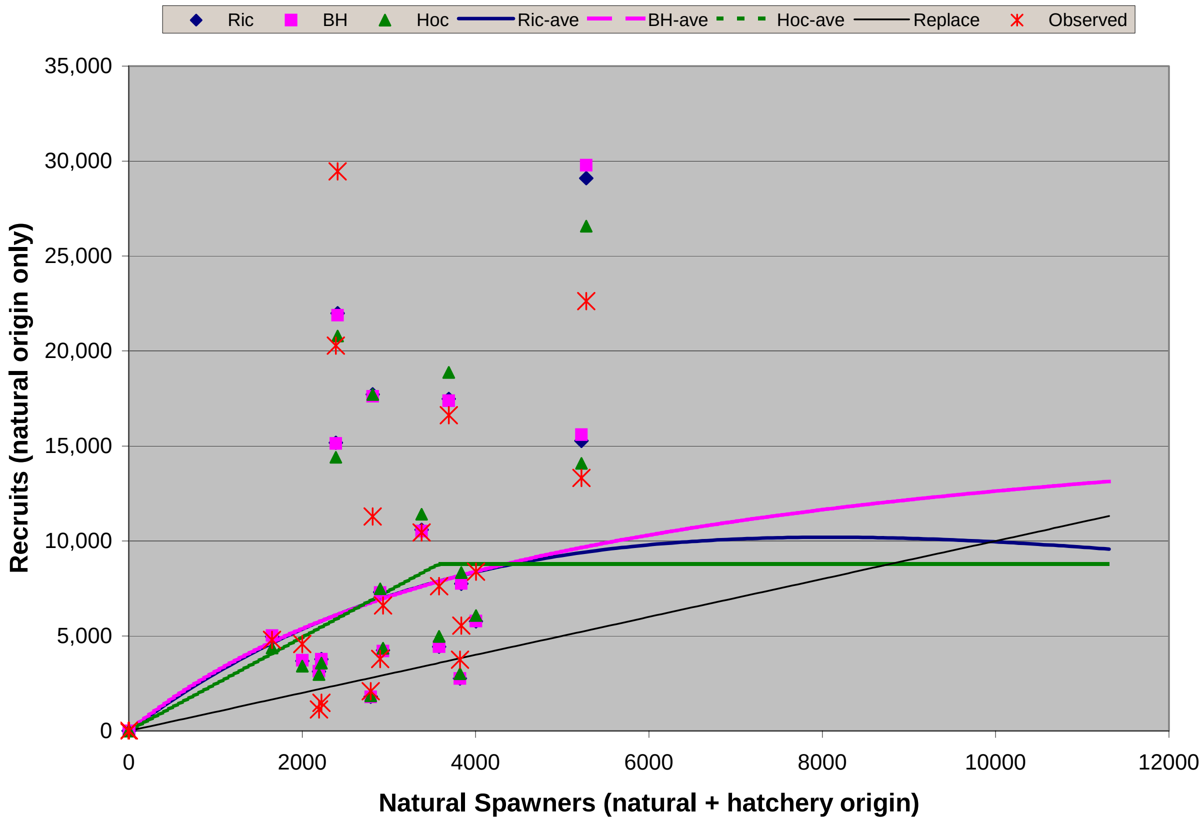
In the above, a is the density independent parameter, b is the density dependent parameter, c is the parameter for marine survival, d is the parameter for the freshwater covariate, M is the index of marine survival, and F is the freshwater correlate, peak Sep-Mar mean daily flow in this case.

Data used for the Skykomish Population

The Skykomish RER was based on analyses of the 1979-1996 brood years. Uncertainty about accuracy of escapement data and completeness of catch data precluded use of data before 1979. The 1996 brood year was the last year for which data were available to conduct a complete cohort reconstruction. There was no evidence of depensation or of a time trend in the data after adjustment for environmental variables.

Results

Figure 1. Comparison of observed and predicted recruitment numbers for the Skykomish chinook



population, brood years 1979 – 1996, under three different models of the spawner-recruit relationship (see text for further details).

The results of model fitting for various combinations of environmental correlates are summarized in Table 7 and graphed in Figure 1. We used the parameters from the fits using the NPS2 marine survival index and using both the marine and freshwater environmental correlates (upper right corner of Table 7).

PROJECTION PHASE

We projected the performance of the Skykomish stock at exploitation rates in the range of 0 to .30 at intervals of .01 using the fitted values of a, b, c, and d for the three spawner-recruit models. All projections were made assuming low marine survival using the average and variance of the marine survival indices observed for the most recent 10-year period. The freshwater environmental correlate (peak winter flow) was projected using the average and variance observed for the entire period used in the model fitting phase. Projections were run for target exploitation rates varying from 0 to .50, in increments of .01. The lower abundance threshold (LAT) was 1,745, derived as described above. The upper abundance threshold was the MSH escapement level (also described above). This biological reference point varies with the assumed marine survival and also with the particular form of the spawner-recruit relationship. We used the average marine survival index for the low marine survival period to obtain the RET for each spawner-recruit function. These values were: 3,500 – Ricker, 3,600 – Beverton-Holt, and 3,600 – hockey stick.

For each combination of spawner-recruit relationship and exploitation rate we ran 1000 25-year projections. Estimated probabilities of exceeding the RET were based on the number of simulations for which the final spawning escapement exceeded the RET. Estimated probabilities of falling below the LAT were based on the number of years (out of the total of 25,000 individual years projected for each combination) that the spawning escapement fell below the LAT. For each spawner-recruit relationship the sequence of Monte Carlo projection running through the exploitation rate range from 0 to .30 started with the same random number seed so that the results for the different spawner-recruit models would be comparable.

Detailed results of these projections are in Table 8, and summarized results are in Table 5. Indicated target exploitation rates are 0.25 – Ricker, 0.27 – Beverton-Holt, and 0.22 – hockey stick. Since there is no basis to choose one of these models over the other, we propose to use the average of these values as the target exploitation rate. This average is 0.24, rounding down to the nearest whole percentage exploitation rate.

Table 5. Results of the VRAP projections of the Skykomish chinook stock under current conditions showing the indicated target exploitation rate for each form of the spawner-recruit relationship.

Model	TgtER	#fish Mort.	% runs extnct	% yrs <LEL	% runs end>UEL	1st Year	LastYrs Ave.
Ricker	0.25	1671	0	4.0	80.0	2123	5711
Bev-Holt	0.27	1889	0	4.5	80.3	2084	6149
H-Stick	0.22	1427	0	3.0	81.3	2172	5747

MANAGEMENT UNIT REBUILDING EXPLOITATION RATE AND LOWER ESCAPEMENT THRESHHOLDS

The management unit maximum exploitation rate was set at 0.24, which is the average of the maximum allowable rates computed for the Skykomish stock using the three different spawner-recruit relationships. This is assumed to provide the appropriate protection to both populations. It was not possible to obtain a fit of the Snoqualmie data to any of the spawner-recruit models, with or without the use of environmental correlates. It is believed that this is due to the fact that some of the escapement estimates for the Snoqualmie are unreliable, and biased low, due to poor visibility in some years.

The lower abundance threshold for management was set starting with critical escapement levels, expands these per population management thresholds, and expands again to a management unit threshold based on the average contribution of each population to the management unit's escapement.

The second step in deriving the management unit lower threshold was to expand each stock's lower management threshold by dividing the percentage of the total escapement that the stock is expected to comprise.

We can then compute the total system escapement required such that we expect each stock to achieve its lower escapement management threshold by dividing the percentage of the total escapement the stock is expected to comprise. The expected percentages of each stock came from the recent 12-year escapement breakout by stock (Table 1). Averaging the ratios of the two stocks' estimated NOR escapements over the twelve years gives an average Snoqualmie fraction of 37.7% of the total.

Table 6. Derivation of the lower management threshold for each Snohomish chinook population and the management unit escapement necessary to achieve this level for each population.

	Snoqualmie	Skykomish
Critical level	400	942
Low R/S	1.01	0.71
Exp. rate	.24	.24
Low threshold	521	1745
Implied MU LT	1,381	2,802

The maximum of the management unit lower thresholds required to achieve the lower thresholds for the two stocks is 2,800 (Table 6), which was chosen as the management unit lower threshold for management planning purposes. Because this is so much higher than the indicated management threshold for protection of Snoqualmie escapement, this Plan is providing extra protection to the Snoqualmie stock pending acquisition of better escapement data.

INTERPRETATION OF FRAM MODEL FOR PRESEASON PLANNING

Currently the comanagers use the Fishery Regulation Assessment Model (FRAM) for preseason planning of total fishery impacts (Table 2). Because a different set of exploitation rates (Table 3) was used in the model fitting phase for Snohomish Chinook, it is important to assess whether preseason exploitation rates from FRAM are directly comparable with the RER derived in the projection phase described above.

The exploitation rates in Tables 2 and 3 cannot be directly compared for a number of reasons. First, the A&P rates (Table 3) are brood year rates, while the FRAM rates (Table 2) are calendar or fishing year rates. FRAM is based on applying current year abundances and fishery exploitation levels to average fishery-specific exploitation rates observed form coded-wire tag recoveries in a base period (Larrie Lavoy, WDFW, personal communication). In contrast the preterminal rates in the A&P tables use current year coded-wire tag recoveries from indicator groups.

Second, FRAM more accurately represents Snohomish Chinook by modeling both the fingerling outmigrant or "ocean type" and yearling outmigrant or "stream type" (Healy 1991) components of the Snohomish run. Comparison of coded-wire tag recoveries from hatchery groups released as age-0 fingerlings as compared with groups released as age-1 yearlings consistently shows differences in patterns of fishery exploitation. FRAM utilizes CWT recovery information from Wallace River (Skykomish) yearling production releases as well as fingerling CWT data to accurately reflect Snohomish Chinook distributions (Larrie LaVoy, WDFW, personal communication). Because yearling recovery data are not incorporated into the A&P tables, these rates may not be an accurate reflection of the true rates for Snohomish Chinook.

Finally, the two models use different set of indicator coded-wire tag groups to represent the Snohomish management unit. This is more difficulty for the Snohomish than for other management units because there is no local indicator coded-wire tag stock available for

Snohomish ocean type Chinook, although a program of double-index tagging at Wallace River hatchery began in 2000 with hopes of developing an appropriate indicator group.

In summary, information available at this time indicates that there is some management risk to using FRAM as we implement annual fishing plans with the intention of achieving our Plan objectives. However, given the uncertainties in estimates associated with estimates of exploitation rates in both the A&P tables and with FRAM, it is not clear that one is more accurate in representing true Snohomish Chinook exploitation rates. Therefore, some additional, precaution is called for in using FRAM to assess whether a given package of proposed fisheries will result in an exploitation rate below the RER guideline of 0.24 for the Snohomish. Therefore, the comanagers will initially use a guideline of 0.21 for the Snohomish instead of the 0.24 derived in the projection phase of this analysis. This guideline was the highest preseason projected exploitation rate for Snohomish since the 2000 application of the comanagers' plan (Table 2). The range of preseason exploitation rates primarily reflects variation in abundance of other chinook stocks and changes in the pattern or level of fisheries outside the comanagers' jurisdiction. Given the procedures in place for annual implementation of the plan, particularly with respect to our intention of not increasing fisheries and our record of managing fisheries to levels that are below exploitation rate ceilings, our expectation is for preseason Snohomish Chinook exploitation rates less than 0.21. Since observed spawning escapements have been increasing during this period (Table 1), consistently above the comanagers' former goal of 5,250 (Ames and Phinney 1977), and generally the largest observed since the beginning of the database in 1965, we feel that recent management has met this plan's objective of reducing fishery impacts so that the population can recover if other factors improve.

In addition, as part of our commitment to evaluate performance of the Plan and modify it as necessary to ensure objectives are achieved, the comanagers intend to l review in detail the implications of the differences between the A&P and FRAM exploitation rates. This may result in the need to recompute RER estimates, compute a quantitative adjustment for FRAM projections.

Data gaps

Priorities for filling data gaps to improve understanding of stock / recruit functions, harvest exploitation rate, and marine survival:

- Annual implementation of a double-index coded-wire tagging program using fingerling summer chinook from Wallace River Hatchery to enable direct assessment of harvest distribution, and estimation of harvest exploitation rates and marine survival rates. (Initiated beginning with the 2000 brood year).

- Estimates of natural-origin smolt abundance from chinook production areas. (Outmigrant trapping began in the Skykomish in 2000 in the Snoqualmie in 2001).

- Estimates of estuarine and early-marine survival for fingerling and yearling smolts.

- Quantification of the contribution of hatchery-origin adults to natural spawning for each stock. (Research is underway. Estimates of hatchery contribution to natural spawning populations is available for the 1997 through 2001 return years.)

Table 7. Results of model fits for different combinations of environmental correlates.

	PS(6) for marine, FW			NPS(2) for marine, FW		
	Ric	Bev	Hoc	Ric	Bev	Hoc
a - productivity	4.1658	0.2400	4.1658	5.1234	0.1782	3.6572
b - Spawners	0.000000	0.000000	42,216	0.000124	0.000035	13,092
c – Marine	0.8330	0.8330	0.8330	0.6418	0.6394	0.6313
d - Freshwater	-0.000011	-0.000011	-0.000011	-0.000014	-0.000014	-0.000014
SSE	2.414	2.414	2.414	0.343	0.345	0.347
MSE (esc)	0.268	0.268	0.268	0.038	0.038	0.039
autocorrelation in error	0.199	0.199	0.199	-0.366	-0.358	-0.449
R	0.680	0.680	0.680	0.895	0.891	0.891
F	2.579	2.579	2.579	12.096	11.569	11.568
PROBABLITIY	0.1184	0.1184	0.1184	0.0016	0.0019	0.0019
MSE (reruits)	0.564	0.564	0.564	0.276	0.278	0.255
autocorrelation in error	-0.390	-0.390	-0.390	-0.133	-0.126	-0.147
Ave.Pred. Error	7237	7237	7237	3994	4092	3999

	No Freshwater, PS(6)			No Freshwater, NPS(2)		
	Ric	Bev	Hoc	Ric	Bev	Hoc
a - productivity	2.8789	0.3474	2.8789	4.6677	0.0761	3.9737
b - Spawners	0.000000	0.000000	42,216	0.000254	0.000132	6,238
c – Marine	0.8398	0.8398	0.8398	0.6986	0.7042	0.7341
d - Freshwater	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SSE	2.897	2.897	2.897	1.056	1.057	1.065
MSE (esc)	0.290	0.290	0.290	0.106	0.106	0.106
autocorrelation in error	0.203	0.203	0.203	0.175	0.141	0.116
R	0.617	0.617	0.617	0.862	0.855	0.877
F	3.066	3.066	3.066	14.505	13.605	16.739
PROBABLITIY	0.0915	0.0915	0.0915	0.0011	0.0014	0.0006
MSE (reruits)	0.447	0.447	0.447	0.298	0.304	0.316
autocorrelation in error	-0.372	-0.372	-0.372	-0.071	-0.088	-0.069
Ave.Pred. Error	7773	7773	7773	4310	4437	4089

	No Marine			No Marine or Freshwater		
	Ric	Bev	Hoc	Ric	Bev	Hoc
a - productivity	3.7071	0.2697	3.7071	2.7118	0.3688	2.7118
b - Spawners	0.000000	0.000000	19,851	0.000000	0.000000	66,517
c – Marine	1.0062	1.0000	1.0000	0.5000	0.5000	0.5000
d - Freshwater	-0.000010	-0.000010	-0.000010	-0.000001	-0.000001	-0.000001
SSE	3.463	3.463	3.463	3.758	3.758	3.758
MSE (esc)	0.346	0.346	0.346	0.342	0.342	0.342
autocorrelation in error	0.086	0.086	0.086	-0.017	-0.017	-0.017
R	0.435	0.435	0.435	0.299	0.299	0.299
F	1.164	1.164	1.164	1.076	1.076	1.076
PROBABLITIY	0.3512	0.3512	0.3512	0.3219	0.3219	0.3219
MSE (reruits)	0.768	0.768	0.768	0.789	0.789	0.789
autocorrelation in error	-0.324	-0.324	-0.324	-0.369	-0.369	-0.369
Ave.Pred. Error	7838	7838	7838	7938	7938	7938

Table 8. Summary of projections of the Skykomish population at different target exploitation rates for three different forms of the spawner-recruit relationship.

	Pr(final esc > UAT) %			Pr(ann. Esc. < LAT) %		
Target ER	**B-H**	**Ricker**	**Hockey-St**	**B-H**	**Ricker**	**Hockey-St**
0.00	99.20	96.60	96.30	0.30	0.50	0.50
0.01	99.40	97.80	96.50	0.40	0.70	0.60
0.02	99.00	96.40	95.80	0.50	0.70	0.60
0.03	98.70	95.80	95.60	0.40	0.60	0.50
0.04	98.10	95.60	94.70	0.40	0.70	0.60
0.05	98.40	96.40	95.80	0.50	0.70	0.70
0.06	97.80	95.10	94.30	0.60	0.90	0.80
0.07	97.40	94.70	93.20	0.60	0.90	0.80
0.08	97.80	94.90	94.00	0.60	0.90	0.80
0.09	97.50	94.80	93.70	0.70	1.00	1.00
0.10	97.40	94.20	92.70	0.70	1.00	1.00
0.11	96.90	94.10	92.20	0.90	1.20	1.10
0.12	95.70	92.10	90.50	0.80	1.20	1.20
0.13	96.50	93.40	90.70	1.20	1.60	1.60
0.14	96.00	92.10	90.30	1.10	1.40	1.40
0.15	95.60	90.40	89.30	1.20	1.50	1.60
0.16	93.60	90.90	88.20	1.60	2.00	2.00
0.17	93.70	89.80	87.00	1.50	1.80	2.00
0.18	91.40	87.90	84.60	1.60	1.90	2.10
0.19	91.10	87.70	83.80	2.10	2.50	2.80
0.20	91.00	86.90	83.90	1.90	2.30	2.60
0.21	91.00	87.90	84.40	2.10	2.40	2.80
0.22	90.70	87.30	**82.50**	2.30	2.70	3.00
0.23	86.40	82.70	78.70	2.80	3.20	3.70
0.24	86.40	82.30	77.10	3.40	3.70	4.40
0.25	84.30	**80.00**	75.30	3.50	4.00	4.80
0.26	85.80	82.40	76.90	3.30	3.90	**4.70**
0.27	**80.30**	77.10	71.50	4.50	**4.90**	6.10
0.28	77.90	73.90	68.70	**4.50**	5.00	6.30
0.29	78.40	73.90	65.80	5.10	5.60	7.20
0.30	75.20	72.00	65.60	5.20	5.60	7.50

Lake Washington Management Unit Status Profile

Component Stocks

Cedar River Fall
North Lake Washington Tributaries Fall

Geographic distribution

Fall chinook are produced in three basins in the Lake Washington watershed, the Cedar River, at the south end of Lake Washington; Big Bear Creek and its tributary Cottage Creek (the "Northern Tributaries" which are tributaries of the Sammamish Slough), and Issaquah Creek, the principle inlet at the south end of Lake Sammamish. Historically, chinook also spawned in other smaller tributaries to Lake Washington (e.g. – May and Kelsey creeks) and the Sammamish Slough, (e.g. Little Bear, Swamp, and North creeks). Recent field studies indicate sporadic use of these streams.

About ten miles of Bear Creek, and three miles of Cottage Creek, are accessible to chinook. Recent surveys have located concentrated spawning between RM 4.25 and 8.75 in Bear Creek and the entire three miles of Cottage Lake Creek. Approximately 75% of the total chinook escapement in Bear/Cottage is in Cottage Lake Creek. Spawning in Issaquah Creek occurs predominately in reaches between RM 1 and the Issaquah hatchery (Ames et al. 1975). Chinook surplus to hatchery needs are often passed upstream of the rack and spawn in Issaquah Creek.

In the Cedar River, access above RM 21 has been blocked by the Landsburg diversion dam since its construction in 1901. Access to an additional 15 miles of habitat above Landsburg became available in 2003 with the completion of fish passage facilities. There is very little chinook spawning in the Cedar River downstream of RM 5.0.

Hatchery contribution

Hatchery production currently exists at Issaquah Creek (chinook and coho), the University of Washington (chinook and coho), and the Cedar River (sockeye). Due to present and historic enhancement efforts, adults that return to Issaquah Creek are presumed to be predominately of hatchery origin. Outplants were made to most of the tributaries to the Lake Washington basin from the Issaquah and Green River hatcheries, during the period of record (1952 on). Many of these plants continued through the early 1990s. The one exception is the Cedar River where the last plants were in 1964.

Genetic information

Allozyme analysis of samples collected from Cedar River chinook suggest that this stock is genetically distinct, but closely related to that in the Green River (Marshall, 1995b). Genetic samples from chinook in Bear/Cottage Creek are similar to those from Issaquah Creek. Green River hatchery fish were outplanted into the Cedar River system from 1952 to 1964. Until 1916 the Cedar River drained into the Green River, so a close relationship is not surprising. Sampling and genetic analysis of returns to the North Lake Washington tributaries and other independent tributaries is in progress, and preliminary analysis suggests that chinook in Bear/Cottage Creek have similar genetics to chinook returning to Issaquah Creek.

Life History Traits

Juvenile trapping in the Cedar River has shown that the outmigration is bimodal with most of the fish entering the lake prior to April as fry. A smaller percentage of these fish rear in the river to smolt size and outmigrate between May and July. On the average, 75% of the outmigrants are fry. These fry rear along the lakeshore, growing quickly and leave the lake as zero-age smolts. The smolts that migrate out of the river are thought to reach the Locks about the same time as the fry, although some fish are still migrating out of the river in late July. The migration through the Locks begins in mid-May and continues until at least September. Recent PIT tagging of Cedar River chinook suggests that the Cedar River fish migrate out later in the season than hatchery chinook. The Cedar River chinook fry that rear along the lakeshore are unique in that most, if not all, of the chinook stocks that use a lake for rearing are age one or two smolts. The Lake Washington stocks also have a protracted smolt outmigration, with a large percentage of the run outmigrating after July 1.

Adult chinook enter the Lake Washington basin from late May through September, and enter drainages from mid-August through early November. Spawning is usually complete by mid-November.

Status

Annual monitoring of the return through Ballard Locks has, since 1994, provided in-season assessment of the total abundance of chinook. Escapement surveys are conducted annually on index reaches in the Cedar River (RM 0 – 21.4), Bear Creek (RM 1.3 – 8.8) and Cottage Lake Creek (RM 0 – 2.3), and some of the smaller tributaries to Lake Washington. An additional mile of upper Cottage Lake Creek, above the index reach (i.e. up to RM 3.3), is also routinely surveyed. Hatchery rack counts occur at Issaquah Creek Hatchery and the University of Washington facility. Since 2003, returns of mass marked hatchery releases from Issaquah Creek Hatchery have enabled assessment of natural- and hatchery-origin chinook at the Ballard Locks and in natural spawning escapement.

For Cedar River, the geometric mean escapement (i.e. live fish counts in the index reach) from 1993 – 1997 was 319; for 1998 - 2002 the mean was 327. For the North Lake Tributaries, the 1993 – 1997 mean escapement to index reach (i.e. live count) was 110; for 1998 – 2002 the mean increased to 330 (Table 1).

Table 1. Escapement estimates for of Lake Washington fall chinook, 1993-2002 (MIT et al. 2003), based on live fish counts in the index reaches of the Cedar River (RM 0 – 21.4), and the North Lake Tributaries (RM 1.3 – 8.8 in Bear Creek, and RM 0 – 2.3 in Cottage Lake Creek).

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Cedar River	156	452	681	303	227	432	241	120	810	369
N. Lake Tribs	89	436	249	33	67	265	537	228	458	268

Additional, and more extensive survey coverage and redd counts, conducted since 1999, have improved our understanding of the distribution and abundance of natural spawning for the two Lake Washington populations (Table 2).

Table 2. Redd count-based estimates of escapement to the Cedar River index reach, and live-fish estimates of escapement to upper Cottage Creek (RM 2.3 – 3.3), 1999 – 2002.

	1999	2000	2001	2002
Cedar River – Redd counts	180	53	395	266
- Expanded by 2.5 fish / redd	450	133	988	665
Upper Cottage Creek – live counts	195	104	231	92

Redd count-based estimates for the Cedar River index reach suggest that escapement has substantially exceeded the standard live-count estimates. The supplemental surveys of upper Cottage Lake Creek indicate that approximately 30% of natural spawning in the Bear Creek system has occurred above, and in addition to, that in the index reach. The additional abundance identified in Table 2, when added to the index counts, still does not fully account for escapement to the Cedar River and North Lake tributaries.

Harvest distribution

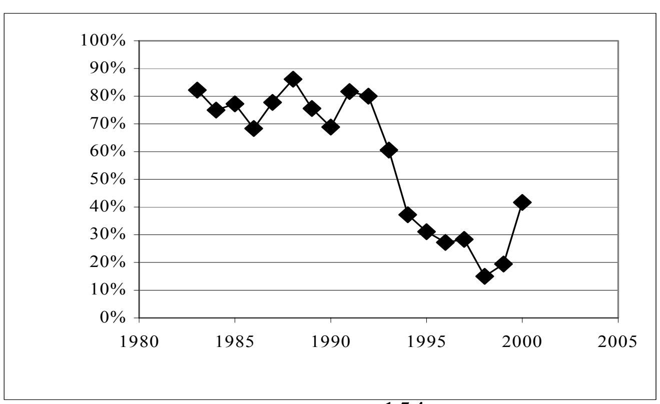
The harvest distribution of Lake Washington chinook has not been directly assessed because representative coded-wire tagged hatchery releases are only available for a few brood years from the Issaquah Hatchery in the late 1980s, and the University of Washington hatchery in the late 90s. However, because of their similar life history and genetic heritage, tagged fingerling releases from Central Puget Sound facilities (Soos Creek hatchery on the Green River, and Grovers Creek Hatchery on the Kitsap Peninsula) facilities provide the best available representation of pre-terminal harvest distribution (see Green River profile).

Terminal harvest of Lake Washington chinook has been minimized since 1994 by regulatory measures that have eliminated directed harvest and reduced incidental impacts in Shilshole Bay, the Ship Canal, and in Lake Washington. Commercial and recreational fisheries directed at sockeye and coho salmon have been specifically shaped to minimize impacts on chinook. Recreational fishing regulations focus effort on Issaquah Hatchery returns.

Exploitation rate trends

Based on post-season FRAM runs, average total annual exploitation rates on the aggregate of natural and hatchery-produced Lake Washington chinook have fallen 66 percent from levels in the 1980s to 1996 – 2000.

Figure 1. Total annual, adult equivalent, fisheries exploitation rate of Lake Washington chinook, estimated by post-season FRAM runs for management years 1983 – 2000.



Management Objectives

The upper management threshold (escapement goal) for the Lake Washington unit is 1,200 (i.e. live count) in the Cedar River index reach. This goal was derived as the average escapement observed from 1965 – 1969, and represents the best available estimate of habitat capacity (Hage et al. 1994). However, current habitat conditions constrain productivity and have prevented achievement of the goal in recent years (Table 1).

The current management objective for the Lake Washington unit is to constrain the exploitation rate, in pre-terminal southern U.S. fisheries, to a level less than or equal to 15%. This objective was derived from highly constrained regimes planned for the 1998 – 2000 management years. Directed terminal fisheries have been closed for ten years, and pre-terminal exploitation rates have been declining. Terminal area fisheries have been reduced to the Minimum Fisheries Regime to conserve Lake Washington chinook, even though forecast abundance has exceed the low abundance threshold. This fishing regime has stabilized escapement.

Management objectives are not currently specified for the North Lake Washington tributaries population. Estimated escapement to the Bear Creek / Cottage Creek index areas averaged 350 during the period from 1983 – 1992 (Hage et al. 1994), and the co-managers previously adopted this as an interim escapement goal. The aforementioned management objectives, for the Cedar River population, provide adequate protection for the North Lake population, as demonstrated by stable escapement levels observed in the last ten years (Tables 1 and 2). The long-term objective for Lake Washington chinook is to increase productivity to the point that the natural escapement goal is regularly met or exceeded.

Anticipating that productivity and abundance will remain low during the term of this plan, the co-managers will continue to implement the recent management actions which constrain impacts on Lake Washington natural chinook to very low incidental levels. These harvest measures ensure that harvest impacts are consistent with recovery of listed stocks. The co-managers will continue to refine their harvest management for Lake Washington natural chinook by shaping terminal fisheries for sockeye and coho to minimize incidental impact on chinook.

The low abundance threshold of 200 for the Cedar River population was set substantially above the historically low escapement from which the stock recovered (e.g. the 1993 escapement of 156). If pre-season fishery simulation modeling indicates that escapement will fall below 200, conservation measures will be implemented to further reduce the pre-terminal SUS exploitation rate to a level no greater than 12%, and terminal fisheries will also be shaped to reduce impacts on Lake Washington chinook, while maintaining fishing opportunity on harvestable sockeye and coho salmon (see Appendix C).

These objectives are intended to maintain the diversity of the naturally reproducing populations that comprise the management unit. Diversity is expressed in various aspects of life history, including the age composition of mature fish, migration timing, and spawning and rearing distribution. Harvest constraint has been exerted, over the last ten years, to maintain stable spawning escapements to the Cedar River and the North Lake tributaries, but is not capable, by itself, of improving their status. If habitat protection and restoration measures succeed in alleviating the primary constraints on productivity in these systems, harvest management will respond by ensuring that spawning escapement is sufficient to optimize production, so that abundance will rebuild.

Data gaps

The highest priority will be placed on collecting the data needed to quantify the productivity of Lake Washington stocks. Until the fundamental aspects of productivity are defined it will be difficult to assess the success of recovery actions, whether they entail improvement in habitat productivity or production supplementation.

Table 3. Data gaps related to harvest management, and projects required to address those data needs.

Data gap	Research needed
Estimates of total spawning escapement for each stock.	Mark/recapture study, repeated for a minimum of three years; or an alternate approach to expanding index reach counts to total escapement. First done in FY2000
Estimates of natural smolt production in Issaquah Creek.	Fry/smolt trapping in Issaquah Creek to supplement ongoing trapping in the Northern Tributaries and the Cedar River.
Quantification of fry and smolt survival in Lake Washington and the Ship Canal.	Smolt trapping at the locks to quantify mortality as smolts transit the lake and the locks. Trapping at the locks has proven to be very difficult.
Quantification of freshwater predation on smolts	Continuation of the Lake Washington Studies Project to further quantify fish, bird and lamprey predation. Fish predation research has been completed and is being written up. Bird predation work has not been started
Comprehensive estimates of incidental fishing mortality.	Creel surveys of recreational fisheries that target other species. The approach should be research oriented.
Estimates of bias in ladder counts at Ballard Locks, relative to spawning ground surveys.	Tagging and tracking of adult chinook from the locks and the ladder to estimate repeat passage. Started in 1998, research is complete and is awaiting write-up.
Estimate of spawning and production above Landsburg Dam	Spawner surveys to account for fish passed above the dam, fry/smolt trapping at or near the dam to independently assess upper basin productivity and survival.
Estimates of hatchery stray rates for Cedar and North Lake Tributaries	All ages are ad-clipped beginning in 2004. Enumerate ad-clipped fish during spawner surveys; sample for and collect CWTs.
Assess pre-spawning mortality	Quantify pre-spawning mortality related to environmental variables like water temperature.

Related Data Questions

Is chinook survival from emergent fry to adult (smolt?) correlated with early life history strategy? (i.e. – what are the relative survival rates of fry outmigrants compared to smolt outmigrants in the Cedar River). Is survival different in the upper basin than it is in the lower basin?

Is scour of chinook redds related to the magnitude of peak flow events in the Cedar River, and the position of redds in the stream channel?

What is the relationship between flow at Landsburg and the availability of water at the Locks for operating the smolt slides?

Green River Management Unit Status Profile

Component Stocks

Green River Fall Chinook

Geographic description of spawner distribution

Fall chinook are produced in the mainstem Green River and in two major tributaries - Soos Creek and Newaukum Creek. Adults that spawn in Soos Creek are presumed to be predominantly of hatchery origin. However, recent investigations into straying raise questions regarding this, and other assumptions related to run reconstruction. (See stock status, below). Newaukum Creek spawners appear to be closely related to the spawners in the mainstem.

Spawning in the mainstem Green River occurs from RM 26.7 up to RM 61. Spawning access higher in the drainage is blocked by the City of Tacoma's diversion dam, and at RM 64 by Howard Hanson Dam. Spawning occurs in the lower 10 miles of Newaukum Creek. Adults returning to the hatchery at RM 0.7 of Soos Creek may also spawn naturally and adults surplus to program needs at the Soos Cr. Hatchery are often passed upstream.

Life History Traits

Fall chinook begin entering the Green River in July, and spawn from mid-September through October. Ocean-type freshwater life history typifies summer/fall stocks from South Puget Sound, with 99 percent of the smolts outmigrating in their first year (WDFW 1995 cited in Myers et al 1998). A long-term average of the age composition of adults returning to the Green River indicates the predominance of age-4 fish (62 percent), with age-3 and age-5 fish comprising 26 percent and 11 percent, respectively (WDF et al 1993, WDFW 1995 cited in Myers et al 1998).

Status

The SASSI review (WDF et al 1993) classified Green River chinook as healthy, because spawning escapement had consistently met the objective since 1978. Spawning escapement has increased recently, with the mean of the 1997–2002 escapement (9077) exceeding that for the preceding five-year period (4799). Total escapement fell below the nominal goal of 5,800 in 1992 – 1994, which triggered an assessment of factors contributing to the escapement shortfall by the PFMC (PSSSRB 1997). However, escapement has exceeded the goal in each subsequent year.

Table 1. Spawning escapement of Green River Fall Chinook, 1992-2002.

1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
5,267	2,476	4,078	7,939	6,026	9,967	7,300	9,100	6170	7975	13950

It is known that returns from hatchery production contribute substantially to natural spawning in the Green River and tributaries. Viability of the naturally spawning stock, absent the hatchery contribution, is uncertain because hatchery returns may be masking poor natural productivity (Myers et al 1998). Analysis of coded wire tags recovered from the spawning grounds and the in-river fishery has yielded highly variable results. Collection of data from Chinook mass-marked since 2000 began in 2003 and is expected to provide better estimates of straying and contribution as analysis is completed.

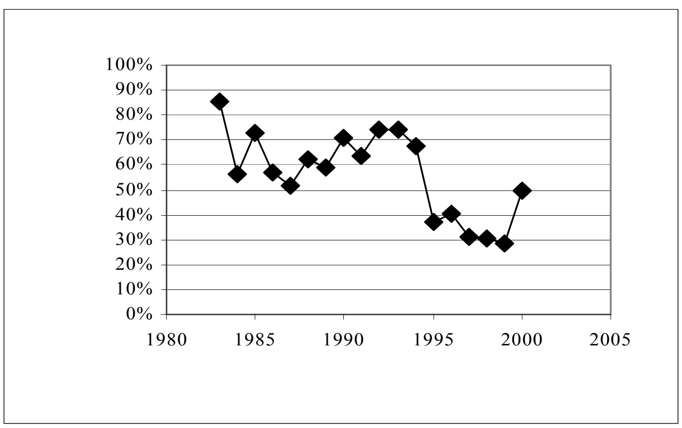
The nominal escapement goal is based on approximate estimates of escapement in the 1970's, and may not reflect the productivity constraints associated with current degraded habitat, but will be used to guide fisheries management until natural capacity is better quantified. Escapement estimation methods are under review. Surveys have been expanded in recent years to calibrate assumptions regarding the relationship between index area counts and total escapement and the third year of a mark/recapture method, also for the purpose of calibration of escapement estimates, was just completed.

Hatchery facilities currently operate on Soos Creek, Keta Creek and Icy Creek. Broodstock has always been collected from local returns, so the hatchery stock presumably retains its native genetic character. Allozyme analysis has shown no detectable difference between hatchery-reared and naturally spawning adults (Marshall et al 1995).

Harvest distribution and exploitation rate trends:

Post-season FRAM runs, incorporating actual catch and stock abundance indicate that annual exploitation rates for Green River chinook have declined 45 percent from levels in the 1980s to 1996 – 2000 (Figure 1). As noted above, recent years' spawning escapement has consistently exceeded the goal.

Figure 1. Total annual, adult equivalent, fishery exploitation rates for Green River chinook for management years 1983 – 2000, estimated by post-season FRAM runs.



Coded-wire tagged fingerling releases from the Green River (and Grovers Creek) describe harvest distribution in recent years. Fisheries in British Columbia and Alaska account for 32 percent of total fishing mortality. Washington recreational and Puget Sound net fisheries account for 38 percent and 24 percent of total mortality, respectively (Table 3).

Table 3. The harvest distribution of Green River chinook, expressed as a proportion of total annual, adult equivalent exploitation. (CTC 2003).

	Alaska	B.C.	Washington Troll	Puget Sound net	Washington sport
1997 – 2001	2.1%	30.1%	9.4%	23.7%	37.7%

Management Objectives

The co-managers manage fisheries to meet or exceed the spawning escapement goal of 5,800 Green River chinook. This goal has been met or exceeded in 10 of the last 13 years. The co-managers expect that the goal will continue to be met or exceeded as a result of this management approach. The co-managers expect to further refine their management plan for Green River chinook in response to on-going ESA recovery planning, to ensure harvest impacts are consistent with recovery of listed stocks and emerging policies for hatchery management. When the escapement is expected to be less than 5,800, the co-managers will discuss what additional actions, beyond those identified below, may be appropriate to bring the escapement above the 5,800 level.

Management objectives for Green River chinook include an exploitation rate objective for pre-terminal Southern U. S. fisheries and a procedure to manage terminal-area fisheries that is based on an inseason abundance triggers to assure that the escapement goal will be achieved. This management regime assures that harvest of Green River chinook will not impede recovery of the ESU.

Washington preterminal fisheries impacts on Green River chinook are managed at or below a 15 percent 'SUS' exploitation rate, as estimated by the FRAM model. Pre-terminal fisheries include the coastal troll and recreational fisheries managed under the Pacific Fisheries Management Council, and commercial net and recreational fisheries in Puget Sound outside of Elliott Bay.

Due to more restrictive pre-terminal fisheries in recent years, a greater proportion of allowable harvest has been available in the terminal fishery in Elliott Bay and the Duwamish (lower Green) River, where tribal net fisheries and recreational fisheries are managed on the basis of terminal abundance triggers.

Terminal area abundance is estimated annually utilizing a test fishery conducted since 1989. Using this data, two thresholds (triggers) have been set below which planned directed fisheries would not proceed. A value below 100 chinook for the test fishery would cause cancellation of subsequent commercial and sport fisheries. A value below 1000 chinook for the first commercial opening would cause cancellation of any further chinook-directed fishing. These values corresponded with a total run of about 15,000 chinook.

Management thresholds were met in 2000, 2001, 2002 and 2003. Terminal area chinook-directed treaty net and sport fisheries were implemented as scheduled. Natural escapement for 2000, 2001 and 2002 are provided in Table 1. The preliminary estimate for 2003 escapement is more than 7000 spawners.

A critical-abundance threshold of 1,800 natural spawners is established for the Green River management unit on the basis of the lowest observed escapement resulting in a higher escapement four years later. If natural escapement is projected to fall below this threshold during pre-season planning, then additional management measures will be implemented in accordance with procedures established in Appendix C, to minimize fishery-related mortalities.

Data gaps

Several aspects of the productivity of Green River chinook are potentially affected by hatchery-origin fish spawning naturally. The abundance, timing, spawning distribution, and age structure of natural-origin chinook may be masked by the presence of hatchery-origin fish. The viability of the natural origin population cannot be accurately assessed without determining the effects of hatchery straying, so the need for this information will prioritize research. Below are descriptions of the data needs and how they are being addressed.

Data need	Related project
Quantification of the proportion of natural escapement that is comprised of hatchery strays.	Completion of a CWT data set for refinement of current CWT-based estimates. (work in progress) Mass marking of hatchery production. (Brood years 1999-2002 marked
Re-evaluation of escapement estimation methodology	Expanded surveys to calibrate expansion of index area data to total. (begun in 1998 – work continues.) Mark/recapture study to independently calibrate total escapement estimate in association with expanded survey effort. (done in 2000-2002, report in progress)
Estimation of the number of Chinook fry and smolts that emigrate annually from the mainstem Green and Newaukum Creek.	Trap placement in the mainstem Green 1999-2002)
Estimation of differential survival of natural and hatchery origin Chinook in-situ in the Green.	A literature review of methodologies that may have utility for an in-situ experiment should be done.
Estimation of estuarine hooking mortality if selective fisheries are proposed for Elliott Bay.	A literature review and preliminary study design should be done.

White River Spring Chinook Management Unit Profile

Component stocks

White River Spring Chinook

Geographic description

White River Spring Chinook are trapped at the Puget Sound Energy diversion dam in Buckley and transported into the upper watershed, above Mud Mountain Dam, where they spawn primarily in the West Fork White River, Clearwater River, Greenwater River, and Huckleberry Creek. They also spawn in the lower mainstem White, below the diversion dam at RM 23.4 where river conditions preclude estimates of spawner abundance.

The White River population is the only spring stock still present in southern Puget Sound, is geographically isolated from summer/fall stocks, and genetically distinct from all other chinook stocks in Puget Sound. The White River Hatchery program, and the Minter Hupp Complex supplement production. The stock has, in past years, been maintained as captive brood at the Hupp Springs and Peale Pass net pen facilities. The supplementation program is considered essential to recovery, so hatchery production is included in the listed ESU.

Life History Traits

Spring chinook enter the Puyallup River from May through mid-September, and spawn from mid-September through October. All adipose-bearing fish arriving at the Buckley trap without detectable CWT's are passed upstream. CWT fish are transferred to the White River Hatchery and confirmed as White River Spring Chinook by genetic testing before they are incorporated into the broodstock supplementation program.

Fry emerge from the gravel in late winter and early spring. In contrast to other spring stocks in Puget Sound, White River chinook smolts emigrate primarily (80 percent) as subyearlings (SSSCTC 1996), after a short rearing period of three to eight weeks. Adults mature primarily at age-3 or age-4.

Status

Escapement of White River chinook exceeded 5,000 in the early 1940's, but the construction of hydroelectric and flood control dams, and degradation of the spawning and rearing habitat, reduced abundance to critical levels in the 1970's. Escapement was less than 100 through the 1980s and fell below 10 in 1984 and 1986. A supplementation program has been operating since 1971, and it has succeeded in raising escapement to levels between 300 and 600 in recent years (Table 1). The geometric mean of escapement in 1992 – 1996 was 477, and for the three more recent years, 413.

Table 1. Spawning escapement of White River spring chinook, 1993-2002.

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Upper River	409	392	605	630	400	316	553	1523	2002	803
Broodstock	1444	2033	1982	924	822	454	429	740	814	
Total	1853	2425	2587	1554	1222	770	982	2263	2816	

The upper river figure represents untagged fish captured at the Buckley trap and transported to upstream spawning grounds (ACOE data cited in HGMP). Broodstock includes collections at Minter Creek, South Sound Net Pens, and the White River Hatchery, and excludes jacks through 1995 (WDFW et al. 1996 cited in HGMP). Broodstock values from 1996 on represent collection at White River Hatchery only.

The status of White River spring chinook has been considered critical. Returns in recent years have improved, but evaluation of natural-origin versus hatchery-origin returns is not complete. Degraded spawning and rearing habitat, and the migration blockage imposed by dams, currently imposes severe constraints on natural productivity. The contribution of natural-origin adults to spawning escapement has not been quantified, but there is evidence to suggest that the stock is not currently viable in the absence of supplementation. The supplementation program succeeded in raising escapement above the critically low levels seen in the 1970's and 1980s, and it may continue to protect the viability of the stock, but natural production will not recover until the habitat constraints are addressed.

Harvest distribution and exploitation rate trends

Based on recoveries of coded-wire tagged yearling released from White River and Hupp Springs hatcheries during calendar years 1996 – 2000, 90 percent of the total harvest mortality of White River springs has taken place in Puget Sound recreational fisheries. An average of five percent of total mortality occurred in British Columbia fisheries.

Table 2. The recent average distribution of annual harvest mortality for yearling White River spring chinook, expressed as a proportion of total annual adult equivalent exploitation rates (CTC 2003)

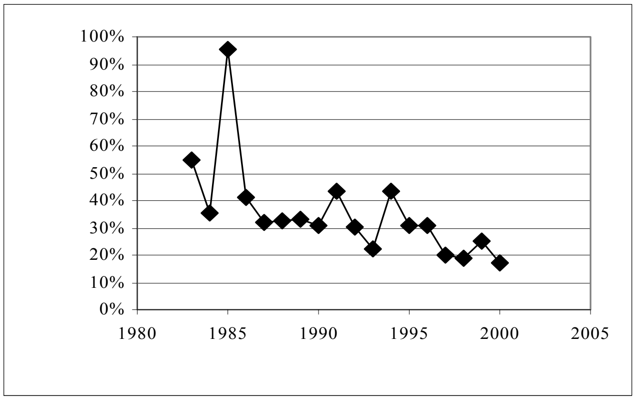
	Alaska	B.C.	Wa troll	PS net	Wa sport
1996 - 00	0.0%	5.4%	0.8%	3.9%	90.0%

Increasingly conservative management of Washington fisheries has resulted in a declining trend in total exploitation rate over the last six years, as estimated by post-season FRAM runs that incorporate actual catch and stock abundance (Figure 1). The average rate for management years 1998 – 2000 was 61 percent lower than the average for management years 1983 – 1987. . The fisheries simulation model (FRAM) has been modified to incorporate only White River fingerling tag codes, which show a slightly different harvest distribution than yearlings that comprise the PSC Indicator Stock.

Management Objectives

Fisheries in Washington will be managed to achieve a total exploitation rate, including fisheries in British Columbia, no greater than 20 percent. This exploitation rate ceiling, which is three points higher than the ceiling in the 2001 Harvest Management Plan, reflects changes in coded-wire tag and historical catch data incorporated in the most recent calibration of FRAM (L. LaVoy, WDFW, memorandum to co-manager technical staff, February 12, 2002). Achievement of this rate requires continued constraint of Puget Sound net and recreational fisheries, and allows minimal tribal ceremonial and subsistence fisheries in the river. Tag recovery and escapement data are insufficient, at present, to support direct assessment of the productivity of the stock.

Figure 1. Total annual, adult equivalent fisheries exploitation rate for White River Spring Chinook for management years 1983 – 2000, estimated by post-season FRAM runs.



The current management objective constrains fishing mortality and, in recent years, has provided spawning escapement well in excess of the critical threshold of 200. Escapement below this level is believed to present significant risk to genetic diversity and exposure to depensatory mortality factors, particularly when considering the low productivity of naturally spawning fish.

If preseason fishery simulation modeling suggests that escapement will not exceed the low abundance threshold, further conservation measures will be implemented in fisheries that catch White River chinook, so as to reduce their total exploitation rate to a level that is defined by modeling the fishing regime described in Appendix C. A conservative approach is warranted in managing this stock, and projected escapement near the critical threshold, or failure to achieve broodstock collection objectives, will be considered grounds to re-institute the captive brood program.

Data gaps

- Description of spawning distribution in the upper White River system.
- Quantification of hatchery- and natural-origin adults on the spawning grounds.
- Estimation of natural smolt production.
- Estimation of pre-spawning mortality of adults that are trapped and transported above Mud Mountain dam.

Puyallup River Fall Chinook Management Unit Status Profile

Component Stocks

Puyallup River fall chinook
South Prairie Creek fall chinook

Geographic description

Fall chinook spawn primarily in South Prairie Creek (a tributary of the Carbon River) up to RM 15, the Puyallup mainstem up to Electron Dam at RM 41.7 , the lower Carbon River up to RM 8.5, Voights's Creek, Fennel Creek, Canyon Falls Creek, Clarks Creek, Clear Creek and Kapowsin Creek, and, possibly, the lower White River. Surplus Voights Creek Hatchery adult chinook are currently released to spawn naturally above the Electron diversion and juvenile chinook produced at the Puyallup Voights Creek Hatchery are outplanted to acclimation ponds in the upper Puyallup River, above the diversion dam. Construction of a fishway at Electron Dam is expected to re-establish adult access to the upper river, however, downstream juvenile passage is still deficient in the near future.

Life History Traits

Hatchery programs have introduced non-native stocks, primarily of Green River origin, into the Puyallup system, so it is not clear that naturally spawning chinook bear the native genetic legacy. A remnant native stock may persist in South Prairie Creek, though genetic testing to date has not been conclusive in that respect.

Freshwater entry into the Puyallup River begins in late July, and spawning occurs from mid-September through mid-November. Based on scale samples collected in 1992-93, returning adults were primarily (76 percent) age-4, and age-3 and age-5 fish made up 16 and 6 percent of the sample (WDF et al. 1993 cited in Myers et al. 1998). South Prairie Creek age samples taken between 1992 and 2002 provides a mean age composition, based on brood contribution of the 1991-1997 broods, of 1.0% age-2, 19.1% age-3, 67.3% age-4, 12.3% age-5 and 0.3% age-6 fish (WDFW, unpublished data). Juveniles exhibit ocean-type life history, primarily, with estimated 97 percent of smolts emigrating as subyearlings (WDF et al. 1993 cited in Myers et al. 1998).

Status

Between 1994 and 2001, escapement to the South Prairie Creek sub-basin has ranged from 667 to 1430 fish, averaging 1048. The turbid nature of the Puyallup and Carbon rivers, due to its their glacial origin, makes enumeration of spawners or redds difficult in the mainstem, so the accuracy of the system-wide estimates is uncertain.

The former nominal escapement goal, that was intended principally to assure adequate broodstock to hatchery programs, was 3,250, including natural spawning and escapement to the hatcheries.

Harvest distribution and exploitation rate trends:

The harvest distribution of Puyallup fall chinook has not been assessed, because a local indicator stock has not been consistently coded-wire tagged. Distribution in pre-terminal fisheries is likely similar to that of the South Sound fingerling indicator stock, which is composed of tagged releases from the Green River (Soos Creek) and Grovers Creek. This distribution is shown, above, in the Green River profile.

Post-season FRAM runs, which incorporate actual catch in all fisheries and actual abundance of all chinook stocks, indicate the total, annual, adult-equivalent exploitation rate for Puyallup fall chinook declined sharply from 1995 – 1998, and that rates have since increased as improved survival has enabled increased harvest, while still achieving the escapement objectives.

Management Objectives

Since the existence of an indigenous fall chinook stock in the Puyallup system is uncertain, and current natural production is substantially augmented by hatchery-origin fish, the harvest management objectives will reflect the need to adequately seed natural spawning areas until the productive capacity of habitat is quantified, and the existence of an indigenous stock is resolved. Until recently fisheries were managed to supply adequate broodstock to the hatchery programs.

The harvest management objective for Puyallup fall chinook is to not exceed a total exploitation rate of 50 percent, to assure that a viable, natural-spawning population is perpetuated. Pre-season fisheries planning, to not exceed this ceiling rate, has been shown to result in spawning escapement of more than 500 to the South Prairie Creek - Wilkeson Creek complex. . Though escapement estimation methods have evolved recently to better quantify total fall chinook escapement to the entire Puyallup system, as previous described, water clarity in South Prairie Creek still affords the most reliable index.. Achieving escapement to South Prairie / Wilkeson of at least 500, according to the most recent surveys, indicates that the entire system is seeded adequately to assure viable natural production. Based on more comprehensive spawning surveys, including monitoring of recolonization of the basin above Electron Dam, the co-managers expect, in the near future, to develop a system escapement goal for fall chinook.

Pre-terminal and terminal fisheries in Puget Sound were constrained in 1999 and 2000 to achieve this objective. The productive capacity of habitat in South Prairie Creek, or in the Puyallup mainstem and tributaries is not quantified, so a system-wide escapement goal has not been established. By reducing the total exploitation rate, relative to those levels in the early- to mid-1990s, this harvest regime will is intended to provide stable or increasing levels of natural escapement. Achieving higher natural escapement, under the new management objective, will experimentally probe the productivity of natural spawners in the system.

A low abundance threshold of 500 spawners, for the entire system, is established for the Puyallup fall management unit. If escapement is projected to fall below this threshold, fisheries-related mortality will be reduced to a level defined by the fisheries regime described in Appendix C. The threshold is set above the point of stock instability, to prevent escapement from falling to that level which incurs substantial risk to genetic integrity, or expose the stocks to depensatory mortality factors.

Should the forecast, terminal-area abundance of Puyallup chinook fall below the low abundance threshold, and the forecast be confirmed by the evaluation fishery in the river (see below), extraordinary conservation measures would be implemented to limit harvest mortality and provide for natural spawning escapement. Directed chinook fishing (i.e., during the fall chinook management period) would be reduced to no more than one day per week for tribal fishers to meet their ceremonial and subsistence needs. Recreational fisheries would be limited to mark selective fisheries in the Carbon River. With concomitant reductions in preterminal fishing mortality, the total SUS exploitation rate would be expected to be approximately 25%.

Data gaps

- Improve spawning escapement estimates for the Puyallup River and/or validate the use of South Prairie Creek and Wilkeson Creek counts as an index for the system.

- Estimate the contribution of hatchery- and natural-origin adults to natural spawning , by mass-marking hatchery production. Brood year 1999 hatchery production was 100% marked.

- Develop a spawner – recruit function for natural-origin, naturally spawning chinook to validate the recovery exploitation rate objective. This task is dependent on completion of the two preceding tasks.

- Conduct an evaluation fishery, during the early weeks of the fall chinook management period, in the Puyallup mainstem, to collect catch and catch-per-effort data that may, in future, become the basis for in-season assessment of stock abundance. Statistical models relating catch or CPUE to abundance will, in addition to several other sources of information regarding migration timing and progress of the river fishery, inform the fishery managers regarding possible changes in the fishery schedule, should these indicators suggest that abundance differs significantly from the pre-season forecast.

Nisqually River Chinook Management Unit Status Profile

Component Stocks
Nisqually fall

Geographic description

Adult chinook ascend the mainstem of the Nisqually River to river mile 40, where further access is blocked by the La Grande and Alder dams, facilities that were constructed for hydroelectric power generation by the City of Tacoma's public utility. It is unlikely that chinook utilized higher reaches in the system, prior to the dams' construction. Below La Grande dam the river flows to the northwest across a broad and flat valley floor, characterized by mixed coniferous and deciduous forest and cleared agricultural land. Between river miles 5.5 and 11 the river runs through the Nisqually Indian Reservation, and between river miles 11 and 19 through largely undeveloped Fort Lewis military reservation. At river mile 26, a portion of the flow is diverted into the Yelm Power Canal, which carries the water 14 miles downstream to a powerhouse, where the flow returns to the mainstem at river mile 12. A fish ladder provides passage over the diversion. Both Tacoma's and Centralia's FERC license requires minimum flows in the mainstem Nisqually.

Fall chinook spawn in the mainstem above river mile 3, in numerous side channels, as well as in the lower reaches of Yelm Creek, Ohop Creek, the Mashel River and several smaller tributaries. Production is augmented by production at the Kalama Creek and Clear Creek hatcheries, which are operated by the Nisqually Tribe.

Life History Traits

Adult fall chinook enter the Nisqually River system from July through September, and spawning activity continues through November. After emerging from the gravel, juveniles typically spend two to six months in freshwater before beginning their seaward migration. Residence time in their natal streams may be quite short, as the fry usually move downstream into higher order tributaries or the mainstem to rear. Extended freshwater rearing for a year or more, that typifies some Puget Sound summer/fall chinook stocks, has not been observed in the Nisqually system.

Returning adults mature primarily at age-3 and age-4, comprising 45 and 31 percent, respectively (WDF et al. 1993, WDFW 1995 cited in Myers et al. 1998).

Stock Status

It is generally agreed that native spring and fall chinook stocks have been extirpated from the Nisqually River system, primarily as a result of blocked passage at the Centralia diversion, de-watering of mainstem spawning areas by hydroelectric operations, a toxic copper ore spill associated with a railroad trestle failure, and other freshwater and marine habitat degradation (Barr, 1999). Studies are underway to determine whether any genetic evidence suggests persistence of the native stock. Initial results indicate that the existing naturally-spawning and hatchery stocks are identical, and were derived from hatchery production that utilized, principally, Puyallup River and Green River fall chinook. Like other stocks in South Puget Sound, in which current production is based on naturalized and supplemented returns from a hatchery program, the Nisqually has been managed to achieve escapement sufficient to provide broodstock to the enhancement program.

Natural escapement has met the escapement goal of 1,100 since 1999. The escapement intent shifted and the goal was increased to 1,100 for the 2000 management year (see below). Recent natural spawning escapement has ranged from 340 to 1,700 (Table 2), and hatchery returns have ranged from 1370 to 13,481, in the period between 1993 and 2002. Escapement surveys are difficult in the mainstem river because of the turbidity caused by glacial flour.

Table 1. The abundance of fall chinook returning to the Nisqually River system.

	River Net	Escapement		
Year	Catch	Hatchery	Natural	Total
1993	4024	1370	1655	3025
1994	6183	2104	1730	3834
1995	7171	3623	817	4440
1996	5365	2701	606	3307
1997	4309	3251	340	3591
1998	7990	4067	834	4901
1999	14614	13481	1399	14880
2000	6836	4923	1253	6176
2001	14098	7612	1079	8691
2002	11687	10794	1532	12326

Harvest distribution and exploitation rate trend:

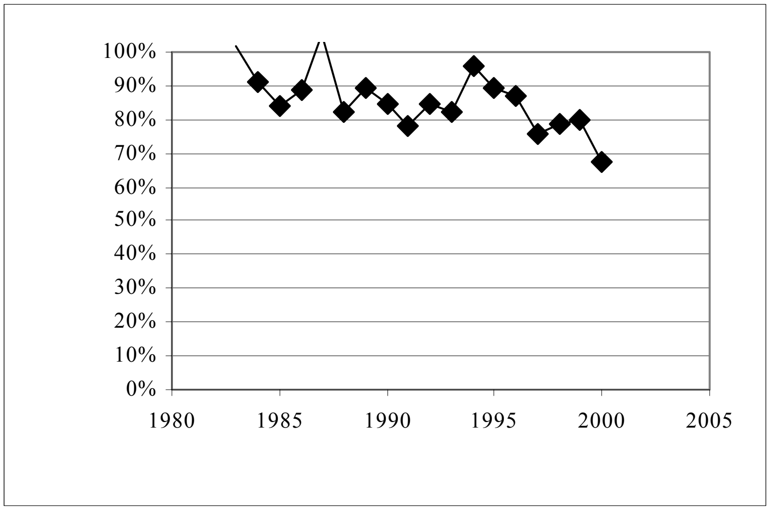
The harvest distribution of Nisqually chinook has been described by analysis of coded-wire tagged fingerling chinook released from Clear Creek and Kalama Creek hatcheries. In recent years 15 percent of the total harvest mortality has occurred in British Columbia and Alaska, primarily in Georgia Strait. Washington troll fisheries have accounted for 14 percent of total fishery mortality. Recreational (ocean and Puget Sound) and net fisheries in Puget Sound , have accounted for 43 and 39 percent of total mortality, respectively.

Table 2. The recent average harvest distribution of Nisqually River fall chinook, expressed as the proportion of annual, adult equivalent fisheries exploitation rate (CTC 2003)
.

	Alaska	B.C.	Washington Troll	Puget Sound net	Washington sport
1997 – 2001	0.5%	14.2%	3.5%	38.7%	43.1%

The total annual exploitation rate for Nisqually chinook has declined slightly since 1993, as described by post-season FRAM runs (Figure 1). FRAM rates are assumed to accurately index the recent trend in exploitation rate, but may not accurately quantify annual exploitation rates, because of the lack of CWT data in the model base period,

Figure 1. Total annual, adult equivalent fisheries exploitation rate of Nisqually fall chinook, from 1983 – 2000, estimated by post-season FRAM runs.



Management Objectives

Because the Nisqually management unit is not a unique, native stock, the need to optimize natural production from natural-origin spawners will be balanced with the fishery enhancement objectives of the hatchery programs. In this sense, the Nisqually unit is similar to other South Puget Sound and Hood Canal natural units where production comprises non-native, introduced chinook stocks, and where natural productivity is severely constrained by habitat degradation. For these units, management intent is distinct from other Puget Sound management units in which production comprises, primarily, native, naturally-spawning stocks.

Analysis of habitat capacity, using the Ecosystems Diagnosis and Treatment methodology (NCRT 2001), enabled derivation of a Beverton-Holt spawner – recruit function that expresses the production potential for a sequence of life stage segments in the mainstem river and major tributaries under currently existing habitat conditions (Moussali and Hilborn 1986). Solution of this production function by standard methods (Hilborn and Walters 1992) estimated that optimum productivity (MSY) under current habitat conditions is achieved by escapement of 1100.

A rebuilding exploitation rate has not been developed for the Nisqually chinook stock. Further analysis, enabled by better quantification of natural escapement, and assessment of the contribution of natural-origin adults to that escapement, mayl allow development of a rebuilding exploitation rate harvest objective based on natural productivity.

The terminal fisheries are managed based on an inseason runsize estimated by the relationship of total runsize and catch success for the tribal commercial net fishery. This method for updating the runsize in-season will initially be applied with information through the third week of August. Subsequent updates will be conducted as catch data continues to accumulate. To enable the fishery to be managed for the 1,100 escapement goal, managers will translate the total runsize to an expected escapement by making an assumption of the proportion of the total run that will spawn naturally. When the in-season update indicates that the escapement goal (1,100) will not be achieved, terminal area fisheries will be constrained by agreement between the co- managers with the objective of increasing spawner abundance to a level at or above the escapement goal.

If forecasted abundance declines very dramatically from the levels observed in recent years, and the in-season assessment confirms the forecast, the comanagers will implement extraordinary conservation measures for the terminal commercial and recreational fisheries to insure the viability of the population. Such measures may include reduced fishing schedules prior to and after the update at the end of August, and closure of chinook-directed fishing in September, after the update. The subsequent coho fishery may be shaped to reduce incidental chinook mortality, but opportunity to catch the entire harvestable surplus of coho will be maintained. In any case, limited chinook harvest will occur as necessary to meet the ceremonial and subsistence needs of tribal members.

Data gaps

- Improve total natural escapement estimates, including age-specific estimates of both natural and hatchery-origin recruits and develop stock-recruit analysis.
- Test the accuracy of the in-season assessment of extreme terminal abundance, and improve the in-season update model as new data allows.
- Quantify the current natural productivity of the system.

Skokomish River Management Unit Status Profile

Component Stocks

Skokomish summer/fall

Geographic description

Spawning takes place in the mainstem Skokomish River up to the confluence with the South and North forks, in the South Fork of the Skokomish River, primarily below RM 5.0, and in the North Fork up to RM 17, where Cushman Dam blocks higher access. Most spawning in the North Fork occurs below RM 13, because flow fluctuation associated with operations of the hydroelectric facility limit access and spawning success higher in the system (WDF et al. 1993).

On the North Fork Skokomish, two hydroelectric dams block passage to the upper watershed. However, a small, self-sustaining population of landlocked chinook salmon is present in Lake Cushman, upstream of the dams. Adults spawn upstream of the lake in the North Fork Skokomish River from river mile 28.2 to 29.9 during November.

Life History Traits

Genetic characterization of the Skokomish chinook stocks has, to date, been limited to comparison of adults and juveniles collected from the Skokomish River with adults from other Hood Canal and Puget Sound populations. Genetic collections were made during 1998 and 1999 in the Skokomish River and there appeared to be no significant genetic differentiation between natural spawners and the local hatchery population. It appears that Hood Canal area populations may have formed a group differentiated from south Puget Sound populations, possibly indicating that some level of adaptation may be occurring following the cessation of transfers from south Sound hatcheries (Anne Marshall, WDFW memo dated May 31, 2000). Current adult returns are a composite of natural- and hatchery-origin fish. During 1998 and 1999, known hatchery-origin fish comprised from 13% to 41% of the samples collected on the natural spawning grounds. Genetic analysis of samples collected from Lake Cushman was inconclusive as to stock origin, and the adults sampled exhibited low genetic variability. (Marshall, 1995a).

Summer/fall chinook enter the Skokomish River starting in late July with the majority of the run entering from mid-August to mid-September. Chinook in the Skokomish River spawn from mid-September through October with peak spawning during mid-October. Adults mature primarily at age-3 (33%) and age-4 (43%); the incidence of age 2 fish (jacks) is highly variable. In 1999, based on a sample of 143 fish, the age composition of naturally-spawning chinook in the Skokomish River system was estimated to be 2.8% age 2, 58.0% age 3, 38.5% age 4, and 0.7% age 5 fish (Thom H. Johnson, WDFW memo dated November 8, 2000). In 2000 and 2001, the age composition of naturally spawning chinook was 16.1% and 1.2% age 2, 11.3% and 58.3% age 3, 71.0% and 36.9% age 4, and 1.6% and 3.6% age 5, respectively (Thom H. Johnson, pers. Comm.. 12/3/02). Consistent with most other summer/fall populations in Puget Sound, naturally produced smolts emigrate primarily during their first year; 2 percent of the smolts may migrate as yearlings (Williams et al. 1975 cited in Myers et al. 1998). In the Skokomish River, most naturally-produced chinook juveniles emigrate during the spring and early summer of their first year of life as fingerlings (Lestelle and Weller 1994).

Status

The SASSI classified Hood Canal summer/fall chinook as a single stock of mixed origin (both native and non-native) with composite production (sustained by wild and artificial production) (WDFW et al. 1992). The combination of recent low abundances (in all tributaries except the Skokomish River) and widespread use of hatchery stocks (often originating from sources outside Hood Canal) led to the conclusion in SASSI that there were no remaining genetically unique, indigenous populations of chinook in Hood Canal. However, a sampling effort is currently under way (led by WDFW in cooperation with NMFS and Treaty Tribes) to collect genetic information from chinook juveniles and adults in the tributaries of Hood Canal. This investigation is intended to provide further information on the genetic source and status of existing chinook populations.

The existence of historical, indigenous populations, that have not been significantly impacted by past management practices and that have remained distinct and sustainable is at least questionable. The genetic sampling effort referenced above is intended to help resolve remaining uncertainty about the existence of any historical, indigenous populations. In the interim, management measures have been formulated to provide reasonable protection for naturally spawning chinook and adequate flexibility for future change**.**

Historically, the Skokomish River supported the largest natural chinook production of any stream in Hood Canal. However, habitat degradation has severely reduced the productive capacity of the mainstem and South Fork portions of the system. As previously noted, the North Fork has been blocked by two hydroelectric dams. Hatchery chinook production has been developed at Washington State’s George Adams and McKernan hatcheries to augment harvest opportunities and to provide partial mitigation for reduced natural production in the Skokomish system, primarily caused by the North Fork dams. The Skokomish Tribe, whose reservation is located near the mouth of the river, has a reserved treaty right to harvest chinook salmon.

Over the period from 1998 – 2002, natural spawning escapement ranged from 926 to 1,913, exceeding the nominal goal of 1,650 twice (Table 1)

Table 1. Total spawning escapement of Skokomish River fall chinook, 1993 - 2002.

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Hatchery	612	495	5196	3100	1885	5584	8227	4033	8816	8828
Natural	960	657	1398	995	452	1177	1692	926	1913	1,479
Total	1572	1152	6594	4095	2337	6761	9919	4959	10729	10307

Harvest distribution and exploitation rate trends:

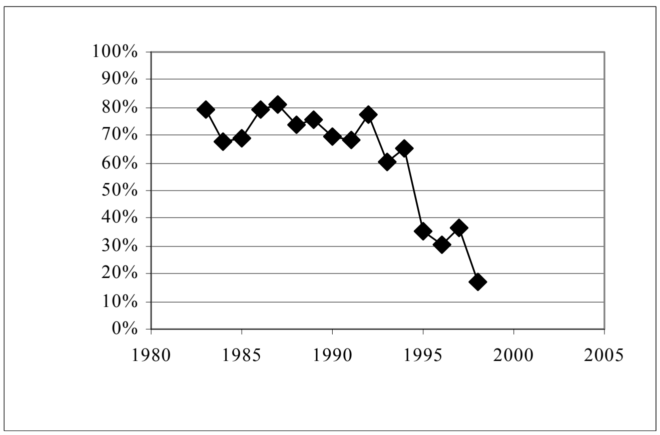
The harvest distribution of Skokomish chinook is best described by recovery of coded-wire tagged fingerlings released from George Adams Hatchery. The average for calendar years 1996 – 2000 indicates that 33 percent of harvest mortality was associated with Canadian and Alaskan fisheries, 13 percent with Washington ocean troll fisheries, 48 percent in recreational fisheries, and 10 percent with net fisheries in Puget Sound.

Table 2. Average harvest distribution of Skokomish River summer/fall chinook, for management years 1997 – 2001, as percent of total adult equivalent fishery mortality (CTC2003).

Years	Alaska	B.C.	Washington troll	Puget Sound net	Washington sport
1997-2001	2.4%	30.9%	8.9%	10.2%	47.7%

The total annual (i.e., management year) exploitation rate, computed by post-season FRAM runs, declined substantially between 1991 and 1998 (Figure 1). The subsequent increase in exploitation rate reflects increased abundance, due in part to improved marine survival, which has allowed higher harvest while still meeting escapement objectives.

Figure 1. Total fishery-related, spawner equivalent exploitation rates of Skokomish River summer/fall chinook for management years 1983 – 1998, estimated by post-season FRAM runs.



Management Objectives

The immediate and short-term objective for Skokomish River is to manage chinook salmon as a composite population (including naturally and artificially produced chinook). The composite population will be managed, in part, to achieve a suitable level of natural escapement; and to continue hatchery mitigation of the effects of habitat loss; and to provide to the Skokomish Tribe partial mitigation for its lost treaty fishing opportunity. Habitat recovery and protection measures will be sought to improve natural production. Over time, alternative management strategies will be explored that may lead to improved sustainable natural production, and reduced reliance on mitigative hatchery support for the Skokomish stock and fisheries.

The nominal escapement goal for the Skokomish River is 3,650. It is the sum of spawner requirements for 1,650 in-stream spawners (HCSMP; 1985) and 2,000 spawners required for the maintenance of on-station hatchery production (see 1996 Production Evaluation MOU, PNPTC-WDFW-USFWS; 2002 Framework Plan, WDFW-PNPTT). Recent composite escapements have been substantially above the 3,650 fish level, averaging 6,941 for the 1997 – 2001 period, and exceeding the 3,650 goal in four of the last five years. In the same period, natural escapement has averaged 1,332, and exceeded 1,650 twice. Escapements to the hatchery have averaged 5,709 fish and have exceeded the 2,000 fish goal in four of the last five years. (Table 1).

The escapement goal of 3,650, along with its component requirements for natural and hatchery spawners, (WDF Tech. Rept. 29, 1977; PSSMP, 1985; HCSMP, 1985; HCSMP Prod MOU,

1996) is intended to maintain full hatchery mitigation and meet current estimates of MSY escapement to natural spawning areas, under current habitat conditions.

A low abundance threshold escapement of 1,300, represents the aggregate of 800 natural spawners and 500 adults returning to the hatchery rack. At these levels, the hatchery escapement component represents the minimum requirement to maintain production. The natural escapement component threshold is set at approximately 50% of the current MSY estimate and represents a level necessary to ensure in-system diversity and spatial distribution (Magnuson-Stevens Act, National Standard for Overfishing Review Threshold). In the 1997 – 2001 period, the critical threshold was exceeded in all years for this management unit. Component critical thresholds in these years were exceeded in all years for hatchery escapement, and in four of the last five years for natural escapement.

During the recovery period, pre-terminal fisheries in southern U.S. areas (SUS), will be managed to ensure a ceiling rate of exploitation of 15%, or less, as estimated by the FRAM model (est. of 1997-1999 SUS preseason impacts). Pre-terminal fisheries include the coastal troll and recreational fisheries managed under the Pacific Fisheries Management Council, and commercial and recreational fisheries in Puget Sound, outside Hood Canal. Terminal fisheries are managed to achieve the escapement goal of 3,650. If the recruit abundance is insufficient for the goal to be met, OR regardless of the total escapement, the naturally spawning component of this population is expected to fall below 1,200 spawners, OR the hatchery component is expected to result in less than 1,000 spawners, additional terminal fishery management measures will be taken, with the objective of meeting or exceeding these spawner levels. The following management measures have been taken in recent years for this purpose, and will be considered in 2003:

- Commercial and recreational fisheries in northern Hood Canal areas (WDFW Areas 12 and 12B) will be reduced or eliminated in the months of July through September.
- Commercial and recreational fisheries in southern Hood Canal areas (WDFW Areas 12C and 12D) will be “shaped” to direct the majority of the fishing effort to the Hoodsport Hatchery zone, thus greatly reducing impacts to the Skokomish Management Unit. In 2000, approximately 90% of the total commercial harvest in Area 12C was directed at, and taken, in that zone.
- In the Skokomish River, Treaty Indian commercial fisheries will be limited in August and September, to areas upstream of the Skokomish delta milling area (upstream of the SR 106 crossing), and downstream of the U.S. 101 crossing.
- In the Skokomish River, recreational salmon fisheries will be limited, through September, to areas upstream of the mouth and downstream of the U.S. 101 crossing.

If, despite the implementation of the above measures, the projected escapement is expected to be less than 1,300 total spawners, OR regardless of the total escapement, the naturally spawning component of this population is expected to fall below the critical threshold of 800 spawners, OR the hatchery component is expected to result in less than 500 spawners, pre-terminal SUS fisheries will be constrained to minimize mortality, in accordance with conservation measures described in Appendix C, or more restrictive measures that have been evaluated and agreed-to by the co-managers for the year in question. In Hood Canal terminal areas, additional management measures will be taken, with the objective of meeting or exceeding these critical spawner levels.

All of the measures shall initially be based on preseason forecasted abundance and escapement projections and may be adjusted during the season, following any inseason reassessment of the terminal abundance. As of 2002, the Co-managers have investigated the feasibility of developing a sufficiently accurate method to derive in-season estimates of abundance, using available commercial and/or recreational, as well as hatchery and/or natural escapement data. However, no approach was found that would result in better estimates when compared to preseason forecasts.

This management regime recognizes the need to optimize natural production in the Skokomish River. However, production potential is currently severely constrained by reduced habitat capacity and quality in the South Fork, and by the influence of the hydroelectric and re-regulation dams on the North Fork. The current productive capacity of habitat has not been quantified in terms of the number of adults required to fully seed the available spawning area or optimize smolt yield.

Principles that underlie the current management intent for Skokomish River chinook include:

> Full recovery of natural productivity in the Skokomish River cannot occur under the current hydroelectric operating regime and degraded habitat status;
>
> The management regime will provide adequate seeding of existing habitat and insure the maintenance of in-system diversity and spatial distribution by assuring that (if available) at least 800, and up to 1,650 (the currently estimated level of MSY), natural spawners reach the spawning grounds;
>
> Natural production is dependent on the mitigative hatchery program to partly support natural escapement;
>
> Hatchery- and natural-origin spawners appear to be genetically similar, and have demonstrated their capacity to adapt to the Skokomish River environment.
>
> Access to harvest opportunity on returning adults produced by the enhancement program at George Adams Hatchery is mandated as partial mitigation for the effects of operation of the City of Tacoma's hydroelectric facility.
>
> The recovery objective for the ESU, which includes conservation and rebuilding of natural production that is representative of the geographic and genetic diversity that characterizes the ESU, is served, in part, by assuring that natural production of locally-adapted populations is recovered in the mid-Hood Canal streams (Duckabush River, Dosewallips River, and Hamma Hamma River) where habitat quality does not constrain to the extent that it does in the Skokomish River.

Management objectives for the Skokomish River management unit will evolve in response to improved understanding of natural productivity, and success in restoring the productive potential of habitat in the system.

Data gaps

- Continue to improve escapement estimates for the South and North Forks of the Skokomish River.

- Develop means to assess the contribution of Skokomish hatchery and natural origin adults to the fishery and to hatchery and natural escapements.

- Quantify the current natural productivity (in terms of recruits per spawners) and natural capacity (in terms of adults and juvenile migrants) of the system.

Mid-Hood Canal Management Unit Status Profile

Component Sub-populations

Hamma Hamma River summer/fall
Dosewallips River summer/fall
Duckabush River summer/fall

Geographic description

Chinook spawn in the Hamma Hamma River mainstem up to RM 2.5, where a barrier falls prevents higher access. Spawning can occur also in John Creek when flow permits access. A series of falls and cascades, which may be passable in some years, block access to the upper Duckabush River at RM 7, and to the upper Dosewallips River at RM 14. Spawning may also occur in Rocky Brook Creek, a tributary to the Dosewallips. Most tributaries to these three rivers are inaccessible, high gradient streams, so the mainstem provides nearly the entire production potential.

Life History Traits

Genetic characterization of the mid-Hood Canal Management Unit (MU) has, to date, been limited to comparison of adults returning to the Hamma Hamma River in 1999 with other Hood Canal and Puget Sound populations. These studies, although not conclusive, suggest that returns to the Hamma Hamma River are not genetically distinct from the Skokomish River returns, or recent George Adams and Hoodsport hatchery broodstock (A. Marshall, WDFW unpublished data). The reasons for this similarity are unclear, but straying of chinook that originate from streams further south in Hood Canal, and hatchery stocking, could be contributing causes.

Status

The Mid-Hood Canal MU is comprised of chinook local sub-populations in the Dosewallips, Duckabush and Hamma Hamma watersheds. These sub-populations are at low abundance (Table 1). Current chinook spawner surveys are typically limited to the lower reaches of each stream. In the Hamma Hamma River, the majority of the chinook spawning habitat is currently being surveyed. In the Dosewallips and Duckabush rivers, however, the areas surveyed are transit areas and do not include all spawning areas. Upper reaches of the Dosewallips and Duckabush have been more routinely surveyed since 1998, but few chinook adults or redds have been observed. Prior to 1986 no reliable estimates are available because all escapement estimates for these rivers were made by extrapolation from the Skokomish River.

Table 1. Natural spawning escapement of Mid-Hood Canal fall chinook salmon, 1993-2002.

River	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
HammaHamma	28	78	25	11		172	557	381	248	32
Duckabush	17	9	2	13	na	57	151	28	29	20
Dosewallips	67	297	76	na		58	54	29	45	43
Total	142	384	103	na		287	762	438	322	95

In 1992, SASSI classified Hood Canal summer/fall chinook as a single stock of mixed origin (both native and non-native) with composite production (sustained by wild and artificial production) (WDFW et al. 1992). The combination of recent low abundances (in all tributaries except the Skokomish River) and widespread use of hatchery stocks (often originating from sources outside Hood Canal) led to the conclusion in SASSI that there were no remaining genetically unique, indigenous populations of chinook in Hood Canal. A study is currently underway to characterize the genetic profile of chinook juveniles and adults in the mid-Hood Canal MU.

In 2002, when SASSI was updated to SaSI, mid-Hood Canal chinook were classified as a single stock, comprised of chinook salmon which currently spawn in the Hamma Hamma, Duckabush and Dosewallips watersheds (WDFW et al. 2002). In 2002, the stock status was rated as "Critical" in SaSI, primarily because of chronically low spawning escapements whose average escapement abundance, over the 1991 – 2002 period, failed to meet the established low escapement threshold of 400.

Harvest distribution and exploitation rate trends:

The harvest distribution of mid-Hood Canal chinook, and recent fishery exploitation rates, cannot be directly assessed because none of the component sub-populations have been coded-wire tagged. However, it is reasonable to assume, given their similar life history, that tagged fingerling chinook released from the George Adams Hatchery, on the Skokomish River, follow a similar migratory pathway and experience mortality in a similar set of pre-terminal fisheries in British Columbia and Washington. A summary of recent analyses of the Skokomish River data are shown in that profile.

Management of the terminal area fisheries in Hood Canal enables some separation of harvest between Skokomish/ Hoodsport and the mid-Hood Canal natural MU. With only Hoodsport and Skokomish tags available to model terminal impacts, the selective intent of the terminal regime will be estimated based on the freshwater entry period for mid-Canal rivers, and the distribution of historical net catch among the sub-areas of Hood Canal.

It is reasonable to conclude that mid-Hood Canal sub-populations experienced a decline similar to that of Skokomish River chinook, but their total exploitation rate has been lower, because the terminal area fishery, which can harvest a significant proportion of Skokomish chinook, has been restricted to the southern end of Hood Canal since the early 1990s.

Management Objectives

The management objective for the mid-Hood Canal MU is to maintain and restore sustainable, locally adapted, natural-origin chinook sub-populations. Management efforts will initially focus on increasing the abundance in the MU and its local, natural sub-populations. Fisheries are being restricted to accommodate the escapement objectives.

The existence of historical, indigenous populations that have remained distinct and sustainable is at least questionable and while additional genetic sampling may help resolve any remaining uncertainty, the Co-managers' intent is to support their ongoing local diversity adaptation.

During the recovery period, fisheries in southern U.S. areas (SUS), will be managed to achieve a preterminal (PT) AEQ rate of exploitation of less than15%, as estimated by the FRAM model (see Section IV). This exploitation rate is the same as that for the remainder of the Hood Canal management units because no means exist to separately assess the exploitation of the mid-Hood Canal unit, and there is no indication that its exploitation pattern is different between Hood Canal

MUs. In this case, preterminal fisheries include the coastal troll and recreational fisheries managed under the Pacific Fisheries Management Council, and the marine commercial and recreational fisheries in Puget Sound. The extreme terminal areas for this management unit include the freshwater areas in each river.

The migratory pathway and harvest distribution of mid-Hood Canal chinook is presumed to be similar to that of the Skokomish River indicator stock, although that stock's return continues past the mid-Canal area and reaches the Skokomish River, farther south. The FRAM simulation model suggests that the terminal (Area 12C) and extreme-terminal (in-river) fisheries may harvest up to 25% of the Skokomish terminal run. However, terminal-area fisheries at the far southern end of Hood Canal, near the mouth of or in the Skokomish River, are not believed to harvest significant numbers of adults returning to the mid-Hood Canal rivers of origin. Time and area restrictions are believed to be effective in relieving harvest pressure on the mid-Hood Canal sub-populations.

When the escapement goal of 750 spawners (established as interim MSY in Hood Canal Salmon Management Plan (HCSMP)) is not expected to be met, recreational and commercial fisheries will be adjusted to the extent necessary to exert a PT SUS AEQ exploitation rate of less than 15%, or meet the escapement target, whichever occurs first. These measures shall also include the closure of all extreme terminal (freshwater) fisheries that are likely to impact adult spawners of these sub-populations. These measures will be considered in order to ensure that the PT SUS AEQ exploitation rate will not exceed 15%.

A low abundance threshold of 400 chinook spawners has been established for the mid-Hood Canal MU, which is approximately 50% of the current MSY goal for the mid-Hood Canal sub-populations, in the HCSMP (1985). If escapement is projected to fall below this threshold, further conservation measures will be implemented in pre-terminal and terminal fisheries to reduce mortality and ensure that the projected PT SUS AEQ exploitation rate does not exceed 12.0%. The best available information indicates that escapement has been below the low abundance threshold in three out of the last five years. The co-managers recognize the need to provide across-the-board conservation measures in this circumstance, and to avoid an undue burden of conservation falling on the terminal fisheries.

Unless genetic studies conclude that distinct populations persist in individual mid-Hood Canal streams, the primary focus of management will be to ensure that sufficient spawners escape to these systems to maintain self-sustaining sub-populations. These sub-populations will contribute geographic diversity to the ESU by their adaptation to the unique environmental conditions found in these drainages of the east slope of the Olympic Mountains.

Data gaps

- Continue to improve escapement estimates
- Test the accuracy of the pre-season forecasts
- Develop means to assess the origin composition of adults in the escapement
- For each sub-population, and the MU, reassess spawner requirements and quantify the current productivity (in terms of recruits per spawner) and capacity (in terms of adults and juvenile migrants).

Dungeness Management Unit Status Profile

Component Stocks

Dungeness River chinook

Distribution and Life History Characteristics

Chinook spawn in the Dungeness River up to RM 18.9, where falls, just above the mouth of Gold Creek, block further access. Spawning distribution , in recent years, has been weighted toward the lower half of the accessible reach with approximately two-thirds of the redds located downstream of RM 10.8. Chinook also spawn in the Graywolf River up to RM 5.1.

The entry timing of mature chinook into the Dungeness River is not described precisely, because of chronically low returns of adults. It may occur from spring through September. Adult weir operations in 1997 and 2001 indicate that most of the adult chinook return has entered the river by early August. Spawning occurs from August through mid-October (WDF et al. 1993). At the current low level of abundance, no distinct spring or summer populations are distinguishable in the return. Chinook typically spawn two weeks earlier in the upper mainstem than in the lower mainstem (WDF et al. 1993). Ocean- and stream-type life histories have been observed among juvenile chinook in the system, with extended freshwater rearing more typical of the earlier-timed segment (Ames et al. 1975). Hirschi and Reed (1998) found that a significant number of chinook juveniles overwinter in the Dungeness River.

Smolts from the Dungeness River exhibit primarily an ocean-type life history, with age-0 emigrants comprising 95 to 98 percent of the total (WDF et al. 1993, Smith and Sele 1995, and WDFW 1995 cited in Myers et al. 1998). Adults mature primarily at age four (63%), with age 3 and age 5 adults comprising 10% and 25%, of the annual returns, respectively (PNPTC 1995 and WDFW 1995 cited in Myers et al. 1998).

Stock Status

The SASSI report (WDF et al. 1993) classified the Dungeness spring/summer as critical due to a chronically low spawning escapement to levels, such that the viability of the stock was in doubt and the risk of extinction was considered to be high. Dungeness chinook continued to be classified as critical in the SaSI report (WDFW 2003) because of continuing chronically low spawning escapements.

The nominal escapement goal for the Dungeness River is 925 spawners, based on historical escapements observed in the 1970’s and estimated production capacity re-assessed in the 1990s (Smith and Sele 1994). This goal has not been achieved in the past 17 years. The mean spawning escapement level, since 1998, has been 298 (Table 1). It should be noted however that the increase in escapements, observed in recent years, is partly due to a captive brood supplementation program.

Table 1. Spawning escapement of Dungeness River chinook 1986 - 2002.

Return Year	Escapement
1986	238
1987	100
1988	335
1989	88
1990	310
1991	163
1992	153
1993	43
1994	65
1995	163
1996	183
1997	50
1998	110
1999	75
2000	218
2001	453
2002	633
1998 – 2002 Mean: 298	

Chinook production in the Dungeness River is constrained, primarily, by degraded spawning and rearing habitat in the lower mainstem. Significant channel modification has contributed to substrate instability in spawning areas, and has reduced and isolated side channel rearing areas. Water withdrawals for irrigation during the migration and spawning season have also limited access to suitable spawning areas.

The co-managers, in cooperation with federal agencies and private-sector conservation groups, have implemented a captive brood stock program to rehabilitate chinook runs in the Dungeness River. The primary goal of this program is to increase the number of fish spawning naturally in the river, while maintaining the genetic characteristics of the existing stock. The first returns of age-4 adults, from the brood year 1996 release of 1.8 million fingerlings, occurred in 2000. Uncertainty over the survival of these fingerlings has led managers to project abundance conservatively, (i.e., discount the potential return from supplementation).

In addition to the broodstock program, the local watershed council (Dungeness River Management Team) and a work group of state, tribal, county and federal biologists have been working on several habitat restoration efforts. Based on the 1997 report, "Recommended Restoration Projects for the Dungeness River" by the Dungeness River Restoration Work Group, local cooperators have installed several engineered log jams, and acquired small riparian refugia properties. Other projects including larger scale riparian land acquisition, dike setback, bridge lengthening and setback, as well as estuary restoration are in the planning, analysis and proposal phases.

Management Objectives

The management objective for Dungeness chinook is to stabilize escapement and recruitment, as well as to restore the natural-origin recruit population basis through supplementation and fishery restrictions. Pre-terminal incidental harvest is constrained to a ceiling AEQ exploitation rate of

10.0% in the southern U.S. Directed terminal commercial and recreational harvests have not occurred in recent years, and incidental harvest in fisheries directed at coho and pink salmon have been regulated to limit chinook mortality .

Direct quantification of the productivity of Dungeness chinook will require either the accumulation of sufficient coded-wire tag recoveries to reconstruct cohort abundance, or an alternate method of measuring freshwater (egg-to-smolt) and marine survival. Releases from the supplementation program are represented by coded-wire tagged groups, adipose fin marked groups, otolith marked groups and blank wire tag groups. Recoveries of these tags, otoliths, and marks will enable cohort reconstruction. However, given the degraded condition of spawning and rearing habitat in the lower mainstem, it must be assumed that current natural productivity is critically low. The captive brood supplementation program will be suspended, following production from the 2003 brood year.

The lack of stock specific historical tag information has necessitated the interim use of a neighboring representative stock in fishery simulation modeling of Dungeness chinook salmon. Tagged Elwha Hatchery fingerlings are used by the FRAM to estimate the harvest distribution and exploitation rates for all Strait of Juan de Fuca chinook management units. (See Elwha Profile, below). Also, for units with very low abundance, such as the Dungeness, the FRAM model's accuracy may be limited. However, the co-managers will continue to develop and adopt conservation measures that protect critical management units, while realizing the constraints on quantifying their effects in the simulation model.

Lacking sufficient direct assessment of the productivity of Dungeness chinook, it may be appropriate to examine what is known about other Puget Sound management units with similar life history and similar status. The status of Nooksack River early chinook, in particular the South Fork Nooksack management unit, is also classified as critical, due to chronically low spawning escapement. Degraded habitat is known to constrain freshwater survival in the Nooksack system, as it does in the Dungeness. The recovery exploitation rate of the Nooksack units has been estimated to be 20 percent (NMFS 2000). The harvest objective for Dungeness (i.e., to maintain exploitation in southern U.S. fisheries below 10 percent), implies a total exploitation rate of 20 percent or less, given that approximately half of the harvest of Dungeness chinook may occur in southern fisheries.

The critical escapement threshold for the Dungeness River is 500 natural spawners, which is approximately 50% of the escapement goal. Whenever natural spawning escapement for this stock is projected to be below this threshold, SUS fisheries will be managed to further reduce incidental mortality. Until the supplementation program is successful in rebuilding returns to levels sufficient to provide escapement levels above this threshold, harvest will be constrained, to SUS incidental AEQ impacts of less than 6.0%.

Data gaps

- Describe freshwater entry timing
- Continue to collect scale or otolith samples to describe the age composition of the terminal run.
- Describe the fishery contribution and estimate fishery-specific exploitation rates from CWT recoveries.
- Estimate marine survival.
- Estimate annual smolt production per spawner (i.e. , freshwater survival)

Elwha River Management Unit Status Profile

Component Stocks

Elwha River chinook

Geographic Distribution and Life History Characteristics

Summer chinook spawn naturally in the portions of the lower 4.9 miles of the Elwha River, below the lower Elwha dam, though most of the suitable spawning habitat is below the City of Port Angeles' water diversion dam at RM 3.4. Their productive capacity is very low, because of extremely restricted suitable habitat. Their productivity is also very low due to severely altered and degraded spawning and rearing habitat, and high water temperatures during the adult entry and spawning season, which contribute to pre-spawning mortality (see Table 2, below).

Entry into the Elwha River begins in early June and continues through early September. Spawning begins in late August, and peaks in late September and early October (WDF et al. 1993). Elwha chinook mature primarily at age 4 (57%), with age 3 and age 5 fish comprising 13% and 29%, of annual returns, respectively (WDF et al. 1993, WDFW 1995, PNPTC 1995 cited in Myers et al. 1998).

Naturally produced smolts emigrate primarily as subyearlings. Roni (1992) reported that 45 to 83% of Elwha River smolts emigrated as yearlings, and 17 to 55 percent as subyearlings, but this study did not differentiate naturally produced smolts from hatchery releases of yearlings. The Elwha Channel facility no longer releases yearling smolts.

Status

Elwha River chinook were designated as "healthy" in the SASSI document (WDF et al. 1993), which considered productivity in the context of the currently available habitat for natural production. However, in the past decade, the total spawner goal of 2,900 was not met in any year (see Table 1). Therefore, in the SaSI report (WDFW 2003), the Elwha Management Unit was classified as depressed, because of the negative escapement trend and chronically low levels of spawning escapement. The stock is a composite of natural and hatchery production. In the Elwha River, chinook production is limited by two hydroelectric dams which block access to upstream spawning and rearing habitat. Recovery of the stock is dependent on removal of the two dams, and restoration of access to high quality habitat in the upper Elwha basin and certain tributaries. Chinook produced by the hatchery mitigation program in the Elwha system are considered essential to the recovery, and are included in the listed ESU.

The comanagers have concluded that recovery of the Elwha stock is not possible unless the dams are removed and access to pristine, productive habitat, which lies largely within Olympic National Park, is restored.

The nominal spawning escapement goal of 2,900 for Elwha River chinook has not been achieved, even in the absence of in-river fishery impacts, in the past 10 years. The average number of spawners over the last five years has been 2,079, which is somewhat higher than the average of the preceding five years (1993-1997), which was 1,611..

Table 1. Total spawning escapement of Elwha River chinook, 1993 – 2002.

1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1,562	1,216	1,150	1,608	2,517	2,358	1,602	1,851	2,208	2,376

Pre-spawning mortality has been a significant factor affecting natural and hatchery production in the Elwha system. High water temperature during the period of freshwater entry and spawning is exacerbated by impoundment of the river behind the two upstream dams. It contributes directly to prespawning mortality, and in some years, promotes the infestation of adult chinook by *Dermocystidium*. Pre-spawning mortality has ranged up to 68% of the extreme terminal abundance (Table 2), largely due to parasitic infestation.

Table 2. Prespawning mortality of Elwha River chinook.

Return Year	Hatchery Voluntary Escapement	In-River Gross Escapement	Gaff-Seine Removals	Hatchery Prespawn Mortality	In-River Prespawn Mortality	Total Prespawn Mortality
1986	1,285	1,842	505	376	482	27.4%
1987	1,283	4,610	1,138	432	1,830	38.4%
1988	2,089	5,784	506	428	50	6.1%
1989	1,135	4,352	905	148	412	10.2%
1990	586	2,594	886	160	64	7.0%
1991	970	2,499	857	108	N/A	3.1%
1992	97	3,762	672	26	2,611	68.3%
1993	165	1,404	771	7	0	0.5%
1994	365	1,181	749	61	269	21.3%
1995	145	1,667	518	37	625	36.5%
1996	214	1,661	1,177	147	120	14.2%
1997	318	2,209	624	3	7	0.4%
1998	138	2,271	1,551	51	0	2.1%
1999	113	1,512	609	23	0	1.4%
2000	177	1,736	1,021	62	0	3.2%
2001	195	2,051	1,396	38	0	1.7%
2002	473	1,943	1,080	40	0	1.7%

Harvest Distribution and Exploitation Rate Trend

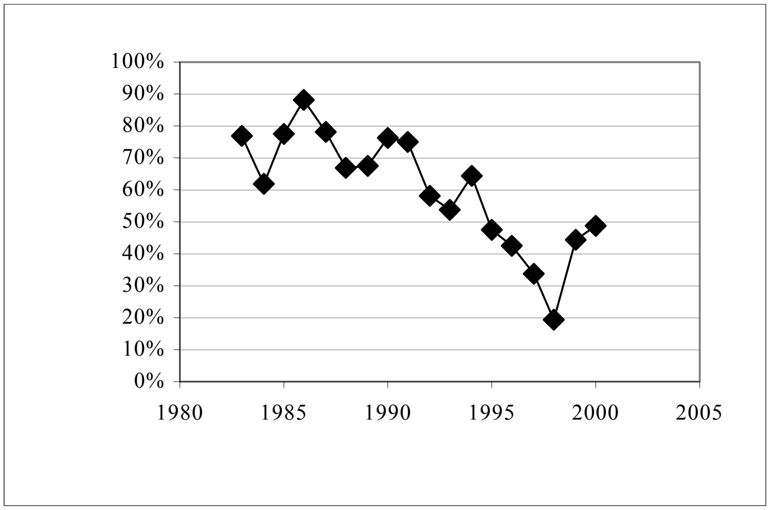
Based on recoveries in 1993 – 1997 of tagged fingerlings released from the local hatchery, Elwha River chinook are a far-north migrating stock, as evidenced by 16% and 59% of total mortality occurring in Alaskan and British Columbian fisheries, respectively (Table 3). Net fisheries in Puget Sound account for only 1% of total fishing mortality, and Washington troll and sport fisheries account for 11%, and 22%, respectively.

Table 3. The average distribution of adult equivalent annual fishing mortality for Elwha River chinook, estimated from post-season FRAM runs (CTC 2003)

Years	Alaska	B.C.	Wash. Troll	Puget Sound Net	Washington sport
1993 – 97	16.2%	58.8%	1.9%	0.8%	22.3%

Post-season FRAM simulations indicate that the total exploitation rate of Elwha River chinook has exhibited a declining trend since 1988 (Figure 1). These post-season FRAM estimates represent the aggregate of JDF units, but are believed to correctly represent the trend in ER for the Elwha unit. The 1998 – 2000 mean exploitation is 51% lower than the average from the 1983 – 1987 period.

Figure 1. Total adult-equivalent exploitation rate for Elwha River chinook, estimated by post-season FRAM runs.



Management Objectives

Fisheries in Washington waters, including those under jurisdiction of the Pacific Fisheries Management Council, when the escapement goal is not projected to be met, will be managed so as not to exceed a "Southern U.S." incidental AEQ exploitation rate of 10.0% on Elwha chinook. Harvest at this level will assist recovery by providing adequate escapement returns to the river to perpetuate natural spawning in the limited habitat available, and provide broodstock for the supplementation program. It represents a significant decline in harvest pressure from southern U.S. fisheries. The SUS exploitation rate on the Strait of Juan de Fuca management unit aggregate averaged 33% for return years 1990 – 1996. Actual SUS AEQ exploitation rates for more recent years have not been calculated, however they were projected to be 7%, 5.0%, 5.2%, 4.8% and 4.7% respectively, in the final pre-season FRAM simulation models for management years 1999 through 2003.

The low abundance threshold for the Elwha River is 1,000 spawners, which represents a composite of 500 natural and 500 hatchery spawners. Whenever spawning escapement for this stock is projected to be below these levels, SUS fisheries will be managed to further reduce incidental AEQ mortality to less than 6.0%.

Data Gaps

- Estimates of total and natural smolt production from the Elwha River.
- Estimates of the age composition and description of life history of smolts.

Status Profile for the Western Strait of Juan de Fuca Management Unit

Component Stocks

Hoko River fall chinook

Geographic description

Fall chinook spawn primarily in the mainstem of the Hoko River, from above intertidal zone to RM 22, but primarily between RM 3.5 (the confluence of the Little Hoko River) to the falls at RM 10. Chinook may ascend the falls and spawn in the upper mainstem up to RM 22, and the lower reaches of larger tributaries such as Bear Creek (RM 0 to 1.2) and Cub Creek (RM 0 – 0.8), Ellis Creek (0 – 1.0), the mainstem (RM 0 – 2.5) and North Fork (RM 0 – 0.37), of Herman Creek, and Brown Creek(0 – 0.8). Chinook also spawn in the lower 2.9 miles of the Little Hoko River. Historically, chinook have also spawned in other Western Strait streams, including the Pysht, Clallam, and Sekiu rivers. Recent surveys of the Sekiu counted 52 and 12 chinook in 1998 and 1999, respectively. Their origin is unknown, but they are assumed to be strays from the Hoko system.

Currently, chinook from the Hoko Hatchery are being outplanted into the upper Hoko mainstem and tributaries of the upper and lower portions of the watershed, to seed high quality habitat, which has not been utilized consistently for spawning or rearing. Re-introduction to the Sekiu River, and other western Strait streams that once supported chinook, is also being planned.

Life History Traits

Based on scales collected from natural spawners and broodstock from 1988 – 1999, returning Hoko River adults are predominately age 5 (49%) and age 4 (31%) , with age 3 and age 6 adults comprising 8% and 10%, respectively, of the mean annual return (MFM 2000. The available data suggest that most smolts produced in the Hoko system emigrate as subyearlings (Williams et al. cited in Myer et al. 1998).

Status

The established escapement goal for Hoko River chinook is 850 natural spawners. This goal, first presented in 1978 in WDF *Technical Report 29*, is based on early estimates of freshwater habitat capacity. The total escapement goal is 1,050, which includes 200 brood stock for the supplementation and reintroduction program. For the Hoko chinook stock as a whole, the combined spawning escapement (natural plus hatchery) has averaged 1,243 spawners in the past five years. Total returns to the river (terminal run size shown above) have exceeded 850 chinook in 8 of the last 15 years).

Numbers of natural chinook spawners have significantly increased since the inception of the supplementation program in 1982, from counts of less than 200, before hatchery supplementation was initiated, to exceeding the natural escapement goal of 850 in three out of the last six years (the 1997 to 2002 average is 1,052 natural spawners). While natural-origin recruits and the recent and overall escapements have shown increasing trends in abundance since the early 1980s, the proportion of natural-origin spawners relative to the proportion of hatchery-origin spawners has declined in recent years. Nearly half the Hoko River natural spawners in most years may be attributed to the supplementation program (MFM 2000). Despite the recent escapements that have exceeded the goal of 850 natural spawners,, this goal has only been achieved in four of the last 15 years (1988 to 2002; Table 1).

Table 1. Natural spawning escapement of chinook and hatchery broodstock removals from the Hoko River, 1988 – 2002.

Return Year	Natural Spawners	Hatchery Brood Stock	Total Escapement
1988	686	90	776
1989	775	67	842
1990	378	115	493
1991	894	112	1,006
1992	642	98	740
1993	775	119	894
1994	332	96	428
1995	750	155	905
1996	1,228	37	1,265
1997	765	126	891
1998	1,618	104	1,722
1999	1,497	191	1,688
2000	612	119	731
2001	768	178	946
2002	443	237	680
1997 – 02 Avg	1,052	191	1,243
Goal:	850	200	1,050

Although the escapement goals set in Technical Report 29 have been commonly accepted over the past two decades, it is not certain that the spawner level of 850 is the optimum chinook escapement level for the Hoko River. Further analysis of habitat suitability and usage should be conducted to determine whether spawning or rearing habitat limits chinook production in the Hoko. Additional years of cohort reconstruction may also shed light on the stock-recruitment relationship for Hoko chinook, which may lead to revision in the escapement goal.

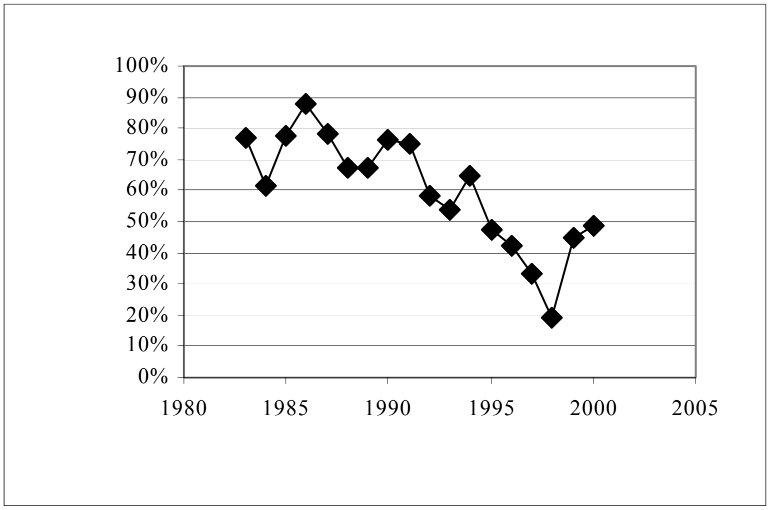
Harvest Distribution and Exploitation Rate Trends

The migration pathway, and harvest distribution, of Hoko River chinook has been described from recoveries of coded-wire tagged fish released from the Hoko Hatchery. The tag data suggest that Hoko chinook are harvested primarily by coastal fisheries in Southeast Alaska and British Columbia (Table 2).

Table 2. Harvest distribution of Hoko River chinook expressed as a proportion of total, annual, adult equivalent exploitation (CTC2003)

Years	Alaska	B.C.	Wash. Troll	Puget Sound Net	Washington sport
1997 - 2001	70.8%	26.5%	1.3%	0.1%	1.2%

Figure 1. Trend in total, adult equivalent, fisheries mortality for Juan de Fuca River chinook management units, estimated by post-season FRAM runs.



Post-season FRAM estimates indicate that the average annual exploitation rates for Juan de Fuca chinook units has declined 51 percent, from 1983-1987 to 1996-2000. These data are believed to correctly represent the trend for the Hoko River unit.

Although Hoko chinook were harvested at rates that should be reasonable for most Puget Sound chinook, even this exploitation rate was higher than would allow for replacement of spawners. This low productivity of Hoko chinook is very likely related to degraded freshwater habitat, including recurrent flooding and erosion, with poor marine survival. Almost the entire watershed (98%) has been clearcut, and 60% of the watershed is currently in a clearcut state (i.e., clearcuts <20 years old). There are 350 miles of roads in the 72 square mile watershed (M.Haggerty, Makah Fisheries Management, personal communication, 2000.)

Management Objectives

Management guidelines include a recovery exploitation rate objective for the Western Strait of Juan de Fuca management unit and a critical escapement threshold. The recovery exploitation rate objective is a maximum of ten percent in southern U.S. fisheries. It represents a lower exploitation rate than these stocks have experienced on average, and a rate that is achievable (and has been achieved in recent years), through conservative fishery management (Table 2). Recent years have shown that the nominal escapement goal can be achieved, with favorable marine survival, under this management regime.

The critical escapement threshold for the Hoko River is 500 natural spawners. Whenever natural spawning escapement for this stock is projected to be below this level, the harvest management plan will call for fisheries to be managed to achieve a lower rate than the interim 10% ceiling SUS exploitation rate.

Data gaps

- Reconstruct abundance of more recent brood years from CWT data
- Derive a spawner/recruit relationship for Hoko chinook

Appendix B. Non-landed Mortality

The fishery simulation model (FRAM) used by the co-managers for pre-season management planning and post-season assessment allows specification of non-landed mortality rates for different fisheries strata and gear types, in order to estimate total fisheries-related mortality for all component stocks. Non-landed mortality comprises a significant proportion of total fisheries mortality. This document summarizes the non-landed mortality rates that are currently specified by the FRAM chinook model (Table 1), and discusses the sources of these rates

When sub-legal fish (i.e. those less than the minimum allowable size) or species for which retention is disallowed are caught, a proportion (i.e. the releases mortality rate) subsequently die. This occurs frequently in commercial troll and recreational hook-and-line fisheries, for which regulations specify a minimum size limit, and may specify, for certain period, non-retention of chinook or coho. Non-retention of chinook may also be specified for certain net fisheries, where the fisherman tends the gear constantly (gillnets), or the gear design (seines) allows live capture and release of non-target species.

Drop-off or drop-out mortality is defined as that which occurs when fish are hooked or entangled by the gear, but they escape before being landed. The rate is applied to the number of landed fish.

Table 1 - Chinook Incidental Mortality Rates Assumed for FRAM Model Fisheries in Washington.

Fishery	Release Mortality	Drop-off, Drop-out, and other
Ocean Recreational	14%	5%
Ocean Troll – barbless hooks Barbed hooks	26% 30%	5% 5%
Puget Sound Recreational	> 22” 10% < 22” 20%	5% 5%
Gillnet Skagit Bay	 52.4%	2% terminal; 3% preterminal
Purse Seine	45% immature 33% mature	0%
Beach Seine Skagit Bay pink fishery	 50%	
Reef Net	None Assessed	0%

Ocean troll and recreational fisheries

Sources of Incidental Mortality

Incidental mortalities in troll fisheries are related to the duration of retention and non-retention periods, size limit regulations, and gear type. Size limits have been used extensively for these fisheries and have changed only a few times since 1979. Recreational and troll fisheries have been allowed to retain fish larger than 24” since the mid- 1980s. Troll fishing techniques differ, depending on whether the target species is chinook of coho. When coho are targeted, encounters with chinook have been reduced, but not eliminated, by species-specific gear, location, and fishing technique. Other management measures to reduce incidental chinook catch, such as landing limits, ratio fisheries, or chinook non-retention fisheries are seldom utilized. Marine mammal predation, ‘sorting’, and other sources of mortality associated with hook and line gear are not accounted in FRAM. ‘Sorting’ refers to release of legal fish in order to retain a larger fish later.

Estimates of Incidental Mortality

The effects of size limits on incidental mortality are modeled by a growth function to estimate what proportion of stock are of legal size at each time step. Encounter rates are calculated by the FRAM, using growth functions specific to each contributing stock to determine the proportion of legal and sub-legal fish, in each age class, present in each time step. Assuming that all ages are equally vulnerable to fishing, the fishery-specific exploitation rate is then applied to estimate legal and sub-legal encounters. Incidental mortality is then estimated by applying mortality rate appropriate to the fishery and gear type. FRAM also allows direct input of encounter rates if they are estimated from direct sampling of fisheries. With funding from the CTC, the Makah Tribe has monitored chinook encounter rates in troll fisheries in Washington Catch Areas 1 – 4 for 1998 - 2001. These data have been incorporated into pre-season fisheries modeling.

Release mortality associated with non-retention periods are calculated as ratios of non-retention days to normal retention days within the model base period. Drop-off mortality for hook-and-line fisheries is distinguished from landed catch by FRAM (i.e. may be reported separately). The current drop-off mortality rate is five percent. This value was derived from a negotiation process and is generally thought to include marine mammal interactions and illegal catch.

Historical estimates of incidental chinook mortality in troll and recreational fisheries, that are provided in the attached spreadsheets, were made by FRAM in ‘validation’ runs that reconstructed fisheries mortality, post-season, from known catch and stock abundance for the years 1983 – 1996. They are annual estimates, including impacts during the October – April time step that precedes the May – September period when most fishing occurs. These estimates express incidental mortality in the same terms as landed catch; they are not adjusted for adult equivalence. They provide a historical perspective on incidental mortality during the 1983-1985 base period, and under the more constrained fishing regimes of 1991 – 1996.

Measures to Reduce Incidental Mortalities

Incidental mortality has been reduced by requiring the use of barbless hooks in troll and recreational fisheries. During periods of chinook-directed fishing, trollers have been required to use large plugs to reduced interactions with sub-legal fish and coho. Time and area considerations are weighed in the structuring of ratio and non-retention fisheries to minimize incidental mortality to the extent possible.

Reduction of Incidental Mortality

Further reduction of incidental mortality in chinook fisheries will primarily be accomplished by measures designed to reduce encounters through time and area restrictions. The status of chinook stocks in Washington State may require reduction of exploitation rates. Future studies may show reductions in release mortality for different hook types and sizes for troll and recreational fisheries.

Net Fisheries

Sources of Incidental Mortality

Drift and set gillnet fisheries are conducted in Grays Harbor and Willapa Bay on the Washington coast, throughout Puget Sound, and in freshwater. However, net fisheries directed at chinook currently occur only in a few areas where harvestable, hatchery-origin chinook may be targeted. These areas include Bellingham Bay and the Nooksack River, Tulalip Bay, Elliot Bay and the Green River, the Puyallup River, Nisqually River, southern Hood Canal and the Skokomish River, and other discrete areas in southern Puget Sound. Incidental mortality occurs in these fisheries as a result of net drop-out and marine mammal predation. Gillnet fisheries retain all fish because the mortality of released fish is believed to be high. Harbor seals and sea lions cause significant incidental mortality in many pre-terminal and terminal gillnet fisheries in Puget Sound, but this source is not accounted in current fishery models or planning.

Purse seine fisheries are conducted in Georgia Strait / Rosario Strait, Southern Puget Sound, and Hood Canal, and are primarily directed at sockeye, pink, coho, and chum salmon. The only seine fishery directed at chinook occurs in Bellingham / Samish Bay.
Incidental mortality, in the context of this discussion, results from injury or stress during capture, or from handling the fish in order to release them. Mortality may be immediate or may occur after some delay from injury or disease.

Non-Indian reef net fisheries that target sockeye and, in some years, coho salmon are conducted in Puget Sound catch areas 7 and 7A. In recent years they have been required to release all chinook salmon, but no associated incidental mortality has been accounted in fishery planning. Reef net hauls catch relatively few fish, and the gear and handling cause relatively minor injuries (e.g. stress, scale loss), so incidental mortality is thought to be very low.

Marine mammal interactions incur significant incidental mortality in many Puget Sound gillnet fisheries, but they have not been generally quantified. A limited number of area-specific studies provide some quantification (PNPTC 1986; 1988?)

Estimates of Incidental Mortality

Drop-out mortality for gillnet fisheries are accounted by FRAM as 3% of landed pre-terminal gillnet catch and 2% of terminal landed gillnet catch. Many factors affect the drop out rate, including mesh dimension, net material and hanging design, sea state, and the frequency of picking. Drop-out rates were derived by technical consensus among state and tribal biologists, because of lack of data from direct sampling. Gillnets fished in the traditional manner are assumed to have a release mortality of a hundred percent. Incidental mortality due to marine mammal predation is highly variable, but is thought to be substantial in many areas in Puget Sound. There has been no systematic sampling of these fisheries that might enable accurate quantification, though anecdotal evidence abounds, and there have been several efforts to document the incidence of scars on spawning chinook.

When chinook are released following capture in purse seine fisheries, immediate and delayed mortality is significantly lower for large chinook than for smaller chinook (Ruggerone and June 1996). Incidental mortality is accounted in the FRAM model as 45% for immature fish (i.e. those caught in fall coho and chum fisheries), and 33% for mature fish caught in sockeye and pink fisheries. Pre-season projections of encounters for any given fishery are based on historic catch, and differential mortality calculated for large and small fish and reported as part of landed mortality. Since FRAM aggregates the incidental mortality associated with all types of net gear for a given fishery, the expected distribution of catch among different gear types underlies the estimate. 'Drop-out' mortality is not accounted for purse seine, roundhaul seine, or beach seine fisheries.

Estimates of mortality in net fisheries, that were included in the previous transmittal to the CTC, were based on a study conducted by WDFW in 1976-1985 (Shepard 1987). Observed encounters per set were expanded to estimate mortality in chinook directed fisheries and encounters per landing in other fisheries. These estimates were previously reported to PSC, but vary widely from FRAM estimates due to differences in methodology. We suggest that FRAM estimates provide the most useful comparison between the base period and more recent year; these are provided in attached spreadsheets.

Estimates of gillnet drop-out mortality from the FRAM validation set, for 1979 – 1985, and 1991 - 1996, are reported for marine net fisheries in North and South Puget Sound, Strait of Juan de Fuca, Grays Harbor, and Willapa Bay. Mortality, during these intervals, in freshwater net fisheries is reported as 2% of the landed catch in each river. River fisheries in this report include the Nooksack, Skagit, Snohomish, Lake Washington (including the Ship Canal), Green, Nisqually, and Skokomish rivers in Puget Sound, and the Sooes, Quileute, Queets, and Quinault rivers on the Washington coast.

Release mortality from purse seine fisheries is hard to tease out of FRAM validation runs. It is calculated by spreadsheet outside of FRAM and input as part of the landed catch. For a given FRAM net fishery, release mortality is dependent on the relative volume of purse seine, beach seine, and gillnet catch; no additional release mortality is assigned to beach seine and gillnet catch.

Measures to Reduce Incidental Mortality

Incidental chinook mortality has been reduced in gillnet fisheries by time and area restrictions that restrict effort during the chinook migration period, which has been specifically defined for all Puget Sound fishing areas. When migration periods for other salmon species overlap, (e.g. for pink or coho salmon), fisheries directed at those species are shortened to reduce chinook encounters.

Commercial net fishers may reduce marine mammal interactions by using 'seal bombs' or may obtain permits to shoot harbor seals and sea lions in some cases.

Since 1973, non-Indian fishery regulations have required that purse seines incorporate a strip of larger mesh at the top of the bunt to allow immature chinook to escape. In 1996, the minimum gill net mesh size for chum fisheries was increased to 6-1/4 from 5-3/4 inch mesh, in order to reduce the incidental catch of immature chinook. In 1997 all purse seine fisheries required release of all chinook. Gillnet fisheries were allowed to retain chinook because release mortality is assumed to be 100%. In 1998 shoreline closures in Rosario Strait (Area 7) were adopted, designed to reduce impacts on chinook salmon while still providing opportunities during sockeye and pink-directed fisheries. In 1999 purse seines were required to use brailers or hand dip nets to remove salmon from seine nets during sockeye and pink salmon fisheries in 7/7A to reduce by-catch mortality (R. Bernard, WDFW, pers comm. October 19, 2000).

Future Reduction of Incidental Mortality

Further reduction in the incidental mortality of chinook in net fisheries will involve coordinated study and development of more selective gear, more effective release techniques, mitigation of marine mammal interactions, and, perhaps, reductions in fishing opportunity.

A study, funded under NMFS' Saltonstall-Kennedy program, is currently being conducted by WDFW to evaluate tangle nets as an alternative to conventional gillnet gear. Tangle nets are constructed of smaller-mesh, loosely hung, monofilament that catches salmon by the teeth or jaw, rather than behind the opercle and gills. Previous studies in British Columbia suggested that non-target species could be released from this gear with low associated mortality. Fishing power with respect to target species, and survival of non-target salmon species caught and released from tangle nets, are being analyzed at two sites in Puget Sound. It may be possible to improve the survival of chinook caught in purse seines with careful handling or by allowing fish to recover in a tank prior to their release.
In certain circumstances fishing opportunity, where species other than chinook are the target, may be further constrained, or planned to achieve a specific level of incidental mortality. These measures require accurate in-season monitoring to assess when the threshold of landed chinook catch has been achieved.

Appendix C. Minimum Fisheries Regime

Non-Treaty Ocean Troll and Recreational Fisheries:.

- Chinook and coho quotas and seasons adopted by the PFMC.
- Exploitation rates on critical Puget Sound Chinook management units will not exceed the range projected to occur for management years 2000 – 2003 (see Chapter 5).

Treaty Ocean Troll Fishery:

- Chinook and coho quotas and seasons adopted by the PFMC.
- Exploitation rates on critical Puget Sound Chinook management units will not exceed the range projected to occur for management years 2000 – 2003 (see Chapter 5).

Strait of Juan De Fuca Treaty Troll Fisheries:

- Open June 15 through April 15.
- Use barbless hooks only.

Strait of Juan De Fuca Treaty Net Fisheries:

- Setnet fishery for Chinook open June 16 to August 15. 1000-foot closures around river mouths.
- Gillnet fisheries for sockeye, pink, and chum managed according to PST Annex.
- Gillnet fisheries for coho from the end of the Fraser Panel management period, to the start of fall chum fisheries (approximately Oct. 10).
- Closed mid-November through mid-June.

Strait of Juan De Fuca Non-treaty Net Fisheries:

- Closed year-around.

Area 5/6 Recreational Fishery:

- May 1-June 30 closed.
- July 1 – Sept 30 Chinook mark selective fishery not to exceed two months, and not to exceed 3500 landed catch in 2004. In subsequent years, this may be extended by agreement of the co-managers, else, Chinook non-retention.
- October closed
- 1-Chinook bag limit in November.
- December 1 - February 15 closed
- 1-fish bag limit February 16-April 10
- April 11-30 closed

Strait of Juan De Fuca Terminal Treaty Net Fisheries:

- Hoko, Pysht, and Freshwater Bays closed May 1 – October 15.
- Elwha River closed April 1 through mid-September, except for minimal ceremonial harvests.
- Dungeness Bay (6D) closed March 1 through mid-September; Chinook non-retention mid-September – October 10.
- Dungeness River closed March 1 through September 30. Chinook non retention when open, except for minimal ceremonial harvests.
- Miscellaneous JDF streams closed March 1 through November 30.

Strait of Juan De Fuca River Recreational Fishery:
- June 1 – Sept 30 Elwha River closed to all fishing from river mouth to WDFW channel. At all other times and places, Chinook non-retention.
- Dungeness closed to salmon 12/1 through 10/15.
- Dungeness Chinook non-retention 10/16 through 11/30.
- Close other streams.

Area 6/7/7A Treaty and Non-treaty Net Fisheries:
- Sockeye, pink, and chum fisheries managed according to PST Annex.
- Net fisheries closed from mid-November through mid-June.
- Area 6A Closed.
- Non-treaty purse seine and reef net fisheries Chinook non-retention.
- Non-treaty gillnet fishery Chinook ceiling of 700.
- Non-treaty closure within 1500 feet of Fidalgo Island between Deception Pass and Shannon Pt; and within 1500 feet of Lopez and Decatur Islands between Pt Colville and James Island.

Area 7 Recreational Fishery:
- May 1-June 30 closed.
- 7/1-7/31 1 fish limit, Rosario Strait and Eastern Strait of Juan de Fuca
- closed; Bellingham Bay closed.
- 8/1-9/30 1 fish limit, Southern Rosario Strait and Eastern Strait Juan de
- Fuca closed Bellingham Bay closed.
- 8/1-8/15, Samish Bay closed.
- Chinook non-retention 10/1-10/31
- 11/1-11/30 1 fish limit.
- December-February 15 closed
- 1-fish bag limit February 16-April 10
- April 11-30 closed

Nooksack/Samish Terminal Area Fisheries:
- Bellingham Bay (7B) and Samish Bay (7C) closed to commercial fishing from April 15 through July 31.
- Area 7B/7C hatchery fall Chinook fishery opens August 1.
- Pink fishery opens August 1.
- Ceremonial fishery in late May limited to 10 natural-origin Chinook.
- Subsistence fishery limited 20 natural-origin Chinook between July 1-4.
- Ceremonial and subsistence harvest to be taken in the lower river, and between the confluence of the South Fork and the confluence of the Middle Fork.
- Nooksack River commercial fishery for hatchery fall Chinook opens August 1 in the lower river section; and staggered openings in up-river sections will occur over 4 successive weekly periods. (see Appendix A).
- Bellingham Bay recreational fishery closed in July.
- Samish Bay recreational fishery closed August 1-15.
- Chinook non-retention in Nooksack River recreational fisheries.
- 2-Chinook bag limit after October 1 in Nooksack River.
- 2-fish bag limit from July 1 to December 31 in Samish River.

Skagit Terminal Area Net Fisheries:

- Skagit Bay and lower Skagit River closed to commercial net fishing from mid-February to August 22 in pink years, and until week 37 (~September 10) in non-pink years.
- Upper Skagit River closed to commercial net fishing from mid-March to August 22 in pink years, and until week 42 (~October 10) in non-pink years, unless there is an opening for Baker sockeye in July.
- Upper Skagit and Sauk-Suiattle fisheries on Baker sockeye require 5½ "
- maximum mesh, and Chinook non-retention.
- Half of the Upper Skagit and Sauk-Suiattle share of Baker sockeye will be taken at the Baker Trap, rather than in river fisheries.
- No Chinook update fishery or directed commercial Chinook fishery.
- Treaty pink update fishery limited to 2 days/week during weeks 35 and 36, and Non-treaty update limited to 1 day/week, gillnets only.
- Pink fishery gillnet openings in the Skagit River limited to a maximum of 3 days/week, regardless of pink numbers. Beach seines may be used on other days, with Chinook non-retention.
- Up to 40% of the Upper Skagit share of pink salmon will be taken in Skagit Bay.
- Release Chinook from beach seines in Skagit Bay.
- Chinook non-retention required in pink fisheries in the upper river.
- Tribal coho openings delayed until Week 39 in the Bay and lower river, and until Week 42 in the upper river.
- Chinook test fisheries limited to 1 boat, 6 hrs/week.

Skagit River Recreational Fisheries:

- Chinook non-retention.

Area 8A and 8D Net Fisheries:

- Area 8A Treaty fishery Chinook impacts incidental to fisheries directed at coho, pink, chum, and steelhead.
- Effort in the Treaty pink fishery will be adjusted in-season to maintain Chinook impacts at or below those modeled during the pink management period.
- ▪ Area 8D Treaty Chinook fisheries limited to C & S beginning in May, and to 3 days/wk during the Chinook management period.
- Non-treaty pink fishery limited to 1 day/week for each gear.
- Non-treaty purse seine fishery Chinook non-retention.
- Area 8D non-treaty Chinook impacts incidental to fisheries directed at coho and chum.

Stillaguamish River Net Fisheries:

- Treaty net fishery Chinook impacts incidental to fisheries directed at pink, chum, and steelhead.
- Treaty pink fishery schedule limited to maintain Chinook impacts at or below the modeled rate.

Stillaguamish River Recreational Fisheries:

- Chinook non-retention.
- Use barbless hooks from September 1 to December 31.

Snohomish River Fisheries:
- Net fisheries closed.
- Chinook non-retention in river recreational fisheries.

Area 8-1 Recreational Fisheries:
- 5/1-8/31 closed.
- Chinook non-retention 9/1-10/31.
- 11/1-11/30 1 fish limit.
- 12/1-2/15 closed.
- 1-fish bag limit February 16 – April 10.
- 4/11-4/30 closed.

Area 8-2 Recreational Fisheries:
- 5/1-7/31 closed.
- Chinook non-retention 8/1-10/31.
- 11/1-11/30 1 fish limit.
- 12/1-2/15 closed.
- 1-fish bag limit February 16 – April 10.
- 4/11-4/30 closed.
- 1-Chinook bag limit in Tulalip Bay in August and September.
- Tulalip Bay openings limited to 12:01 AM Friday to 11:59 AM Monday each week.

Area 9 Net Fisheries:
- Net fisheries limited to research purposes.

Area 9 Recreational Fisheries:
- 5/1-7/31 closed.
- Chinook non-retention 8/1-10/31.
- 11/1-11/30 1 fish limit.
- 12/1-2/15 closed.
- 1-fish bag limit February 16 – April 10.
- 4/11-4/30 closed.

Area 10 Net Fisheries:
- Closed from mid-November through June and August.
- Sockeye net fishery during first three weeks of July when ISU indicates harvestable surplus of Lake Washington stock.
- Net fisheries for coho and chum salmon will be determined based on in-season abundance estimates of those species. Limited test fisheries will begin the 2nd week of September. Commercial fisheries schedules will be based on effort and abundance estimates. Marine waters east of line from West Point to Meadow Point shall remain closed during the month of September for Chinook protection. Chinook live release regulations will be in effect

Lake Washington Terminal Area Fisheries:

- Chinook run size update from lock count to re-evaluate forecasted status.
- No Chinook directed commercial fishery in the Ship Canal or Lake Washington.
- Net fishery impacts incidental to fisheries directed at sockeye and coho. Sockeye and coho fisheries dependant on lock count ISU. Incidental Chinook impact minimized by time, area and live Chinook-release restrictions. Sockeye fisheries scheduled as early as possible. Coho fishery delayed until September 15th when 95.2% of the Chinook run has cleared the locks.
- Possible directed Chinook fishery in Lake Sammamish for Issaquah Hatchery surplus.
- Cedar River and Issaquah Creek closed to recreational fishing.
- Chinook non-retention in Sammamish River, Lake Washington, Lake Union, Portage Bay, and Ship Canal recreational fisheries

Area 10A Treaty Net Fisheries:

- Chinook gillnet test fishery 12 hours/week, 3 weeks, beginning mid-July to re-evaluate forecasted status.
- No Chinook directed commercial fishery.
- Net fishery impacts incidental to fisheries directed at coho. Coho opening delayed until September 15th.

Duwamish/Green River Fisheries:

- Commercial Chinook fishery dependant on Area 10A test fishery results.
- No Chinook directed commercial fishery.
- Net fishery impacts incidental to fisheries directed at coho. Coho opening delayed until September 15th and restricted to waters below the 16th Ave Bridge. Coho opening above the 16th Ave Bridge to the turning basin delayed until September 22nd. Coho opening above the turning basin up to the Hwy 99 Bridge delayed until September 29th.
- Chinook non-retention in river recreational fisheries

Area 10E Treaty Net Fisheries:

- Closed from mid November until last week of July.
- Chinook net fishery 5 day/wk last week of July through September 15.
- Chinook impacts incidental to net fisheries directed at coho and chum, from mid-September through November

.Area 10 Recreational Fisheries:

- 5/1-6/30 closed.
- Chinook non-retention 7/1-10/31.
- 11/1-11/30 1 fish limit.
- 12/1-2/15 closed.
- 1-fish bag limit February 16 – April 10.
- 4/11-4/30 closed.

Area 11 Net Fisheries:

- Closed from end of November to beginning of September.
- No Chinook-directed fishery
- Net fishery Chinook impacts incidental to fisheries directed at coho and chum.
- Non-treaty purse seine fishery Chinook non-retention.

Area 11A Net Fisheries:
- Closed from beginning of November to end of August.
- Net fishery Chinook impacts incidental to fisheries directed at coho.

Puyallup River System Fisheries:
- Net fisheries closed from beginning of February to beginning of August.
- Limit gill net test fishery for Chinook to 1 day a week, scheduled from mid-July through August 15.
- Chinook net fisheries limited to 1 day/week, August 15 – September 10 (delayed to protect White River spring Chinook.
- Muckleshoot on-reservation fisheries on White River limited to hook and line C & S fishing for seniors, with a limit of 25 Chinook.
- Net fishery Chinook impacts incidental to fisheries directed at coho and chum.
- 2-Chinook bag limit in river sport fisheries.
- Chinook non-retention before August 1 in Puyallup River sport fishery.
- Chinook non-retention before September 1 in Carbon River sport fishery.
- Chinook non-retention in White River.

Area 11 Recreational Fisheries:
- 5/1-5/30 closed.
- 1-fish limit June 1 – November 30.
- 12/1-2/15 closed.
- 1-fish limit February 16 – April 10.
- 4/11-4/30 closed.

Fox Island/Ketron Island Net Fisheries:
- Closed from end of October to August 1.
- Net fishery Chinook impacts incidental to fisheries directed at coho and chum.

Sequalitchew Net Fisheries:
- Net fishery Chinook impacts incidental to fisheries directed at coho.

Carr Inlet Net Fisheries:
- Closed from beginning of October through August 1.
- Net fishery Chinook impacts incidental to fisheries directed at coho and chum.

Chambers Bay Net Fisheries:
- Closed from end of mid-October to August 1.
- Net fishery Chinook impacts incidental to fisheries directed at coho and chum.

Area 13D Net Fisheries:
- Closed from mid-September to August 1.
- Net fishery Chinook impacts incidental to fisheries directed at coho and chum.

Henderson Inlet (Area 13E) Net Fisheries:
- Closed year-around.

Budd Inlet Net Fisheries:

- Closed from mid-September to July 15.
- Net fishery Chinook impacts incidental to fisheries directed at coho and chum.

Areas 13G-K Net Fisheries:

- Closed Mid-September to August 1.
- Net fishery Chinook impacts incidental to fisheries directed at coho and chum.

Nisqually River and McAllister Creek Fisheries:

- Chinook fishery late-July through September, up to three days per week dependent on in-season abundance assessment (see Appendix A).
- Coho fishery October through mid-November.
- Late chum fishery mid-December – mid-January.
- Nisqually River recreational closed February 1 through May 31.
- McAllister Creek recreational closed December 1 through May 31.
- Chinook non-retention in June recreational fishery.
- 2-Chinook bag limit.

Area 13 Recreational Fisheries:

- 1-fish bag limit May 1-November 30.
- 12/1-2/15 closed.
- 1-fish bag limit February 16 – April 10.
- 4/11-4/30 closed.

Hood Canal (12, 12B, 12C, 12D) Treaty Net Fisheries: (also see: Skokomish and Mid-Hood Canal Management Unit profiles in Appendix A):

- Chinook directed treaty fishery limited to Areas 12C and 12H.
- Coho directed fisheries in Areas 12 and 12B delayed to Sept. 24; in Area 12C, to Oct. 1. Beach seines release Chinook through Oct. 15.
- 1,000 foot closures around river mouths, when rivers are closed to fishing.
- Net fisheries closed from mid December to mid July

Area 9A Treaty Net Fisheries:

- Closed from end of January to mid-August (dependent upon pink fishery).
- Beach seines release Chinook through Oct. 15.

Area 12A Treaty Net Fisheries:

- Closed from mid-December to mid-August.
- During coho and chum fisheries, beach seines release Chinook through Oct. 15.

Hood Canal Freshwater Treaty Net Fisheries:

- Dosewallips, Duckabush, and Hamma Hamma rivers closed.
- Skokomish River Chinook fishery August 1 – September 30, limited to two to five days per week.
- Skokomish River closed March – July 31(also see: Skokomish MU profile in Appendix A).

Area 12 Recreational Fishery:

- 5/1-6/30 closed.
- Chinook non-retention 7/1-10/15.
- 10/16-12/31 1-fish limit.
- 1/1-2/15 closed.
- 1-fish bag limit February 16 – April 10.
- 4/11-4/30 closed.

Hood Canal Freshwater Recreational Fisheries:

- Closed March 1 to May 31.
- Chinook non-retention from June 1 to February 29 in all rivers.
- Dosewallips, Duckabush, and Hamma Hamma closed in September and October.

Appendix D. Role of Salmon in Nutrient Enrichment of Fluvial Systems

INTRODUCTION

Continued declines in abundance of Pacific salmon (*Oncorhynchus* spp.) populations have focused increased attention on factors limiting their survival. While the decline in abundance of Pacific salmon stocks (National Research Council 1996) has been attributed to may factors, just recently have researchers focused their attention on the nutrient re-cycling role of returning adult salmon in maintaining productive freshwater ecosystems. Given that Pacific salmon accumulate the significant majority of their body mass while in the marine environment (Groot and Margolis 1991), returning runs of adult salmon potentially represent a substantial source of marine-derived nutrients (MDN) for freshwater and riparian communities (Larkin and Slaney 1996; Gresh et al. 2000; Murota 2002; Schoonmaker et al. 2002). Research has shown that the addition of nutrients to freshwater systems can influence community structure and increase stream productivity at several trophic levels (Kline et al. 1990; Piorkowski 1995; Quamme and Slaney 2002). Benefits include increased growth and density of juvenile salmonid populations (Johnston et al. 1990; Bradford et al. 2000; Ward and Slaney 2002). Gresh et al. (2000) estimate that the current contribution of MDN from adult Pacific salmon to rivers in the Pacific Northwest is as low as 6-7% of historic levels and that the resulting 'nutrient deficit' could be exacerbating continued declines in salmon abundance or impeding recovery.

The concept of a 'nutrient deficit' has several implications for current fisheries management, harvest strategies and recovery of depressed salmon stocks. It is asserted that current harvest management strategies for salmon stocks fail to consider the importance of MDN for maintaining properly functioning ecosystems and self-sustaining salmon populations (Micheal 1998; Cederholm et al. 2000; Gresh et al. 2000; Bilby et al. 2001). More directly, current escapement goals for salmon runs may be perpetuating a negative feedback loop in salmon population dynamics (Larkin and Slaney 1996, 1997). Ideally, research might quantify the nutrient input, and escapement density, necessary to optimize ecosystem function, viable salmon runs, and harvest. However, nutrient dynamics in aquatic systems are often complex (Northcote 1988; Polis et al. 1997; Bisson and Bilby 1998; Murphy 1998; Naiman et al. 2000) and depend on numerous site-specific factors including the species of salmon, spawning density and location, stream discharge regimes, stream habitat complexity, basin geology, light, temperature and community structure. Researchers are just beginning to recognize and understand these complexities in relation to salmon and MDN. In this paper I will review the current state of knowledge on the relationship between Pacific salmon, MDN and stream ecosystem function in the **c**ontext of determining 'ecologically based' salmon escapement goals.

NUTRIENT PATHWAYS

Adult salmon contain proteins, fats and other biochemicals comprised of marine- origin carbon, nitrogen and phosphorous (Mathisen et al. 1988). Returning adult salmon act as vectors in delivering nutrients of marine origin to terrestrial ecosystems through excretion (O'Keefe and Edwards 2002), gametes and carcasses (Mathisen et al. 1988). In general, stream biota incorporate salmon-derived nutrients through three primary pathways: 1) trophic transfer following uptake of inorganic nutrients by primary producers; 2) streambed microfaunal uptake of dissolved organic matter released by salmon carcasses; and 3) direct consumption of salmon carcasses, eggs and fry (Cederholm et al. 1999). Additionally, high flow events and scavenging by birds and mammals (Cederholm et al. 1989, 2000; Ben-David et al. 1998) can deliver salmon-derived nutrients to riparian and upland communities (Garten 1993; Wilson and Halupka 1995; Helfield and Naiman 2001; Hocking and Reimchen 2002; Reimchen et al. 2002).

STABLE ISOTOPE AND PROTEIN STUDIES

Applied relatively recently to the issue of salmon and MDN, stable isotope analysis has allowed researchers to quantitatively identify nutrient sources and further understand nutrient pathways in freshwater systems. Carbon, nitrogen, and phosphorous are typically considered principal nutrients that limit ecosystem productivity (Gregory et al. 1987; Peterson and Fry 1987; Murphy 1998). While phosphorous has only one stable isotope, limiting our ability to distinguish the origin of phosphorous, carbon (C) and nitrogen (N) have two stable isotopes. The isotopic properties of carbon and nitrogen provide natural tracers for determining differences in stable isotope abundance in trophic food webs. Stable isotope ratios are typically expressed as $\delta^{13}C$ and $\delta^{15}N$ values and represent the level of enrichment or depletion of the heavier isotope C or N relative to a standard (Peterson and Fry 1987). Spawning salmon contain higher proportions of the heavy isotopes carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$, Mathisen et al. 1988; Piorkowski 1995; Bilby et al. 1998). Nitrogen is especially applicable in salmon-derived nutrient studies due to the dichotomous nature in N sources between Pacific salmon (oceanic N) and terrestrial and freshwater systems (atmospheric N_2, Peterson and Fry 1987; Kline et al. 1997).

Kline et al. (1990) developed an isotope-mixing model to investigate the incorporation of MDN in Sashin Creek, southeastern Alaska. The isotope-mixing model allows for determination of percent contribution of marine nitrogen across trophic levels. The study design compared isotope ratios between a lower reach, accessed primarily by pink salmon (approximately 30,000 adults annually), and an upper control reach isolated from anadromous fish. Isotope values indicate that standing crop of periphyton in the anadromous section was dependent on marine N, with levels greater than 90% immediately after spawning and near 50% at other times of the year. The sustained marine N signal in periphyton further indicated nutrient retention. Stonefly nymphs and caddis fly larvae also showed high levels of enrichment in April possibly due to overwintering retention and trophic transfer through periphyton and decomposers (e.g. fungi). The isotope model suggested that turbellarians were incorporating marine N through direct consumption of salmon eggs. In rainbow trout, high levels of $\delta^{15}N$ were found with increasing isotope values as the size of trout increased. Using a dual isotope method, Kline et al. (1990) concluded that trout from the enriched section were likely incorporating a portion of marine N from autochthonous production (dependent on primary producer uptake of remineralized nutrients) as well as direct feeding on salmon carcasses and eggs. Researchers surmise that MDN have a trophic-wide effect in the anadromous section of Sashin Creek. They also note that the use of fertilizers to alleviate nutrient loss in streams may not adequately substitute for salmon carcasses and eggs that are directly fed upon by consumers and decomposers, a point further developed in this review.

Since the Kline et al. (1990) study, numerous investigators have used stable isotope methods to distinguish MDN pathways in lotic systems (Bilby et al. 1996, 1998, 2001; Helfield and Naiman 2001; Piorkowski 1995; Winter et al. 2000). These studies show similar results indicating incorporation of MDN in food webs with anadromous runs of salmon. However, results do not universally indicate the degree of importance or pathways of MDN across different lotic systems. In an in-depth ecosystem study on five creeks in southcentral Alaska, Piorkowski (1995) used stable isotopes to distinguish marine N in stream food webs. The five study creeks are used by multiple species of anadromous salmon of which Piorkowski (1995) found different isotopic composition between adult salmon species with chinook salmon being significantly more enriched in $\delta^{15}N$ (due to increased ocean residence time) as compared to pink, coho and chum salmon. Isotope samples were collected from organisms at several trophic levels. Samples from sites with adult salmon returns indicated that the diets of grayling, rainbow trout, and coho salmon fry were predominately comprised of salmon tissue and eggs. Also, examination of stream macroinvertebrates revealed increased taxa richness and diversity in anadromous stream sections compared with non-anadromous sections. Despite this, results failed to detect a significant marine N signal between control and treatment sites in samples of riparian vegetation, algae, and stream macroinvertebrates (grazers) and implies that marine N was not significantly incorporated through pathways of primary production. Piorkowksi (1995) notes that results markedly differ from the Sashin Creek study (Kline et al. 1990) and are likely due to two important considerations: 1) Sashin Creek received a much larger run of salmon utilizing a smaller stream area; and 2) total dissolved nitrogen content in Sashin Creek was likely much lower given intense precipitation (nutrient flushing), causing the system to be more dependent on seasonal pulses of salmon-derived nutrients.

Many headwater streams in the Pacific Northwest exhibit low levels of primary and secondary productivity (Gregory et al. 1987; Bilby and Bisson 1992), and are systems typically preferred by adult coho salmon for spawning (Sandercock 1991). Bilby et al. (1996) compared isotope ratios in four tributaries of the Snoqualmie River, Washington, to determine the influence of coho salmon carcasses on food webs of headwater streams. Overall, the study suggests that even modest inputs of MDN can influence small streams. $\delta^{15}N$ and $\delta^{13}C$ values were similar between anadromous and non-anadromous streams prior to coho salmon spawning; during and shortly after spawning, elevated $\delta^{15}N$ values were found in stream biota (epilithic organic matter and stream invertebrates) and riparian foliage. Juvenile coho salmon more than doubled their weight following the appearance of spawning adults. Using an isotope model assuming no direct consumption on salmon carcasses and eggs (resulting in a conservative estimate without trophic fractionation), juvenile coho salmon were enriched approximately 30% with marine N. As well, researchers found rapid uptake of MDN through chemical sorption by streambed gravel. Chemical uptake of dissolved organic matter by streambed substrate was similar in both light and dark controlled experiments. Bilby et al. (1996) stress the importance of chemical sorption for initial nutrient uptake in headwater streams where primary production is limited during winter due to cold temperatures, low light levels, and frequent scouring by high flow events.

Carcass tissue and eggs appear to be an important food source for juvenile fish during winter periods and may play a critical role when other food items are less available. In four streams in southwestern Washington, Bilby et al. (1998) observed significant increases in density, weight and condition factor of juvenile steelhead and coho salmon following addition of hatchery spawned coho carcasses (with some eggs remaining). In enriched stream sections, 60-96% of stomach contents of juvenile steelhead and coho salmon were comprised of carcass flesh and eggs (with eggs being the preferred food item) while carcass material was present. Also, diet content of juvenile coho salmon had five times the amount of invertebrate biomass as compared to non-enriched areas. While significant increases in density and condition factor of juvenile coho salmon and steelhead were observed in carcass enriched areas, fish were not marked to confirm site fidelity throughout the study period. Even so, increased fish size and condition factor has implications for higher survival for both juvenile coho salmon (Bell 2001; Brakensiek 2002; Hartman and Scrivener 1990; Quinn and Peterson 1996; Holtby 1988) and steelhead (Ward and Slaney 1988) and subsequent returns of adults (Hager and Noble 1976; Bilton et al. 1982).

Findings by Wipli et al. (in review) further corroborate conclusions by Bilby et al. (1998) on the importance of salmon carcasses and eggs for juvenile coho salmon. In experimental and natural streams in Southeast Alaska, Wipfli et al. (in review) found strong positive correlations between salmon carcass loading rates and growth of juvenile coho salmon, cutthroat trout and Dolly Varden char. Over a 60 day experiment, juvenile coho salmon gained over 60% of fish body mass in study reaches with the highest carcass loading rates (4 carcasses / m^2). Similarly, cutthroat trout and Dolly Varden char exhibited growth rates over five times higher in carcass rich areas as compared to control areas. Nutritional status of juvenile coho salmon was evidenced by concentrations of triacylglyceride (TAG) and ratios of marine-based to terrestrial-based fatty acids in juvenile samples; both percent TAG and fatty acid ratios increased with increasing density of carcasses. TAG concentrations in juvenile fish correspond to storage of marine-derived long-chain n-3 fatty acids and indicates direct benefits of salmon carcasses to growth and nutritional status of stream salmonids.

BOTTOM-UP EFFECTS OF NUTRIENT ENHANCEMENT

Studies reviewed thus far indicate that stream delivery of MDN and biogenic material from returning adult salmon provide an immediate food resource for fish and can influence lotic food webs. Addition of nutrients can certainly have a bottom-up effect in freshwater systems, boosting primary production and ultimately benefiting fish populations (Johnston et al. 1990; Bradford et al. 2000; Ward et al. 2002; Wilson et al. 2002). This management concept has seen successful application in lake enrichment programs in Alaska and British Columbia where returning runs of sockeye salmon have increased as a result of manual application of nutrients. The extensive knowledge and management success in sockeye rearing lakes is due, in part, to the relative simplicity of these systems in food web and nutrient dynamics, as compared to fluvial systems (Kline et al. 1997; Kyle et al. 1997). Sockeye salmon rearing lakes have generally been identified as oligotrophic systems, primarily limited by phosphorous. Ratio additions of nitrogen and phosphorous have successfully elevated lake rearing capacities for juvenile sockeye salmon through increased zooplankton production (Hyatt and Stockner 1985; Kyle et al. 1997; Bradford et al. 2000). British Columbia has carried this management tool further and begun fertilizing large river systems in efforts to boost declining steelhead and coho salmon populations. Results so far show overall stimulation of system productivity with increased density and growth of juvenile coho salmon and steelhead as well as earlier age at outmigration of steelhead (Johnston et al. 1990; McCubbing and Ward 2000; Ward and Slaney 2002). Whether manual fertilization of large river systems can recover coho salmon and steelhead runs remains to be seen. While certainly a management and research tool, it is questionable if manual nutrient supplementation programs can adequately replace ecosystem function of spawning adult salmon.

Examples of manual supplementation studies are raised to illustrate issues of trophic capacity in relation to fish production. Productivity can be defined as the capacity of a system to produce a product of interest (Bisson and Bilby 1998). A nutrient limited system can mean food limited in the interest of fish production (Chapman 1966; Dill et al. 1981; Johnston et al. 1990). While adult salmon carcasses and eggs provide a direct food resource for fish populations, salmon-derived nutrients can potentially influence fish production through autotrophic and heterotrophic pathways as well (see Vannote et al. 1980, Bilby and Bisson 1992). Wipfli et al. (1998) conducted highly replicated tests of adding salmon carcasses in experimental and natural stream channels in Alaska to assess responses in primary production. Biofilm production (a food source for aquatic invertebrates) increased approximately 15 times in the carcass enriched section (with an approximate return run size of 75,000 pink salmon) compared to the upstream control section. Further, total macroinvertebrate densities increased up to 8 and 25 times in artificial and anadromous stream sections, respectively, as compared to control sections. Similar results were found in a follow-up study by Wipfli et al. (1999), and also suggest a threshold level of response in biofilm production (over a two-month study period) in relation to carcass loading rates (up to 1.45 kg, the lowest carcass loading rate in artificial channels). Both studies (Wipfli et al. 1998, 1999) show trophic responses to MDN and suggest potential growth benefits to fish through increased availability of fish food organisms (see also Perrin et al. 1987, Johnston et al. 1990, Perrin and Richardson 1997, Quamme and Slaney 2002). Wipfli et al. (1999) caution however, that the capacity for stream systems to retain marine nutrients and the long-term effects of 'excessive' carcass loadings for stream productivity have yet to be sufficiently addressed by researchers (O'Keefe and Edwards 2002).

STREAM RETENTION OF SALMON CARCASSES

Stream incorporation of marine-derived nutrients necessitates that salmon carcasses are retained for a sufficient period of time. Cederholm and Peterson (1985) investigated winter retention of coho salmon carcasses in several small streams on the Olympic Peninsula in western Washington. They initially released 180 carcasses throughout nine streams with varying abundance of large woody debris. One week following releases, 78 (43%) of the study carcasses were identified of which 80% were within 200 m of initial placement. Carcass retention was positively correlated with increases in large woody debris. The researchers speculated that carcass retention could be even higher in unlogged streams where large woody debris loading was higher as compared to their study streams.

In a similar follow-up study on carcass retention in Olympic Peninsula streams, Cederholm et al. (1989) released 945 tagged coho salmon carcasses, of which 174 were implanted with radio transmitters to more definitively determine the fate of mobilized carcasses. Few study carcasses were flushed beyond 600 m with a median travel distance of 49.5 m from initial placement. Again, large woody debris was influential in retaining salmon carcasses with the majority of carcasses found in pools. Cederholm et al. (1989) also assessed retention during high flows by depositing 25 radio-tagged carcasses at the beginning of a flood event (estimated discharge 6.20 m^3/s). Following the flood event, 21 of the 25 radio-tagged fish were located within 600 m of initial placement, with a median travel distance of 66 m. Ten of the radio-tagged carcasses were found on stream banks well above low flow levels. In a different study, Glock et al. (1980) investigated retention of chum salmon carcasses on a much larger system, the Skagit River in Washington. Although carcasses drifted as far as 39 km within the first five days, the majority of carcasses (20%) were located within 1.5 km of initial placement. Habitat, discharge, amount of large-woody debris, and species of salmon appear to be important factors in considering retention of salmon carcasses in fluvial systems.

The study by Cederholm et al. (1989) also revealed significant predation by mammals and birds on salmon carcasses. Approximately 22 taxa of mammals and birds were documented consumers of salmon carcasses. Surveys identified 374 partially eaten study carcasses removed from stream channels with 88% of these carcasses located within 15 m of the stream bank. Cederholm et al. (2000) provide a more extensive review of wildlife-salmon relationships that documents over 138 species having a 'strong' positive life-history relationship to Pacific salmon. This and other research suggests the ecological relationships between salmon and wildlife (Wilson and Halupka 1995; Ben-David et al. 1998; Wilson et al. 1998). Further, wildlife species appear to play a significant role in the removal of salmon carcasses from lotic systems where nutrient benefits may be more realized in riparian and upland communities (Cederholm et al. 2000; Garten 1993; Helfield and Naiman 2001; Reimchen et al. 2002).

IMPLICATIONS FOR FISHERIES MANAGEMENT

Although research to date provides evidence of the role of salmon-derived nutrients in ecosystem function, this complex relationship is poorly understood. Further understanding of the ecosystem context of returning adult salmon and MDN will require both the synthesis of several scientific disciplines and human values. Given the high cultural and economic value of salmon, and the public mandate to recover natural salmon populations, fisheries managers must insure that harvest practices do not impede recovery. Research on salmon and MDN frequently implies that current harvest management strategies exacerbate the risk of further decline in salmon populations, due to removal of salmon and nutrients bound for terrestrial systems. However, the science of quantifying salmon escapement goals necessary to properly functioning ecosystems is still in infancy.

Nonetheless, research is beginning to focus on quantifying nutrient input levels necessary to improve juvenile salmon survival. Bilby et al. (2001) used stable isotope levels from juvenile coho salmon collected throughout western Washington to test for a marine N threshold level in juvenile fish. Representative of 26 stream reaches from 12 different watersheds, juvenile coho salmon samples were collected in late February and early March over a seven-year period. Juvenile samples were only collected in known areas where no other anadromous fish spawn. Cutthroat trout were collected above anadromous barriers in the same systems that juvenile coho salmon samples were collected. Isotope values from cutthroat trout represented $\delta^{15}N$ background levels used to establish site-specific ratio index measures of marine N enrichment in relation to $\delta^{15}N$ values from juvenile coho salmon. Also, tissue samples were collected from hatchery returns of adult coho salmon throughout the region to relate $\delta^{15}N$ values from cutthroat trout and juvenile coho. Adult returns of coho salmon to each creek were determined using spawner count and stream habitat data; average weights from adult hatchery returns were used to estimate biomass (wet-weight kg / m^2) of spawners in each study creek.

Bilby et al. (2001) found that $\delta^{15}N$ values were consistently higher, by study site, for juvenile coho salmon as compared to cutthroat trout. However, isotope values revealed considerable variation between study streams for both cutthroat trout (ranging from 4.5‰ to 8.5‰, the per mil deviation of $^{15}N/^{14}N$ from air N_2, Peterson and Fry 1987; Kline et al. 1990) and juvenile coho salmon (5.8‰ to 11.7‰). Cutthroat $\delta^{15}N$ values suggest other sources of marine N, or possibly nutrient fractionation (Peterson and Fry 1987; Kline et al. 1990). Variation in isotope values reveals the need to establish basin-specific background isotope levels when using isotope methods.

Using the relationship between estimated carcass abundance and ^{15}N index values of enrichment in juvenile coho salmon, Bilby et al. (2001) found that enrichment levels increased with increasing carcass abundance. The relationship also revealed a point of diminishing enrichment of marine N in juvenile coho salmon above carcass abundance levels of 0.10 kg/m^2; in locations where carcass abundance was less than 0.10 kg/m^2, enrichment index values averaged 0.19± 0.11(one standard error) as compared to 0.48± 0.13 in areas with carcass abundance above 0.10 kg/m^2. Carcass abundance of 0.10 kg/m^2 approximately equals 120 fish/km^2, above which marine N in juvenile coho salmon rapidly approached a 'saturation level'. Based on previous findings (Bilby et al. 1996, 1998), researchers in this study assumed that juvenile coho salmon were primarily incorporating marine N through direct consumption of salmon carcasses and eggs. Given this premise, the saturation level found in coho salmon parr could be interpreted as the maximum level of dietary enrichment for this trophic interaction. Based upon spawner escapement data and research findings, Bilby et al. (2001) conclude that the majority of coho salmon spawning streams in western Washington are well below capacity for incorporating more marine-derived nutrients.

From both a research and management perspective, there are numerous limitations to applying results from Bilby et al. (2001) as a standard for salmon escapement goals (many of which the researchers acknowledge). First, study sites were purposely chosen to only include areas with spawning coho salmon and no other returns of anadromous salmonid species. This implies that results may only be applicable in such areas and questions if marine nutrient dynamics would be similar in systems with returning runs of multiple salmon species. The temporal distribution of spawning by numerous species of salmon can mean prolonged input of marine nutrients, which may be more effectively incorporated within a system (due to nutrient flushing) at a lower density of spawners for a given species. Second, juvenile coho salmon alone are probably not an appropriate indicator for determining whether productivity in a system is nutrient limited (Simberloff 1998). The marine N signal found in juvenile coho salmon has been primarily attributed to direct consumption of salmon carcasses and eggs. If this is indeed the primary mechanism for nutrient uptake then isotope values from juvenile coho salmon are less revealing of other pathways for incorporation and trophic distribution of MDN within a system. Third, uncertainty remains as to whether increasing the input of salmon-derived nutrients to fluvial systems will subsequently result in higher returns of adult salmon. Results from the Bilby et al. (2001) study would suggest this due to higher $\delta^{15}N$ index values in juvenile coho salmon from systems with higher carcass densities. The effects of hatchery-origin salmon, that spawn naturally, must also be considered.

Gaps remain in our understanding of nutrient dynamics in fluvial systems. While it appears that salmon-derived nutrients can benefit sockeye salmon, cutthroat trout and coho salmon populations, at this time there are no research publications that directly establish the relationship between MDN and chinook salmon. ‘Ocean-type’ juvenile chinook, which comprise most of the production in Puget Sound, generally spend between three to nine months in freshwater before outmigrating (Healey 1991), a much shorter period than coho and steelhead (Montgomery et al. 1996; Healey 1991). Degraded spawning habitat and winter flow conditions, with direct influence on egg survival and emergence, may be more critical to chinook production than inputs of MDN. Upon outmigrating from the freshwater environment, juvenile chinook salmon may reside in estuarine environments for extended periods of time where conditions are critical for early growth and survival (Simenstad 1997; Simenstad et al. 1985).

Numerous questions arise in considering the potential role of MDN for ocean-type chinook salmon populations. Whether newly emerged chinook salmon fry actively feed on salmon carcasses and eggs has not been established and further questions if carcasses are retained for a sufficient period of time, especially in large river systems with peak winter flow events. The immediate benefits of MDN for chinook salmon fry is most likely limited given the relatively short time juveniles reside in freshwater. However, the River Continuum Concept (Vannote et al. 1980) suggests that upstream inputs of MDN affect downstream communities. This concept questions nutrient dynamics and source-sink effects within a river basin.

Ultimately, the benefits of MDN for juvenile chinook salmon may be more fully realized in estuaries (Simenstad 1997). That said, in some instances the eutrophication of estuaries associated with agricultural and urban development may be negatively affecting fish habitat and survival (Bricker et al. 1999). Currently, little is known about the effects of salmon and MDN on estuaries.

At a watershed scale, the connectivity of nutrient cycles and the pathways involved needs further investigation. Such considerations question the relative importance and actual contribution of MDN from different species of spawning salmon. In many river systems throughout the Pacific Northwest, returns of chum and pink salmon comprise the majority of spawner biomass. These species typically spawn in the lower portion of stream and river systems. This implies that chum and pink salmon contribute substantial inputs of MDN to environments used by ocean-type juvenile chinook salmon. Whether survival of juvenile chinook salmon is limited by nutrient deficiencies needs to be evaluated in a multi-species context. Furthermore, the relative contribution by adult returns of different salmon species to both ecosystem function and salmon populations with unique life-history strategies needs to be more fully recognized.

In considering the importance of MDN to ecosystem function and sustaining salmon populations, the large returns of adult salmon runs recently experienced throughout the Pacific Northwest dictates that an experiment is now in-progress. The current scenario provides unique research opportunities to assess if marine nutrient inputs are limiting salmon populations. This will necessitate that isotope methods are further developed and tested (see Kline 2002) to properly reveal MDN in food-web dynamics. Assessment of watershed nutrient levels will be necessary to determine regional variation. Identification of bottlenecks in survival to salmon populations will require careful monitoring of population dynamics across fish life-stages. Long-term studies on a larger spatial scale need to be initiated before we can properly understand the contributions of salmon and MDN to ecosystem function. The multiple values associated with salmon necessitates that this understanding be further developed and integrated between numerous disciplines before ecosystem based escapement goals for Pacific salmon can be a realized and effective management approach.

Appendix E. Escapement Estimation

Introduction

Accurate estimates of chinook spawning escapement are essential to management of Puget Sound chinook stocks. They represent the most immediate post-season monitoring of stock abundance and are essential to subsequent forecasting and reconstruction of cohort strength. Total escapement is also an invaluable measure for survival and productivity measurements, which is important in developing escapement goals and recovery objectives. With the availability of other relevant data, abundance reconstruction enables the estimation of cohort survival (returns per spawner), which, in turn, is the basis for setting harvest exploitation rate objectives. It is appropriate, therefore, to scrutinize the survey and computation methods utilized to estimate escapement with respect to the accuracy and precision of the resulting estimates.

The listing of the Puget Sound chinook has created further determination to improve escapement estimates. However, it is important to realize that accurate and precise estimates of escapement come at a cost. Given the limits on staff and funding, along with logistic limitations, a careful triage is required to determine where existing deficiencies should be addressed. The co-managers' chinook harvest management plan includes a mandate to insure effective monitoring of the productive status of Puget Sound chinook stocks.

There has not been a formal Puget Sound-wide review of escapement estimation methods since Smith and Castle (1994). However, a summary of escapement methods is documented each year, concurrently with preseason forecasts. A critical assessment of escapements has been a major task of the Chinook Technical Committee (CTC) of the Pacific Salmon Commission, especially those populations used as indicator stocks. Concerns about Puget Sound estimates has focused on the following issues:

1) accuracy and precision of estimates of total or partial escapement (including the testing of inherent assumptions);
2) Natural Management Units lacking estimates of total escapement;
3) currency of escapement goals: females or PED, vs total;
4) straying – contribution of hatchery-origin adults;
5) accounting of natural returns to hatchery rack;
6) age composition of escapement.

This document summarizes current methods for estimating escapement and describes recent work intended to validate or improve escapement estimates.

Current Methods

Spawner surveys, with the intent of estimating abundance, are conducted in all waters where naturally sustainable populations exists (category 1 and 2 watersheds). In addition, some category 3 watersheds are also surveyed. There are two basic types of surveys—census and index. Census surveys are conducted where all fish (carcasses or redds) can be counted. This implies that all redds and/or fish are visible and all spawning areas can be viewed so that there is no expansion of the estimate to account for unsurveyed areas. In the case of a redd census, all redds must be visible and all spawning areas must be viewed. In some areas, a marked redd census is used, where redds are marked, usually with a colored stone, to avoid recounting the redd during subsequent surveys.

Weirs can also provide opportunity to census returning fish. However, weirs are generally associated with the collection of hatchery brood stock and not natural spawning populations. In cases where excess fish are passed upstream, fish can be counted directly. Other situations include Baker Dam, which has a trap-and-haul facility to pass fish over the dam, as does the Mud Mountain Dam (Buckley Trap) on the White River. On the Snohomish system, chinook are trapped and hauled over Sunset Falls. Although counting sites such as these may provide accurate estimates of fish passing a single point, estimates may not necessarily reflect of spawning success.

With watershed that are too large to survey their entire length, and/or all potential spawning sites, index areas are used to estimate total spawner abundance. These are selected (non-random) sites where chinook are likely to concentrate. Although index areas may represent only a portion of the watershed, they usually incorporate a significant component of the spawning population. Index areas can be used to estimate either fish (carcasses or live fish) and/or redds. Surveys are conducted periodically throughout the spawning period, and include such information as location, time, date, water conditions, number of redds, live and dead counts, along with collecting scales for age data. Counts are conduct on foot or by floating the index areas. In the case of redd counts, aerial surveys are often used either exclusively or in conjunction with ground surveys.

Once the counts are completed and data assimilated, the actual estimates are usually calculated using peak counts, cumulative counts or area-under-the-curve (AUC). Peak count estimates are simply the highest number of observations made within a specific time period, such as one day. Once that number is identified it is expanded to account for such factors as non-surveyed areas, fish per redds, visibility, etc. Cumulative counts involve enumerating observed fish and/or redds over a period of time, usually the spawning period, and summing the observations. This usually requires some sort of marking program to prevent recounting. A more sophisticated variation of this is AUC which accounts for the entire duration of fish presence, using specific observation dates that are compared to the total spawning duration. This produces a curve of the counts that has typically been constructed for either redds or fish. This method has been widely used by many previous management biologists for various northeast Pacific salmon (Ames and Phinney 1977, Bue et al. 1998, Hilborn et al. 1999, Hill 1997, Liao 1994, Smith and Castle 1994). In the case of redds, the left side of the curve, the last date before the first redd is formed defines the beginning of the curve (i.e. the last date with zero redds). Ground observation and interpolation may be needed to specify this date. Straight lines are typically used to connect each subsequent count of visible redds, although some researchers have attempted curvilinear fits (Ames 1984). On the right side of the curve, the first date where the count is judged to be zero (known or interpolated from ground observation) forms the end of the curve. The area-under-the-curve (AUC) is the sum of the areas between each subsequent count, beginning and ending with the zero count dates, a method known as trapezoidal approximation (Hahn 1998, Hahn et al. 2001, Hilborn et al. 1999, Hill 1997). Each segment AUC is simply the sum of the two adjacent counts divided by two then multiplied by the number of days between the count dates plus one (i.e. simply subtract the earlier date from the later date). The total AUC is the sum of the segment AUCs. For redds, the primary variables are redd-life (the duration of redd visibility) and fish per female (since it is the female that builds the redd).

Nearly all escapement estimates of Puget Sound chinook are translated into total escapement for the watershed. The systems where escapement estimates reflect only the index areas are North Lake Washington tributaries and Skokomish River. Within the Lake Washington system, counts at the Ballard Locks estimate annual returns, but do not account for fall-back or pre-spawning mortality. Ballard counts also cannot be used to estimate escapement to individual watersheds. Skokomish mainstem counts are used to provide relative comparisons with two tributaries (Hunter and Vance creeks), which are generally not surveyed.

Improving current methods

There are four basic ways that may potentially improve escapement estimates: 1) expand indices (area of surveys), 2) conduct more frequent surveys, 3) re-establish base years by calibrating expansion factors or total estimates by comparing it with alternate methods, or by 4) testing basic assumptions such as expansion factors, spawner density, redd life, fish per female, adults per redd, etc.

Parameters such as confidence intervals and standard deviations have generally not been applied with any significance to escapement estimates. Exceptions include some of the work funded through the Chinook Technical Committee (CTC) of the Pacific Salmon Commission, such as those conducted on the Stillaguamish, Snohomish and Green rivers. Attention has focused on gaining more confidence of some basic assumptions, such as redd life and fish per redd. In many large river systems in Puget Sound chinook escapement is assessed by making repeated counts of redds, plotting these counts against time, then calculating the total number of redds from the area under the curve. Each redd has been assumed to represent one female and 1.5 males in calculating escapement. Whether made by aerial, boat, or foot survey, redd counts are subject to errors associated with visibility, insufficient survey frequency, observer error, false redds, superimposition, and the inability of distinguishing chinook redds from pink salmon redds. Assumptions regarding redd life and sex composition have been based on a few supporting, mostly old, studies, with the standard assumption for redd life as 21 days (Ames and Phinney 1997 and Orrell 1976 and 1977). Because the cumulative effects of these sources of error have not been quantified, the accuracy and precision of the resulting estimates is unknown.

A recent study (Hahn et al. 2001) examined redd estimators, as applied to chinook escapement to the Skagit and Stillaguamish rivers, and reached the following conclusions:

- The accuracy and precision of redd census ranged from very good (C.V. 10 – 15%) to uncertain, depending on conditions in each stream or river. Aerial surveys (particularly helicopter) were accurate in some streams, and varied from foot or boat surveys in others. More frequent aerial surveys were believed necessary to accurately define the spawning curve in some systems.
- The secondary assumption that females build only one redd was generally supported by field observations, though the potential for multiple redds per female or false redds exists in certain streams.
- Estimates of sex composition based on carcass counts or gillnet test fisheries engender significant, but unquantified bias. Thus the assumption that 1.5 males per female was not validated. Males and small chinook are undersampled by carcass surveys and gillnet samples.
- Intensive foot surveys to mark and monitor redds found that redd life varied significantly from 21 days in some systems.
- Covariance between the area under the curve and redd density is presumed, but should be quantified.
- Mark / recapture methods for estimating escapement and its variance, such as have been employed in the North Fork Stillaguamish River and Green River in recent years, are affected by several factors that bias their result. The resulting estimates (Conrad 1993, 1994, 1995, 1996, 1997; Nason 1999) were substantially lower than concurrent redd count-based estimates, and were probably affected by unequal probability of capture, non-random mixing and loss of marked carcasses from the study reach. However, recent

studies on the Green River show mark and release estimates to be higher than the standard redd and carcass estimates (Hahn et al. 2000).

Redd census techniques employed successfully in large river systems are usually supplemented by carcass counts and/or redd surveys in tributaries where aerial census may be impossible. Estimates of total escapement for a given stock may therefore be composed of several techniques. Details for each management unit are summarized within each watershed section.

CTC funded studies have specifically been devoted to improving estimates. On the Skagit attempts have been made to compare the existing escapement estimates with a live mark-recapture estimate. The primary objective of the study was to estimate the drainage-wide escapement of chinook salmon returning to the Skagit basin and to evaluate the fishwheel and beach seine sites in the lower Skagit River for capturing adult chinook salmon. The study was conducted for two years (2000 and 2001), and it was determined that these two methods alone would not capture enough fish to generate a reliable mark-recapture estimate of escapement (Smith et al, 2002). For 2002, the primary objective remains as a mark-recapture study. However, the planned method of capture included tangle nets and angling. In addition, radio-telemetry was also planned to investigate the distribution and behavior of chinook after capture and release.

Another mark-recapture study has also been underway on the Green River for three years (2000, 2001 and 2002). Adults are captured with a beach seine and released, with subsequent recapture within the spawning areas. This study has proved more successful than the Skagit study in that the number of marks and recaptures has been high enough to provide credible estimates. Studies have also been conducted on the Stillaguamish and Snohomish river systems. Final reports for all years should be forthcoming shortly

Oregon has used similar methods in assessing their coastal fall chinook populations. Standard index areas have been chosen based on survey history as well as being a valid representative of spawning escapement. which is indexed as the peak count of live and dead fish observed in a given survey area. Because standard survey sites were not chosen from a randomized sampling design, spawner density estimates obtained from these sites are used only to provide relative abundance (Jacobs 2001).

However, for coho Oregon uses a different approach. A review of the Oregon Coast Naturals (OCN) spawning survey program by Oregon State University Department of Statistics led to the initiation of the OCN escapement methodology study in 1990. This study involved the development and experimental implementation of a stratified random sampling (SRS) approach, which consists of randomly selecting spawning survey sites from geographical strata and estimating spawner abundance from visual counts in these survey sites (ibid). This approach follows EPA's Environmental Monitoring and Assessment Program (EMAP), which is similar to that of the National Park monitoring. The basis of this program is to avoid bias through random selection of sampling units and to use a sampling design that estimates population attributes that can produce reliable, absolute values of population abundance.

Some discussion has been initiated regarding its use for Washington chinook. However, there are several major disadvantages in implementing this sort of method. Among the most critical would be that present index areas would no longer be used, thus making past data unusable for comparison purposes. Because chinook spawn in specific areas, a large number of sampling sites would be required to provide adequate observations, and there would likely be many samples with no observations. The cost of identifying new sites and their subsequent monitoring would be more expensive and require additional staff to carry out than with current methods.

In general, assumptions regarding uniform spawning density have not been tested. This assumption applies not only to waters outside index areas but also to different times. Chinook will spawn in different areas in different years, depending upon changing environmental conditions, run size, human factors, etc., and the use of a single constant, or expansion factor, may not provide accurate estimates or be comparable from year to year. Survey conditions can also change, making it more or less difficult in observing fish and redds. In problem areas, estimates can be improved by expanding index areas. However, it should be noted that, in terms of recovery assessment, annual trends are as important as the escapement numbers, and changing survey procedures may result in estimates that are not comparable to previous surveys. In such cases, the importance of accurate estimates versus precise trend information must be weighed.

One remedy is to incorporate supplemental areas, which are spawning sites that are not included as index areas. Another method is to survey the entire watershed where chinook spawn. This is only feasible in smaller rivers where access is available throughout the entire length of the watershed or, in larger rivers, by using aerial-redd surveys where conditions allow complete view of the river substrate.

In summary, escapement estimates can be improved, but it is unlikely that there are new methods that will replace the current ones. Actual improvement of any population estimate will likely have unique requirements specific to the watershed. Some watersheds, for example, are inherently difficult to survey regardless of available resources. However, before a decision is made to invest resources to further improve an estimate, it is importance to weigh the needed information and the status of the stock against the potential benefits and costs..

Refining escapement goals

Fixed escapement goals have been used as the performance standard for harvest management. However, they were merely averages of escapements for various years during the 1960s and 70s (Ames et al. 1977) and did not necessarily reflect habitat productivity nor maximum sustain yield, upon which harvest goals were based. Because of the need to closely monitor the performance of the annual harvest regime, harvest management plans now calls for developing exploitation rate objectives for as many management units as possible, based on current and potential productivity. Basically this requires estimating the productivity (stock:recruit) function for the populations and implies that harvest rates can be associated with an escapement range for a given watershed.

Nevertheless, the question of escapement objectives remains under consideration within at least three forums. The Technical Recovery Team, which is coordinated through NMFS, has defined a number of parameters necessary for recovery. Among them is abundance of natural-origin recruits, which is expected to include both ESU and specific watershed criteria. The Ecosystem Diagnosis Treatment (EDT) process has also developed an initial review of some Puget Sound watersheds and identified escapement ranges based on properly functioning conditions (Molbrand 2000, Anonymous 2002). Finally the Chinook Technical Committee has been involved with a review of escapement goals throughout Washington (Hahn et al. 2001). All of the above review sources have started releasing results, and it is expected that additional information will be forthcoming. It is expected that escapement objectives will change as new information, such as habitat productivity, stray rates and other hatchery/wild interactions, become available.

The need to estimate escapement accurately is not lessened under this exploitation rate management system since escapement abundance remains a primary measure of stock health. If the harvest regime operates as planned, and abundance is close to what is forecasted, the escapement should also conform to pre-season expectations. The co-managers are committed to assessing the performance of the harvest regime annually, and modifying fishery regulations as necessary to assure that exploitation rate objectives are met. Over the longer term, regular assessment of stock productivity, for which accurate assessment of survival and productivity is essential, will also modify the harvest objectives to insure that recovery will not be hindered.

Straying

Estimating the contribution of first-generation, hatchery-origin adults to natural spawning is essential to understanding the natural productivity of any chinook population. Natural productivity (i.e. survival) can only be estimated by distinguishing hatchery and natural-origin components of harvest and escapement. In most Puget Sound systems, hatchery production is directed towards harvest augmentation, whereas only a few programs are directed at recovery. The concern is that hatchery fish may intermingle and interbreed with natural-origin chinook, resulting in direct interactions, such as competition for food and space and/or indirect interactions such as reduced fitness due to genetic modifications. Various studies with salmonids species have reported potential genetic and behavioral hazards to natural production caused by the interactions with hatchery fish. (Ames et al. 1984; Fleming and Gross 1995; Pearson and Hopley 1999; Reisenbichler 19??; Chilcote 2002).

Hatchery-origin adults are usually distinguished by some identifying mark, either externally, such as a fin clip (which may signify that the fish also carries a coded-wire tag), or internally, such as an otolith mark. Double index tagging (DIT) programs, which are intended to estimate mortality in selective fisheries of unmarked fish, involve coded-wire tagging two equal-size groups of hatchery releases, only one of which is externally marked by an adipose clip.

Estimation of stray rates is made more certain if hatchery production is mass-marked, which allows spent adults or carcasses to be quickly examined. Where DIT programs exist, unmarked fish will pass through an electronic tag detector to recover CWTed fish. Studies in the Green River suggest that carcass sampling provides superior estimates of the contribution of hatchery fish to natural spawning as compared to sampling extreme terminal (freshwater) catch. In the case of otoliths marks, otoliths are dissected from a sample of unmarked carcasses to establish the presence of this mark group. Otolith marking has been used successfully to estimate the stray rates of Tulalip Hatchery fall chinook into adjacent watersheds (Rawson et al. 2001).

In the case of recovery programs, it is not desirable to mark hatchery fish since they are liable to be harvested during selective fisheries. However, an internal or external mark (other than an adipose clip) would still allow the ability to identify hatchery returns in the escapement. This has been the case for Nooksack and White River spring chinook as well as for Dungeness River chinook. Selective fishing for chinook has not yet been widely implemented by the Washington co-managers, but mass marking programs have been initiated not just in anticipation of future selective recreational fisheries, but as a way to better determine hatchery/wild interactions and stray rates. In turn this will help address the productivity characteristics of the watershed.

Age and sex composition

Estimating spawning escapement and cohort reconstruction require information on the age and sex composition of the return. Escapement estimates, as discussed above, rest on assumptions about the number of redds that each female builds, and pre-spawning mortality. Reconstruction of the cohorts comprising brood year abundance requires estimates of the age composition of annual returns. The age and sex of returning adult chinook may be determined by sampling terminal or extreme terminal (i.e. freshwater) fisheries, carcasses of spawned-out fish, or fish returning to hatcheries.

Terminal fisheries, carcass surveys, hatchery rack collections are all used to obtain samples. However, each of these sampling methods may engender bias into the result. Gillnet gear that is designed to target chinook is often selective of larger fish, and may not catch jack males. The catchability of each size class of chinook may also vary under different conditions of flow and turbidity in the river. Terminal fishing occurring in the bays adjacent to the river mouth can be equally selective, and may intercept significant numbers of fish destined to other systems. Hahn et al. (2001) concluded that larger sample sizes from terminal fisheries would improve estimates. Recreational catch may also be selective, but it may be logistically difficult to obtain large enough sample sizes. In addition, recreational fisheries may not operate across the entire migration period nor target within terminal areas.

Carcass sampling tends to undersample small fish and males, but studies differ in their conclusions in this regard (Conrad 1996; various studies cited in Hahn et al. 2001). The magnitude of true bias is usually unknown, because carcass retrieval can only be compared with other, possibly biased, samples, such as those from fisheries or hatchery racks. The fieldwork involved is labor and time intensive, and frequently complicated by high flow, turbidity, and debris. ‘Carcass life’ (i.e. the time window available to sampling) is often affected by predators removing carcasses before they can be sampled, and by fish moving or being swept out of the sampling area. Carcass weirs have not been employed in Puget Sound streams.

Hatchery racks allow sampling throughout the entire migration period, allowing scales or other samples can be collected at frequent intervals. However, hatchery returns may not be representative of wild populations, particularly where non-indigenous stocks have been used. For many wild stocks there is no associated hatchery program, precluding rack and brood stock sampling. These include the South Fork Nooksack springs, Skagit falls (though broodstock collection for a PSC Indicator Stock has begun), Lake Washington / Cedar, and Mid-Hood Canal rivers.

In general, sampling should:

- encompass the entire migration period.
- be representative of single stocks or populations;
- Be designed to achieve unbiased and statistically significant results
- be random but represent the population.

Methods currently used for each management unit

Smith and Castle (1994) documented escapement estimate methods within Puget Sound and the Straits of Juan de Fuca. In general, these methods continue to apply. However, for most watersheds, there are on-going efforts to maintain and improve spawner estimates. The following reflects the current methods as of 2002.

Hoko: (Ground surveys, redd census)
The Makah Tribe and WDFW conduct surveys using cumulative redd counts for the mainstem and tributaries found between river miles 1.5 to 21.7, which represents the entire range where chinook spawn in the Hoko basin. Redd counts are multiplied by 2.5 adults/redd. There are ten mainstem reaches plus 13 reaches within tributaries, which include the Little Hoko River, a tributary to the lower mainstem, and Browne's, Herman, N.F. Herman, Ellis, Bear and Cub Creeks, which are tributaries to the upper mainstem. The Makah Tribe also surveys the mainstem and other independent tributaries in the Sekiu basin, including Carpenter, S. Fork Carpenter, and Sunnybrook Creeks, and unnamed tributaries (WRIA 19.0215, 19.0216, and 19.0218). The escapement estimates for these two rivers are based on total natural escapement for the Hoko basin, plus broodstock capture, and total escapement in the Sekiu basin.

Elwha: (Ground surveys, redd census using AUC)
Spawning chinook are limited to the lower 4.8 river miles below the dam. The preferred method of estimating adult escapement, in the mainstem, is plotting visible redds versus date and calculating the area under the curve, resulting in redd-days, which are divided by the 21-day redd life. The resulting redd total is added to the number of redds counted by the Lower Elwha Tribe in the 1 mile, Hunt's Road side channel index. The total redd count is then multiplied by 2.5 adults/redd.

Dungeness: (Ground surveys, redd index counts)
Since 1986, cumulative redd count surveys have been conducted from RM 0 to 18.7 in the mainstem Dungeness and from RM 0 to 5.0 in the Gray Wolf mainstem. Counts are multiplied by 2.5 adults/redd. A captive brood program has been underway in this system since 1992, with the first releases from this production effort occurring in 1995. The various families and year classes are uniquely marked with cwt and otoliths. Hence surveys also sample for these items.

Nooksack, North Fork: (Ground surveys, carcass index counts)
The primary difficulty is the turbid conditions that usually exist in the north fork, making redd counts impossible. Estimates are cumulative carcass counts in established index areas in the north and middle forks. Total estimate is scaled to a single year when carcass and redd counts were visible throughout the duration of the spawning period. With the return of otoliths marked fish, their sampling has become routine. Recent changes to production goal at Kendall Hatchery has led to the elimination of the summer/fall release program and reduction in the release of native, spring stock. Past escapement estimates have been complicated by spawn timing overlap of native and introduced stocks.

Nooksack, South Fork: (Aerial and ground surveys, redd census)
There are at least three groups of chinook that can be identified as spawning in the South Fork: 1) South Fork natives, identified by DNA and lack of other distinguishing marks, 2) North Fork natives as strays from the Kendall Creek hatchery restoration program (otolith marks, CWT) or natural strays (DNA) and 3) Green River /Soos Creek chinook as strays originating from hatchery programs past and present (DNA, adipose clips and CWTs). A total chinook estimate is derived from redd surveys conducted on foot by teams of two, done weekly from the middle of August

until the first week in November in all sections of the river and in 2.6 miles of tributary streams. Redds are counted, and expanded by a factor of 2.5 chinook per redd (i.e. 1 female and 1.5 males per redd) to obtain a total estimate. Because of high flows late in the survey season, the confidence in the total estimate deteriorates. Native chinook are estimated from the numbers of redds detected prior to September 29. An initial estimate of the North Fork native chinook is calculated from the proportions of carcasses which can be identified by otolith mark, or CWT and fin clip as coming from the recovery program. This estimate is subtracted from the total early native chinook estimate to provide an estimate of the South Fork native chinook spawning population**.**

Samish: (Ground surveys, redd/carcass census)
This system is considered a Category 3 watershed, which, historically, did not possess as sustainable chinook population. However, large numbers of summer/fall chinook (introduced) fish are released from Samish Hatchery each year. As a result, natural spawning does occur in the river below the hatchery. In addition, fish surplus to hatchery needs are released above the hatchery. This stock is managed for harvest augmentation and is managed only for achieving hatchery brood needs. Estimates are made using peak visible redd counts, multiplied by 0.95 to estimate true redds and then by 2.5 fish per redd. If river conditions are not conducive for redd counts; carcass counts are made on weekly basis. Fish spawning above the hatchery are counted as they are passed upstream over the rack.

Skagit: (Mainstem-aerial surveys, redd index counts; tributaries-ground surveys, redd census and index counts)
The entire Skagit and known spawning areas in the Sauk and Cascade rivers have been surveyed by helicopter on either a weekly (odd years) or biweekly (even years) basis. During odd years, surveys are concentrated within the first half of the run with a straight line connecting the peak to the end of redd visibility. This is due to the large numbers of pink salmon spawning in the same location as chinook salmon. Earlier chinook spawners are located in the upper Sauk, Suiattle and Cascade rivers. Later spawners typically spawn in the mainstem Skagit, associated tributaries and the Sauk River.

For the earlier-timed chinook, data from 1994 to present is not comparable to previous escapement estimates. This is due to a new escapement methodology, using expanded cumulative redd counts, which is thought to represent the total spawner population better than the pre-1994 method using peak live plus dead counts. (Rebecca Bernard, Skagit System Co-op, personal communication).

Studied funded through the Chinook Technical Committee (CTC) has provided initial assessments of the validity of the current escapement estimates. Work conducted in 1998 and 1999 showed that the 21-day redd life was a valid assumption for Skagit chinook (Hahn et al. 1998) But work still remains in testing the 2.5 fish per redd. To accomplish this, and to establish as base year for future estimates, the basic plan was to proceed with a mark and recapture study, using a fish wheel to capture adult chinook. This fish wheel was used for two years without success (too few fish were captured). In 2002 attempts were be made to use a combination of collection methods including tangle nets, angling and radio-telemetry (CTC January 8, 2002).

***Lower Skagit Mainstem fall*:** Data are total escapement estimates based on redd counts from the mainstem Skagit between the town of Sedro Woolley and the mouth of the Sauk River and in Finney and Day creeks. Three fixed wing aerial surveys are conducted from RM 15.6 to RM 67.1. There is a turbidity problem downstream of the Sauk, which questions the assumption of old surveys of 100% visibility. AUC estimates for three reaches using Sept 15 as start date on lower reach and Sept 1 for upper two reaches. End dates are December 1 for lower and middle reach and Nov 15 for upper reach. The old method used Sept 1 - Dec 1 for all reaches. Tributary census is conducted in Finney, Johnson, Jackson creeks.

Upper Skagit Mainstem/Tributaries :This stock was formerly known as Upper Skagit Mainstem/Tribs summer chinook. In the 2002 SaSI revision, the run-timing designation ("summer") has been dropped from most Puget Sound chinook stock names because timing designations have been applied inconsistently to Puget Sound chinook stocks. Total escapement estimates are based on redd counts from the mouth of the Sauk River to Newhalem, the lower Cascade River (RM 0.0 to 6.5) and in Illabot, Diobsud, Bacon, Falls and Goodell creeks. Surveys include three helicopter flights of upper mainstem, plus two helicopter flights and three ground surveys on the lower Cascade (RM 0.0 – 0.9), using Aug 15 to Nov 1 as AUC period (previous assumption has been Nov 8).

***Lower Sauk (fall*)**: Total escapement estimates are based on redd counts from the mouth of the Sauk upstream to the town of Darrington (RM 0.0 to 21.1). Aerial counts below mouth of Suiattle are not conducted due to turbidity. This sediment concentration is believed to inhibit spawning downstream, and past estimates assumed 22% of redds occur below RM 13.2. However, a simulation based on 1996 flights suggested that the majority of fish spawn below RM 13.2. Three flights are made above confluence (RM 13.2 – 21.1 Darrington Br.), with foot surveys of Dan Creek slough, which is now part of the mainstem. The estimate is a redd census above RM 13.2 plus assumed number downstream plus tributary counts times 2.5 fish per female.

Upper Sauk spring: Total escapement estimate is based on redd counts from the town of Darrington up to the forks (RM 21.2 to 39.7), in the North Fork Sauk from the mouth upstream to the falls and in the South Fork Sauk from the mouth to about RM 2.5. A new escapement methodology was developed beginning in 1994, using expanded cumulative redd counts, which are thought to represent the total spawner population better than peak live-plus-dead counts. (Rebecca Bernard, Skagit System Co-op, personal communication). The new estimates are not comparable to the estimates in the 1992 SASSI.

Surveys include five helicopter surveys and six ground surveys to monitor redds and count carcasses. Foot 'census' is thought to underestimate numbers due to width and depth of some reaches, and the fact that foot counts consistently yield lower numbers than aerial counts. Aerial-based AUC determined endpoints of Aug 15 and Nov 1. Redd life arbitrarily assumed to be mean of values derived from foot survey (22.9 days) and back-calculation from aerial AUC (37.5 days) = 30.2 days. Total escapement is based on 2.5 fish per redd. Other samples have show different female to male ratios such as the lower river test fishery (1.65) and carcass surveys (1.42).

Suiattle: Total escapement estimates are based on redd counts in Big, Tenas, Straight, Circle, Buck, Lime, Downey, Sulphur, Milk creeks. As mentioned above, new escapement methodology was developed beginning in 1994. Prior to 1994 four index areas (Big, Tenas, Buck, Sulphur) were used, averaging peak live-plud-dead count/mile from these areas. Since 1994 cumulative redd counts have been used. Index areas now include Big, Buck (excluded summer strays – early Oct), Circle, Downey, Lime, Milk, Straight, Sulphur and Tenas creeks along with Whitechuck River. The estimate assumed no redds in the turbid portion of the mainstem. Of all systems in this study, Siuattle thought to have highest potential for multiple redds per female. However, the present estimate remains based on 1 female per redd, or 2.5 fish per redd.

Upper Cascade springs: Total escapement estimate for this stock is based on redd counts from the mainstem Cascade River above RM 7.8, the lower reaches of the north and south forks of the

Cascade, and in Marble, Found, Kindy, and Sonny Boy creeks. As with the other early stock, new escapement methodology was developed beginning in 1992. Data for the estimates originated from five surveys conducted on foot and two helicopter flights (RM 7.8 – 18.6). Redds are multiplied by 2.5 fish per redd.

Stillaguamish: (Ground and aerial surveys, redd census using AUC (NF) and peak counts (SF))

Smith and Castle 1994 mentioned that the Stillaguamish escapement estimate used the same method as Skagit (aerial survey calibrated by foot surveys of index reaches). One to three flights have been used, with assumed starting dates for redd visibility. Redd counts were summed at 21-day intervals to get cumulative total redds times 2.5 fish per redd. Studies began in 1998 to improve the accuracy and precision spawning estimates by testing redd life and the number of female per redd. Aerial surveys were increased as well as the foot surveys, and both were compared throughout the sampling period.

North Fork Stillaguamish summer: Escapement estimates are made using cumulative redd counts within the mainstem and North Fork derived by graphing visible redds versus survey date.Although there were some discrepancies between redd count on the foot versus floot surveys, Hahn (2001) concluded that the estimates of chinook redds and of female spawners were precise and accurate. Seventy-five percent of the redds were censused with surveys every three to five days; water remained low and clear during this time with little canopy overhang, and good estimates of redd life were made (20-day).

South Fork Stillaguamish fall Escapement estimates are based on peak redd counts multiplied by 2.5 fish/redd. Tributaries surveyed include Boulder, Squire and Jim creeks. Assumption include: zero redds below the confluence of the North and South forks, 2.5 fish per redd and 21-day redd life. Hahn et al. (2001) stated precision and accuracy of the fall chinook estimate was uncertain. The primary problem in the AUC method was due to the inability to measure redd life. Low redd density and poor visibility at times also attribute to this uncertainty.

Snohomish River: (Aerial and ground surveys, redd census using AUC; direct census for Sunset Falls, index on Sultan)

Skykomish This stock now includes Snohomish summer, Wallace Summer and Bridal Vail Creek fall chinook stocks as well as a portion of the Snohomish fall chinook stock. Spawning occurs throughout the mainstem Skykomish and Snohomish rivers, Wallace River, Bridal Vail Creek Sultan River, Elwell Creek and in the North and South Fork Skykomish including fish passed above Sunset Falls. Natural spawning also occurs in the Wallace River, but many of these spawners originate from the Wallace River Hatchery, located at the confluence of May Creek and Wallace River. Escapement estimates are derived using cumulative redd curves from aerial surveys in index area RM 20.5-49.6 on Skykomish mainstem and South Fork to Sunset Falls. Calculation uses 21-day intervals. Additional surveys are conducted on Wallace River using cumulative redd counts times 2.5 fish/redd and .95 (true redds). Estimate is based on mid-Sept visible redds / total escapement ratio in prior year. Added to this is the number of fish trucked above Sunset Falls.

Snoqualmie*:* The Snoqualmie stock is composed of Snohomish fall chinook, which spawn in the Snoqualmie River and its tributaries, including Tolt and Raging rivers and Tokul Creek. Spawning also takes place in Pilchuck and Sultan rivers. Spawn timing occurs from mid-September through October. Snoqualmie escapement is based on aerial survey of 10.1 miles of index out of 39.6 miles of river below Snoqualmie Falls, and calculated using area under the curve. Redd days are divided by 21-day redd life times 0.95 and 2.5 fish per redd. No expansion factor is used.

Both sets of estimates are intended to be total estimates although there are some small tributaries that are not surveyed nor included in the final estimate. However, it is considered to be less than five percent of the surveyed areas.

Cedar River: (Ground surveys, live counts using AUC)
Cedar River escapement is estimated using live counts, plotting counts versus survey dates and calculating the area under the curve. Counts are obtained from float surveys throughout the river length below the dam. Redds have been enumerated since 1999, and at some point redd counts may be used to produce escapement estimates.

North Tributaries: (Ground surveys, live counts in index areas using AUC):
Spawning ground index areas have been established in Bear and Cottage creeks. Since 1998 other portions of the Bear Creek watershed are also surveyed annually, but are not part of the index areas used for estimates. There is no expansion to unsurveyed areas in other north tributaries. Escapement for Bear and Cottage creeks is based on live counts and area under the curve methodology. The index areas are: Bear Ck--RM 1.3 to 8.8, Cottage Lake Ck.-- RM 0-2.3.

Issaquah Creek: (Ground surveys, carcass and live fish counts using AUC):
This watershed is not believed to have historically supported a sustainable population of chinook and is classified as a Category 3 system. Returns to Issaquah Creek are believed to be entirely the result of hatchery production. Many more fish return beyond brood stock needs and the surplus is allowed to spawn naturally. Escapement estimates on Issaquah Creek are calculated as the sum of the individual carcass counts plus the live count from the last survey. For the East Fork, the estimate is based on live counts and area under the curve methodology.

Green River: (Aerial and ground surveys, redd index counts)
There are a considerable number of hatchery fish released from this watershed each year, and, as a result, the proportion of hatchery strays among natural spawners is high. Based upon CWT recoveries from carcasses sampled on the spawning grounds, the estimated annual proportion of hatchery strays averages about 60 percent, and ranges from about 25 to over 90 percent of the total natural spawners.

The standard method used to estimate the annual natural spawning escapement in the system employs the use of a single 1.6 mile index reach (River Mile 41.4 to 43.0) where individual redds are counted and marked weekly by raft to obtain a season cumulative redd count. Concurrent weekly aerial counts of visible redds are made in all reaches (including the index reach) from RM 29.7 to 47.0. At the end of the spawning season, the highest (peak) weekly aerial count of visible redds in the index reach is compared to the cumulative total of redds in the index reach, and an adjustment factor is derived. The peak weekly aerial count from non-index reaches is adjusted by this factor, and an estimate of cumulative redds is obtained for the reaches surveyed only by air. This estimate, when combined with the cumulative redds in the index, yields the total estimated redds for the surveyed portion of the mainstem Green.

An expansion factor of 2.6 is then applied to the surveyed mainstem redds to estimate the total redds for the entire system, including tributaries. This expansion factor was derived by Ames and Phinney (1977) after comparing their estimates of escapement in the surveyed reaches in 1976 and 1977 to estimates of total escapement in the system obtained from independent mark-recapture studies conducted by the Muckleshoot Tribe and the U.S. Fish and Wildlife Service in those years. Total system redds are multiplied by 2.5 fish/redd to convert system redds to the escapement estimate of individual chinook.

Beginning in 1999, funding originating from the Pacific Salmon Commission has been directed at improving spawning estimates on the Green River. Objectives have included estimating population size using live mark and recapture, developing new redd index expansion, comparing area under the curve method, testing chinook redd visibility, estimating number and proportion of hatchery-origin chinook and age composition. This work continues through 2002.

Puyallup (fall): Ground surveys, cumulative redd counts (even years), AUC (odd years)

With the large hatchery releases into Puyallup River, it is likely that some unquantified proportion of natural spawning fish are hatchery origin. Thus the extent of natural sustainability is unknown. Puyallup basin hatchery chinook production is currently 100% adipose marked, which will help determine natural production levels and stock status.

Annual spawning ground surveys are reliable in the South Prairie Creek system (considered to be the most productive portion of the watershed) and in the mainstem tributaries, where fish and redds are observable. In other spawning areas (Puyallup mainstem and the Carbon River), glacial flour reduces visibility and prevents credible observation in most years. Historically, estimates were based on the 1975 and 1976 tagging studies, which used South Prairie Creek index peak live count multiplied by a factor of 37 to estimate total escapement. However, there has been a lack of confidence in this method, and beginning in 1999 estimates were calculated using a different method. This involved using South Prairie Creek cumulative redd counts during even years, while odd years would be based on area under the curve (AUC) using live counts. This difference was needed to adjust for the presence of pink salmon during odd years. Redd based estimates can also be calculated for the following Puyallup River tributaries: Fennel, Canyon, Kapowsin and Clarks creeks. In 2000, the tributary escapement ratio was applied to the mainstem Puyallup to estimate Year 2000 spawners. For the Carbon, in 1999 water conditions were conducive for good redd counts within some river reaches. Reaches with incomplete data were expanded using South Prairie Creek spawn timing-curve. In 2000, river conditions did not allow counts, and an indirect estimate of relative returns between 1999 and 2000 were used. Although this method is considered an improvement over the old method, escapement estimates previous to 1999 are not comparable to recent year estimates. .

White River Spring Chinook: (Trap census over dam, no estimate below dam)
Although there has been a significant increase in the number of chinook returning to the White River, it is largely due to the successful hatchery program. There is no evidence that the population has re-established itself naturally or achieved self-sustainability. Improvements have been made in the upper watershed related to habitat and fish passage, but those actions have not been necessarily credited with the increased abundance levels. There is also concern that the increased numbers of chinook are, at least partially, attributable to a fall stock that has become more predominate. Recent year spawning information shows that the fall run of chinook has increased in abundance. However there has been no estimate of total escapement. Those fish passed over the dam are counted, but fish spawning below the dam are not surveyed. However, chinook are enumerated in Boise Creek and the lower White River below Buckley Trap.

Nisqually: (Ground surveys, fish and redd index, peak counts)
Given that a large number of hatchery fish are released into this watershed, it is believed that a significant proportion of natural spawners are hatchery strays, but no direct information is

available to verify this. This system is difficult to survey since it is glacial fed. Abundance estimates are fair at best; stock origin information is poor.

Since 2000, all hatchery chinook have been marked, making it possible to determine the hatchery/wild composition of natural chinook spawners in the future. Spawning surveys are conducted on Nisqually mainstem from RM 21.8 to 26.2 and on Mashel from RM 0 to 3.2 to obtain peak redd count on the Nisqually and peak fish count of the Mashel. An expansion factor of 2.5 is used for the Nisqually relative to the Mashel, followed by a 6.82 expansion for both systems. Ohop Creek (RM 4.6-6.3) has also been surveyed for cumulative redd counts and carcass sampling the last two years (2001 and 2002).

Skokomish: (Ground counts, fish and cumulative redd counts in index areas)

As described in the current co-managers' Puget Sound Comprehensive Chinook Management Plan, the immediate and short-term objective is to manage Skokomish River chinook salmon as a composite population, comprised of naturally and artificially produced chinook. Hence, natural production is dependent on the chinook hatchery program to partly support natural production. Based on the sampling of adult chinook carcasses on the natural spawning grounds, chinook released from the George Adams Hatchery on Purdy Creek or from Endicott Ponds on the lower Skokomish River stray in substantial numbers onto Skokomish system natural spawning areas. Hatchery chinook releases are not currently mass-marked, but they are now double-index tag groups. In addition, genetic (allozyme) analysis results to date suggest that there is no significant genetic differentiation between Skokomish natural spawners and George Adams hatchery chinook (A. Marshall, WDFW memo dated May 31, 2000).

Chinook spawning takes place in the mainstem Skokomish River up to the confluence with the South and North Forks at RM 9, in the South Fork (primarily up to RM 5.5), and in the North Fork from RM 9 to 17 (where Cushman Dam blocks further access). Natural escapement estimates are based on counts of chinook redds in index areas in the mainstem Skokomish (RM 2.2 to 9.0), North Fork (R.M. 9.0 to 12.7), and South Fork (R.M. 0 to 2.2). In addition, escapement estimates are made for tributaries including Purdy Creek, Vance Creek, and Hunter Creek.

Since 1991, live and dead adults, along with visible redds were counted in Skokomish River index areas using foot and raft surveys (Smith and Castle 1994). Surveys were done every 10 to 14 days from late August through October. In one index area of the Skokomish (RM 8 to 9), new redds were flagged and visible redds were counted each survey, cumulative redds for the season was determined, and escapement for this index was estimated as cumulative redds times 2.5 adults/redd. For each remaining section, the peak count of visible redds in a section was multiplied by the ratio in the RM 8 to 9 index of cumulative redds :: number of visible redds at peak which was then multiplied by 2.5 adults/redd to estimate escapement for a section.

Since 1991, escapements to Hunter Creek and Vance Creek were estimated using the spawners/mile for RM 0.8 to 2.2 in the South Fork and the available habitat in each creek (i.e., 1.7 miles for Hunter Creek and 0.5 miles for Vance Creek). Escapements to Purdy Creek were based on the counts of live chinook downstream of George Adams Hatchery (Smith and Castle 1994).

To improve escapement estimates, (1) surveys were scheduled every 7 to 10 days beginning in 1998, (2) new redds and visible redds were counted each survey in more sections of the mainstem Skokomish (RM 5.3 to 6.3, 6.3 to 8, and 8 to 9) and South Fork (RM 0 to 2.2) beginning in 2000, (3) a helicopter flight was made most seasons during peak spawning to count redds and adult chinook in the South Fork upstream of RM 2.2, and (4) foot surveys were made in Hunter and Vance creeks to spot check chinook abundance and better determine escapement there.

Coded-wire tag (CWT) data and age and sex composition data have been routinely collected for chinook returning to George Adams Hatchery. More intensive sampling has been done since 1998 on the natural spawning grounds; however, more frequent sampling would improve sample sizes. The mass marking of chinook released from the hatcheries would improve the ability to determine both the level of straying by hatchery chinook and natural chinook productivity in the Skokomish River system.

Mid-Hood Canal: (Ground surveys, live peak fish counts in index areas)
The Mid Hood Canal management unit is comprised of chinook populations of the Hamma Hamma, Duckabush, and Dosewallips watersheds. All of these populations are at low abundance. As described in Smith and Castle (1994), chinook escapement for the Hamma Hamma, Duckabush and Dosewallips rivers was estimated as (peak count of live fish in each stream) x (escapement for Skokomish RM 8-9 index / peak live count for Skokomish RM 8-9 index) x (available habitat / surveyed habitat in each stream). This method was used since few chinook adults or redds were counted and chinook spawner surveys were limited to the lower reaches of each stream.

In the Hamma Hamma River, most of the chinook spawning area is currently being surveyed. A cooperative supplementation program was initiated in 1995 to rebuild chinook abundance. Since 1998, abundance has increased and escapement was estimated from counts of live chinook using the area-under-the curve (AUC) method.

In the Dosewallips and Duckabush rivers, the reaches surveyed are spawning and transit areas, but do not include all spawning areas. Upper reaches have been occasionally surveyed in the Dosewallips and Duckabush since 1998, but few adults have been observed. It has been possible to count chinook redds in the upper Dosewallips and Duckabush river reaches (especially in years without pink salmon). However, counts of live chinook are conducted on in the lower reaches since chinook redds cannot be identified due to concurrent spawning of summer chum salmon. Current escapement estimates are derived from counts of live chinook adults and chinook redds.

It has been assumed that many of the naturally-spawning chinook in the Hamma Hamma, Duckabush, and Dosewallips rivers have, in recent years, been due to straying of hatchery spawners as well as adult returns from hatchery fry released into these rivers. However, sampling for CWTs and age information indicate that few hatchery adults have been recovered. The mass marking of chinook released from the hatcheries would improve the ability to determine both the level of straying by hatchery chinook and natural chinook productivity in these rivers. In addition, a smolt trap was installed on the Hamma Hamma River in 2002 with one objective being to assess natural chinook productivity.

Priorities for Improving Escapement Estimation

To identify priorities for improving escapement estimates, recovery goals and objectives must be clearly stated. The basic template should refer to the ESU as a whole rather than individual stocks. Since recovery can represent any number of different outcomes, the process must be iterative and based on the outcomes of strategies that may be experimental. However, regardless of the specific results, the basic guidelines of a healthy ESU can be stated.

Populations have been classified according to the historical presence of chinook and the present status of native (indigenous) stocks. Category 1 watersheds are those that possess indigenous stocks; Category 2 are those that once possessed sustainable indigenous chinook populations but they have either been lost or no longer sustainable; Category 3 watersheds are those that historically never possessed sustainable populations of chinook.

Category 1 watersheds would be of high priority, as would those in Category 2. Within the first category, highest priority would go to those stocks that are at critical abundance levels and where escapement estimates are considered unreliable (imprecise and inaccurate). Perhaps the single stock that best fits this would be the South Fork Nooksack stock. Another concern would be White River spring chinook. Both of these populations have been recently infiltrated with other stocks, which is causing some concern regarding genetic integrity in the direction of recovery. Cedar River chinook is another population that needs close scrutiny. Although the escapement greatly improved in 2001, previous years returns were in dramatic decline, with the 2000 estimate of 120 adults. For other systems like the Skagit, Stillaguamish and Snohomish, as mentioned, additional studies have been underway to test some of the major assumptions, and it is believed that this will improve accuracy and precision of current methods. In the Green River , a mark and recapture estimation method has provided significantly different results than the traditional method. Analysis of the differing escapement estimates for 2001 and 2002 will help determine the method used in future An important component on the Green is determining stray rates. Since all hatchery fish are now been marked before release, the estimation natural-origin recruits and habitat productivity will improve.

As important as accurate escapement estimates is the need to identify hatchery stray from natural-origin recruits. This is especially true for Category 2 watersheds where past management direction has focused on hatchery production at the expense of natural sustainability. For Nisqually and Puyallup chinook, marking of hatchery fish and subsequent evaluation of natural production must be maintained as an important objective. One difficulty common to both of these systems is inability to survey mainstem spawning reaches because of glacial turbidity. Experimental application of the “change in ratio” method, which estimates total natural escapement and the proportion of natural-orogin adults, began in 2001

Past management for Skokomish River has also been hatchery-oriented, and to date there has been no attempt to determine stray rates and natural productivity. It would also be useful to test the assumptions for Vance and Hunter creeks, which are estimated indirectly. A production study on the Hamma Hamma is currently underway that involves intensive spawner surveys as well as smolt out-migration

Appendix F. Selective Effects of Fishing

Introduction

The direct juvenescence or 'fishing-down' effect (shift toward younger ages and smaller fish) that must result from size-selective fishery harvest has been recognized for nearly 100 years (see Ricker's (1975, p. 260) discussion of Baranov's 1918 paper). But it seems only very recently that the possible genetic impacts of selective fisheries on fish populations have generated widespread concern among fishery scientists and ecologists. For example, Conover and Munch (2002) published a highly visible article noting that "current models and management plans for sustainable yield ignore the Darwinian consequences of selective harvest." In a similar vein, in the leading European quantitative fisheries journal, Law (2000) noted that "Fisheries managers should be alert to the evolutionary changes caused by fishing, because such changes are likely to be hard to reverse ...." Although this general concern may appear to be very recent, astute fisheries scientists have long speculated concerning the possible genetic impacts of selective fisheries on chinook salmon populations. Indeed, nearly 100 years ago Rutter (1904) expressed concern that gillnet fisheries in California's Sacramento River, selective for larger and older chinook salmon, might generate long-term selection toward age two male jacks and small adults due to selection against survival and reproduction of larger and older adults. More recently, but still a full thirty years before the recent Conover and Munch paper, Ricker (1980, 1981) published extremely provocative reports concerning the possibility that size-selective fisheries on chinook salmon might, in the long-term, result in age composition of chinook salmon populations that would be composed almost exclusively by age 2 male jacks and age 3 adult females. Thus, it is accurate to state that the potential long-term consequences of selective fisheries on chinook salmon have been recognized for almost 100 years. Yet, it is also accurate to state that fishery management plans have not yet attempted to address these potential long-term consequences. In part this is because much of the evidence for selective effects of fishing (e.g., change in the size or age composition of catch or spawners) is circumstantial, and is strongly influenced by other factors such as marine productivity.

Selective Fisheries

It is important to define more explicitly and carefully a number of terms and concepts. In particular, it is critical to define carefully just what one means by "selective fishing", to distinguish among the kinds of selective fishing to which chinook salmon populations may be exposed, and finally to distinguish between the rather immediate and direct fishing-down consequences of selective fishing and the potential long-term genetic consequences of selective fishing.

Generally, a fishery is characterized as selective whenever different components of a population of fish are exploited at different rates in recreational or commercial fisheries. Traditionally, most fisheries have been sex-selective (e.g., only males may be harvested in the commercial fishery for Dungeness crabs, Cancer magister) and/or size-selective (e.g., groundfish fisheries in which regulated codend mesh size theoretically allows small fish to escape whereas large fish are trapped in the codend; or the minimum size limit for male Dungeness crabs). In fisheries for chinook salmon, there are no sex-selective fisheries of which we are aware, but most fisheries are size-selective. For example, ocean commercial and recreational fisheries typically have minimum size limits, thereby generating greater exploitation rates on larger and older fish than on younger and smaller fish. Terminal gillnet fisheries typically select for fish that are within an intermediate size range that usually dominates runs. Often, such terminal gillnet selection is almost *"age-selective"* fishing. For example, in California's Klamath River the Native American gillnet fishery uses a mesh size that deliberately targets age 4 fish; most age 3 and younger fish pass through nets whereas many age 5 fish are too large to be caught by gill nets.

The above examples of selective fisheries apply within individuals populations of fish. Other types of selective fisheries operate in the peculiar context of ocean and freshwater fisheries for salmon. First, in both ocean and terminal fisheries, salmon managers must grapple with the so-called "mixed stock" harvest problem (see, e.g., Bevan 1987). In the ocean, a large number of salmon stocks originating from different river basins may be vulnerable to fishing at similar times and locations and may therefore suffer similar ocean exploitation rates. Optimal harvest policies would instead call for application of *stock-specific* exploitation rates that depend on the underlying stock productivity which, of course, must vary among salmon stocks. For a variety of reasons, the time, location or physical attributes of fish that may be caught in ocean fisheries may be deliberately structured so as to be *stock-selective.* For example, ocean fisheries off California and Oregon are structured so that the overall ocean exploitation rate on Klamath River fall chinook is quite low (to allow for terminal harvest in recreational and Indian fisheries), whereas ocean exploitation rates for chinook salmon originating from the Sacramento River (with no Indian terminal fisheries) are much higher. Mixed-stock fisheries are often constrained so that the exploitation rate appropriate to commingled weak stocks is not exceeded.

Similar, but often unintentional, *stock-selective* fisheries may take place in freshwater as a consequence of regulations. For example, in a large river system with a large number of distinct chinook salmon stocks, each with its own distinct river entry pattern, open and closed periods for fisheries may result in differential exploitation rates being applied to different stocks. If harvest in not allowed until a substantial number of fish have escaped to spawn, then it seems inevitable that exploitation rates are lower for those stocks that enter earlier as compared to those stocks that enter when fisheries are open. The most extreme examples of stock-selective fisheries for chinook salmon are those that call for the release of all fish with adipose fins present clips, whereas a certain number of fish (specified by bag or possession limits) may be retained so long as adipose fins are not present. These policies are deliberately designed to produce, at least in theory, greater exploitation rates for hatchery fish (often marked) than for wild fish (typically unmarked). Finally, ocean fisheries may also be *species-selective* as, for example, results when coho salmon must be released if caught whereas chinook salmon may be retained.

The "fishing-down" process and long-term genetic selection

The "theory of a fishery", as first advanced by Baranov (1918; see Ricker 1978), recognized *fi*shing-down as an inevitable consequence of size-selective fishing when only fish above a certain minimum size limit were legal targets of exploitation. The direct cumulative effect of removing larger and older fish is to shift the age structure of a fish population toward younger and smaller fish. Although these historical results were obtained for typical iteroparous (repeat spawning) teleost fish, similar results obtain for a semelparous (single spawning) chinook salmon population subjected to a size-selective ocean fishery (Hankin and Healey 1986). In classical fisheries population models, growth rates of fish are fixed and independent of population density, and fishing down-effects are therefore predictable and reversible. The extent to which genotypes of a populations are changed by selective fishing must be related to the harvest rates imposed by these fisheries and their duration. If selective fishing were eliminated, then one would expect the age and size structure of a population to return to exactly the state that existed prior to introduction of size-selective fishing. (Possible to make a general statement that selective effect is dependent on the harvest or exploitation rate, so that reducing the rate would reduce the effect?)

Concerns regarding the potential genetic impact of fishing have arisen in part because minimum size limits theoretically result in differential exploitation rates being applied to *fast-growing* as opposed to *slow-growing* fish. If growth rates of fish were genetically inherited and if realized size at age were highly correlated with genetically inherited growth rates, then the greater mortality on fast-growing fish and resulting dominance of slow-growing fish among spawners would, over the long-term, result in selection for slow-growing fish.. If such fishery-induced genetic changes took place, then a population would not return to its original state if fishing were eliminated entirely. Instead, if fishing were relaxed or eliminated slow-growing fish could become the norm. Exactly this kind of selective fishery result was documented, under a controlled laboratory setting, in *Menidia menidia* by Conover and Munch (2002). These laboratory results may or may not be relevant to "real" fish populations and fisheries, however.

Long-term genetic changes due to selective fisheries

Size-Selective Fisheries.

In ocean fisheries for chinook salmon, minimum commercial size limits typically mean that only a fraction of the age 3 adults from a given stock are vulnerable to commercial capture. If those age 3 fish that are above the legal size limit were genetically programmed "fast-growing" fish, then one might imagine that selective fisheries would be generating long-term selection for reduced growth rates, as described above.

Possible fishery-induced selection for reduced growth rates would, however, be complicated by several factors in chinook salmon fisheries. First, the actual size that a salmon reaches at a particular age may not be highly correlated with a genetically determined "growth rate" for several reasons. The realized size of a fish at a given age must reflect unknown interactions between inherent growth rate, variability in supply and quality of food, and variability in environment (especially variability in water temperature). Actual size at age may not, in general, be highly correlated with some underlying "growth rate"

Second, long-term genetic selection due to size-selective ocean fisheries may be stronger for (reduced) age at maturity than for growth rate. As shown by Hankin et al. (1993) and others, age at maturity is an inherited trait in chinook salmon. Generally, older aged parents will produce progeny that mature at older ages, whereas younger aged parents will produce progeny that mature at younger ages. This kind of effect is especially pronounced for age 2 males (jacks). If jacks are used as parents, there will be a strong tendency for male progeny to also mature as jacks. Therefore, if younger aged salmon spawned randomly on the spawning grounds, then size-selective fisheries for chinook might select for earlier age at maturity.

Third, for chinook salmon (see Hankin 1993 and references therein) there is substantial evidence that age at maturity depend in part on size at age. For a fixed age, say age 2, fish that are smaller are less likely to mature at that age than are fish that are larger. Through this interaction between size at age and maturity, size-selective fisheries, through removal of fish that are larger at age, might instead select for fish that mature at later ages!.

Finally, spawning behavior of chinook salmon may to some extent alleviate the kind of long-term genetic shift toward younger age at maturity that might be expected to result from size-selective fisheries. Baxter (1991) found that larger and older chinook salmon, especially males, enjoyed greater reproductive success on spawning grounds that younger and smaller males. Thus, even if size-selective fisheries generated substantial shifts toward younger aged spawners, this kind of size-dependent mating success might at least partially buffer against such fishery-induced shifts to younger ages.

Ricker (1976) and Henry (1972) calculated the loss in potential yield that results from size-selective ocean fishery capture of immature and maturing chinook salmon as compared to terminal fishery capture of mature fish only. Calculated losses range from 30-50% of total yield. In two important reports, Ricker (1980, 1981) examined changes in average size of chinook salmon (and other Pacific salmon species) and presented a number of plausible hypotheses that might explain the apparent decline in average size of harvested chinook salmon. Included among these hypotheses was the possibility that size-selective fisheries had selected for long-term genetic changes in age at maturity. Hankin and Healey (1986) presented analysis of an age-structured Ricker stock-recruitment model and, among other things, attempted to calculate the maximum possible changes in mean age of spawning populations that could be explained as a direct consequence of *fishing-down* effects. They contrasted these calculated values with observed changes in mean ages in some populations. Hard (in press) used age-structured quantitative genetics models to assess the possible long-term genetic effects of size-selective fishing on chinook salmon populations

Stock-Selective Fisheries.

There seems little doubt that certain stock-selective fisheries must have long-term genetic effects on chinook salmon populations. Suppose, for example, that a terminal fishery were regulated by allowing harvest to take place only after a certain number of fish were estimated to have escaped to spawn. In that case, the fishery-related mortality rate would be much less for fish (or stock type) in the early part of the run than for fish (or stock type) in the late part of the run. Because run timing (stock type) is known to be an inherited trait, such fishery harvest policy should, in the long-term, unintentionally select for early-returning fish (or for a particular stock type). (See Nicholas and Hankin 1988 for examples of this phenomenon in a hatchery setting.)

Lawson and Sampson (1986) examined the potential impacts of stock-selective ocean fisheries on non-catch mortalities of species (e.g., coho vs chinook) or stock types (e.g., hatchery vs wild) that may not be landed in stock-selective fisheries. Such prohibited species or stock types would be captured but then released. Ricker (1958) presented modeling results showing that total yields in mixed stock ocean fisheries were considerably less than those that could be achieved if stocks could be managed and harvested separately. (This same theme was later noted by Hilborn (1985).
Evidence for Inheritance of Traits

Donaldson and Menasveta (1961) provide evidence that growth rate, survival rate, disease resistance and temperature tolerance are all traits which are subject to deliberate artificial selection in a hatchery setting. Ricker (1972) provides an extensive review of older studies that provide evidence that age at maturity and other traits are inherited trait, but also presents information on environmental influences on these same traits. By contrasting the rates of production of jacks in two chinook salmon stocks reared in a hatchery environment under controlled conditions, Hard et al. (1985) provide evidence that the tendency to produce age 2 male jacks is an inherited trait. Hankin et al. (1993) summarize evidence that age at maturity (all ages) is an inherited trait based on age-specific mating experiments carried out at Oregon's Elk River Hatchery. These analyses attempt to account for the fishery-induced biases that might result from differential mortality on older-maturing as compared to younger-maturing fish. Both Hankin (1993) and Hard et al. (1985) provide evidence that jacking rate does not depend on growth rate alone, but size nevertheless has an important effect (Hankin 1993, Silverstein et al. 1998), with faster-growing fish (at age) generally maturing earlier. If growth rates are sufficiently enhanced in hatchery environments, then mature yearling chinook can apparently be produced (Clark and Blackbird 1994). Heath et al. (1994a) carried out known matings designed to assess inheritance of jacking rate with male parents that were jacks or non-jacks. They found a significant sire age effect, but did not find that jacking was related to growth rate. Heath et al. (1994b) used DNA probes to show that allele distributions differed between maturing and immature chinook salmon of the same age and stock. Heath et al. (1999) presented experimental evidence for a maternal effect (via female egg size) on offspring size during early life (first several months, but thereafter no effect could be detected.

Behavior and Life History

Numerous papers have stressed the possible importance of large size in naturally spawning populations of chinook salmon. Baxter (1991) observed spawning behavior of fall chinook salmon in northern California and found that larger-sized males enjoyed much greater spawning success than smaller-sized males. Females exhibited behaviors suggesting their preference for mates that exceeded their size. Berejikian et al. (2000) found that there was a greater amount of time between successive nests for females paired with small males than with large males and suggested that this behavior might be an important means of achieving mate choice (i.e., finding a preferred larger-sized male. Healey and Heard (1984) examined variation in fecundity of chinook salmon among many chinook populations. Using life history models, they found that age-specific increases in fecundity would not "justify" the old ages at which many chinook salmon spawn. Presumably, there are some additional important benefits of large size and late age at maturation.

Egg size of chinook salmon varies across populations and within populations. Within a given population, egg sizes are generally larger for larger and older fish than for smaller and younger fish. Silver stein and Hershberger (1992) found that females with larger egg sizes were more likely to produce progeny that matured precociously. Healey (2001) reported that stream type chinook salmon, that typically spend more than a full year in freshwater prior to ocean entry, have smaller eggs and generally make a smaller reproductive investment than do ocean type chinook salmon, that typically enter saltwater during their first year of life.

Detecting Selective Effects of Fishing

Ricker (1980, 1981), previously mentioned, presented evidence for declines in average size and age of Pacific salmon, including chinook salmon, and listed a number of possible explanations for these declines. More recently, Bigler et al. (1996) found a decreasing average body size in 45 of 47 salmon populations in the Northern Pacific. They found that body size was inversely related to population abundance and speculated that enhancement programs during the 1980s and 1990s have increased population sizes but reduced growth rates due to competition for food in the ocean. Clearly, these kinds of causes could result in the same kinds of reductions in size at age as might be caused by long-term genetic selection against fast-growing fish.

There is substantial cause for concern regarding long-term genetic effects of both stock-selective and size-selective fishing on chinook salmon stocks. Of these two kinds of selective fisheries, the effects of stock-selective fisheries seem most clear and most easily minimized. If terminal fisheries consistently result in substantial removal of specific temporal components of a stock's spawning run, then it seems inevitable that there will be strong selection against perpetuation of these temporal components. This kind of effect would seem avoidable by regulating open and closed terminal fishing periods so that continuous fishing periods are always short (say, no more than 3 days duration), and so that the duration of fishing periods is always short compared to the duration of closed periods. Terminal net fisheries in Puget Sound are scheduled in this manner – pulsed openings scheduled over the duration of the run.

It seems clear that size-selective ocean fishing on immature chinook salmon can shift the age distribution of adult spawners toward smaller and younger fish. A long-term genetic shift to younger aged spawners would result (1) *If* chinook salmon mated randomly, without regard to age, on spawning grounds, and (2) *if* age at maturity were independent of growth rate. However, (3) larger and older male chinook salmon (and possibly females) generally have greater mating success than smaller and younger male chinook salmon (and possibly females); (4) fast-growing chinook salmon tend to mature at younger ages than slow-growing chinook salmon, but are selected *against* in size-selective ocean fisheries; and (5) size at age may have only a weak correlation with some inherent genetically inherited "growth rate". Together, items (3)-(5) may reverse or ameliorate the kinds of long-term genetic effects that one might expect if items (1) and (2) were valid. Most of these potential long-term genetic effects again seem avoidable. If ocean fishing for chinook salmon were prohibited by regulation (see Ricker 1976 for one example calculation of the improved yield that could result!), and if all sizes and ages of chinook salmon were equally vulnerable to terminal fisheries (e.g., by fishing gill nets of variable mesh sizes in Indian fisheries), then it would seem unlikely to expect any long-term genetic changes in age at maturity of chinook salmon stocks.

The absence of explicit consideration of possible long-term genetic impacts of selective fishing in management plans for chinook salmon stocks probably reflects the ambiguity and complexity of potential impacts for this species. No chinook salmon stocks have yet been reduced to the extreme scenario (only jacks and age 3 females) sketched by Ricker (1980, 1981), but it is also certainly true that one would be hard-pressed to find a stock of chinook salmon for which one might claim that the largest fish seen today are as large as those seen 100 years ago. Of course, given classical fishing-down effect that results from ocean fisheries, one would not expect to see these large fish even if there were no long-term genetic changes in age or size at maturity.

APPENDIX B

Puget Sound Chinook Population Information

APPENDIX B – ADDITIONAL INFORMATION ON THE BIOLOGICAL AND HABITAT CHARACTERISTICS OF PUGET SOUND CHINOOK POPULATIONS, THEIR DISTRIBUTION, ASSOCIATED HATCHERY PROGRAMS

This technical appendix presents additional data referenced in Section 3, Affected Environment. Tables B-1 through B-3 provide more detailed descriptions of chinook salmon populations, and their riparian habitats, including age composition, stock origin, spawning and juvenile migration timing, spawning location, and barriers to migration. Table B-4 presents detailed information on hatchery production of chinook salmon in Puget Sound basins.

Table B-5 is adapted from the Fishery Regulation Assessment Model (FRAM), the basis for estimates of fishery exploitation on chinook salmon populations.

FRAM predicts point estimates for fishery impacts by stock, for specific time periods and age classes. The model simulates chinook salmon fisheries over the course of one year. Fishery harvest rates and stock exploitation rates are predicted using “base period” coded-wire tag recovery data on chinook harvest by fishery. Chinook FRAM currently includes 32 stocks, representing Puget Sound, Columbia River, Oregon and Canadian chinook salmon. The model includes fisheries operating in southeast Alaska, Canada, Puget Sound, and off the coasts of Washington, Oregon, and California. Only Puget Sound chinook salmon stocks are presented in the summary table in this appendix.

Table B-6 summarizes data used to show the distribution of fishery mortality on Puget Sound chinook salmon populations. As discussed in Section 3, these impacts are estimated from recoveries of coded-wire tagged indicator stocks that are released from numerous locations throughout Puget Sound.

Appendix Table B-1a. Key life history traits of chinook salmon in the northern Puget Sound area of the affected environment.

RMP Management Unit	Population	Recovery Category	Race	Origin	Production Type	Juvenile Migration	Age of Smolts (% age 0 or 1)	Age @ Spawning (% return of given age)					Up-Stream Migration Timing (month. week)	Spawn Timing (month. week)
								1	2	3	4	5		
Nooksack Early	NF Nooksack	1	Sp	N	C		≥90	≤10	<1	4	75	20	3.4-7.3	7.4-9.4
	SF Nooksack	1	Sp	N	W		≤69	≥31	1	10	61	28	3.4-7.4	8.1-10.1
Skagit									10	73	2			
Spring	Upper Sauk	1	Sp	N	W	May-June	55	45					4.2-7.1	7.2-9.4
	Suiattle Spr	1	Sp	N	W	May -June	18-53	47-82	1	8	43	47	4.2-7.1	7.2-9.4
	Upper Cascade	1	Sp	N	W	May- June							4.2-7.1	7.2-9.4
Skagit Summer / Fall	Lower Sauk	1	Su	N	W								6.2-8.1	8.2-10.2
	Upper Skagit MS / Tribs.	1	Su	N	W								6.1-8.1	8.2-10.2
	Lower Skagit MS / Tribs.	1	Fa	N	W								7.1-9.1	9.2-10.4
Stillaguamish Summer / Fall	Stillaguamish	1	Su	N	C	Mar-June	97	3	4	30	59	7	6.1-8.1	8.2-10.1
	Stillaguamish	1	Fa	Unk.	W								8.4	9.1-10.4
Snohomish Summer / Fall	Snohomish	1	1	Su-Fa	N	W	Apr-July						8.1-9.1	9.2-11.2
	Wallace R.	2	2	Su - Fa	M	C								
	Bridal Veil Cr.	1	1	Fa	N	W	Apr-July							

Abbreviations: **Population** NF = North Fork SF = South Fork **Recovery Category** 1= Genetically unique indigenous population present. 2 = Indigenous population no longer present but natural production possible. 3. No historically self-sustaining natural population **Race** Sp = Spring Su = Summer Fa = Fall **Origin** N = Natural C = Composite of Hatchery and Natural. **Production Type** W = Wild C = Composite of Hatchery and Wild **Status** C= Critical D = Depressed H = Healthy U = Unknown

Sources: **Stock Origin:** Washington Department of Fisheries, 1993. **Smolt Migration:**, Appendix A Myers et al. 1998. Age at Smolting, Appendix A Myers et al.; Age at Maturation, Appendix B Myers et al. 1998; **Fresh Water Entry:** Table 1 Myers et al. 1998.; **Spawn Timing:** Table 1 Myers et al. 1998 **Spawning Location / Description:** Puget Sound Indian Tribes and Washington Department of Fish and Wildlife, 2003; Washington Department of Fisheries, 1993. Note: Spawners have been transported above Sunset Falls, a natural barrier, since 1958.

Appendix Table B-2a. Factors limiting natural chinook production in Puget Sound watersheds.

Basin / Stock Group	Status	Habitat Factors Affecting Stock Status				
		Dams (River Mile Location / Miles Habitat Lost)	Riparian Habitat	Flow / Water Temp	Estuary Habitat	Hatchery Influence
Nooksack						
NF Nooksack Early	Critical		1		1	4
SF Nooksack Early	Critical		1, 2		1	
Skagit		RM 97 / Unknown				
Upper Skagit Summer	Healthy		1, 2		2	
Lower Skagit Fall	Depressed		2		2	2
Lower Sauk Summer	Depressed		1		2	3
Upper Sauk Spring	Healthy		1		2	2
Suiattle Spring	Depressed		1		2	
Upper Cascade Spring	Unknown				2	
Stillaguamish						
Stillaguamish Summer	Depressed		1, 2		2	4
Stillaguamish Fall	Depressed		1, 2		2	
Snohomish						
Snohomish Summer	Depressed	Sultan River RM 17 / 20	1, 2		1	
Wallace Summer / Fall	Healthy				1	1
Snohomish Fall	Depressed		1, 2		1	
Bridal Veil Creek Fall	Unknown		1, 2		1	

Notes	Sources
Dams: Location of Dam (Rivermile) / estimated miles of lost spawning habitat.	S.P. Cramer and Associates 1999.
Riparian Habitat: Riparian habitat affected by: Logging and associated road building including loss of large woody debris, siltation, and erosion 2. Diking and channel modification 3. Other land development practices and agriculture.	Pacific Fishery Management Council 1999. Puget Sound Indian Tribes and Washington Department of Fish and Wildlife 2003. Washington Department of Fisheries 1993.
Flow / Water Temperature: 1. Loss of habitat from water diversions, dewatering of spawning redds; 2. Elevated stream temperatures from low flows due to diversion or runoff modification.	Pacific Fishery Management Council 1999. Puget Sound Indian Tribes and Washington Department of Fish and Wildlife 2003. Washington Department of Fisheries 1993.
Estuary Habitat: Habitat loss or degradation due to: 1. port or industrial development 2. Agriculture, forestry, or urbanization.	Pacific Fishery Management Council 1999. Puget Sound Indian Tribes and Washington Department of Fish and Wildlife 2003. Washington Department of Fisheries 1993. S.P. Cramer and Associates 1999.
Hatchery Influence: 1. Production hatchery using out-of-basin stock; 2. Production hatchery using within-basin stock; 3. Supplementation hatchery or indicator stock program; 4. Supplementation hatchery essential for recovery.	Pacific Fishery Management Council 1999. Puget Sound Indian Tribes and Washington Department of Fish and Wildlife 2003. Washington Department of Fisheries 1993.

Appendix Table B-2b.Factors limiting natural chinook production in Puget Sound watersheds.

Basin / Stock Group	Status	Habitat Factors Affecting Stock Status				
		Dams (River Mile Location / Miles Habitat Lost)	Riparian Habitat	Flow / Water Temp	Estuary Habitat	Hatchery Influence
Puyallup						
White Spring	Critical	RM 23.4	1, 2, 3	1	1	4
White Summer / Fall	Unknown		1, 2, 3	1	1	
Puyallup Summer / Fall	Unknown	RM 41.7 / 10			1	1
Nisqually						
Nisqually Summer / Fall	Healthy	RM 26 / RM 43 / 30			1	1
South Sound						
South Sound Tributaries Summer / Fall	Healthy				1	1
Hood Canal						
Hood Canal Summer / Fall	Healthy		1,2,3			
Skokomish River		RM 21 / 13	1	1		1 (mixed origin)
Juan de Fuca Strait						
Dungeness Spring / Summer	Critical		1,2,3	1,2		4
Elwha / Morse Creek Summer / Fall	Healthy	RM 4.9 and 13.4 / 35 main and 35 tributaries	1	2		2

Notes	Sources
Dams: Location of Dam (Rivermile) / estimated miles of lost spawning habitat.	S.P. Cramer and Associates. 1999
Riparian Habitat: Riparian habitat affected by: Logging and associated road building including loss of large woody debris, siltation, and erosion 2. Diking and channel modification 3. Other land development practices and agriculture.	Pacific Fishery Management Council 1999. Puget Sound Indian Tribes and Washington Department of Fish and Wildlife 2003. Washington Department of Fisheries 1993.
Flow / Water Temperature: 1. Loss of habitat from water diversions, dewatering of spawning redds; 2. Elevated stream temperatures from low flows due to diversion or runoff modification.	Pacific Fishery Management Council 1999. Puget Sound Indian Tribes and Washington Department of Fish and Wildlife. 2003. Washington Department of Fisheries 1993.
Estuary Habitat: Habitat loss or degradation due to: 1. port or industrial development 2. Agriculture, forestry, or urbanization.	Pacific Fishery Management Council 1999. Puget Sound Indian Tribes and Washington Department of Fish and Wildlife. 2003. Washington Department of Fisheries 1993. S.P. Cramer and Associates 1999.
Hatchery Influence: 1. Production hatchery using out-of-basin stock; 2. Production hatchery using within-basin stock; 3. Supplementation hatchery or indicator stock program; 4. Supplementation hatchery essential for recovery.	Pacific Fishery Management Council 1999. Puget Sound Indian Tribes and Washington Department of Fish and Wildlife 2003. Washington Department of Fisheries 1993.

Appendix Table B-3a. Hydrological and spawning area profiles of chinook spawning basins in northern Puget Sound.

Watershed Tributary	Area (mi2)	Avg. Elev. (ft.)	Chinook Spawning Tributaries	Spawning Miles Used	Upstream Migration Barriers		
					Barrier	RM	Passage
Nooksack	795	2208		90.6			
NF Nooksack			Boulder, Canyon, Cornell, Deadhorse, Glacier, Kendall, Maple and Racehorse Creek	49.8	Nooksack Falls	65	No
SF Nooksack			Hutchinson and Skookum Creek	40.8			
MF Nooksack				7.0	Bellingham Water Diversion	7.2	No
Skagit							
Lower Skagit	447	1128	Bacon, Carpenter, Day, Diobsud, Finney, Goodell, Illabot, Jackman, Jones, Mannser, Morgan, Nookachamps Creek; Baker River, McLeod Slough	53.4	Lower Baker Lk. Upper Baker Lk.	1.1 9.3	T&H
Sauk	741	3726	Suiattle, N.F. Sauk, South Fork Sauk, Whitechuck River; Clear and Dan Creek	97.8			
Suiattle	346		Big, Buck, Downey, Lime, Milk, Straight, Sulphur, and Tenas Creek	42.7			
Upper Skagit	1630 [1]	4002	Goodell, and Illabot Creek; Cascade River	51.4	Gorge	96.6	No
Stillaguamish	704	1792		132.8			
NF Stillaguamish	284			40.3			
SF Stillaguamish	255		Canyon and Jim Creek	46.2			
Snohomish	278	518					
Skykomish	853	2769	Sultan and Wallace R., Proctor, Deer, Elwell and Woods Cr.	159.6	Sultan R. Water Diversion	9.7	No
NF Skykomish	147			14.0			
SF Skykomish	362		Foss, Miller and Beckler River; Money and Bridal Veil Cr.	44.0	Sunset Falls		Yes
Snoqualmie	693	2136	Raging and Tolt River; Tokul Creek		Snoqualmie Falls Tolt R. S. Fk	 8.4	 No

Sources: **Area and Elevation**; USGS data from University of Montana Environment Statistics Group, Hydrological Research Project (website). **Spawning Tributaries and Use**; S.P. Cramer and Associates, 1999. Washington Department of Fisheries, 1993; **Migration Barriers**; S.P. Cramer and Associates, 1999. Myers et al. 1998.

Appendix Table B-3b. Hydrological and spawning area profiles of chinook spawning basins in southern Puget Sound, Hood Canal and Strait of Juan de Fuca.

Watershed Tributary	Area (mi2)	Avg. Elev. (ft.)	Chinook Spawning Tributaries	Spawning Miles Used	Upstream Migration Barriers		
					Barrier	RM	Passage
Lake Washington	619	898	Issaquah Creek and Northern Tributaries	116.6	Ballard Locks	0	Yes
Cedar River	188			22.6	Landsburg Diversion	21.3	No
Duwamish / Green	487	1671	Soos, Crisp, May and Newaukum Creek	110.8	Tacoma Water Diversion	60.3	No
Puyallup	996	2892	Clark, Fennel and Kapowsin Creek	146.8	Electron Diversion	41.8	No
Carbon			South Prairie and Voight Creek	31.5			
White			Clearwater, Greenwater and West Fork White River; Boise and Blueberry Creek	72.3	Buckley Diversion	24.25	T&H
					Mud Mountain	29.7	T&H
Nisqually	726	1778	Mashel River; Ohop and Yelm Creek	87.5	Yelm Diversion	26.2	Ladder
					La Grande	42.5	No
S. Sound Tribs							
Deschutes	168	829		44.5			
Skokomish	248	1896		51.5	Cushman No.2	17.3	No
NF Skokomish				29.0			
SF Skokomish				10.5			
Hood Canal	957	2333	Anderson, Big Beef, Eagle, Fulton, Lilliwaup, Misson, Stavis, and Tarboo Cr.; Big Quilcene, Dewatto, Dosewalips, Duckabush, Hamma Hamma, Little Quilcene, Tahuya and Union River	44.7			
Strait of Juan de Fuca							
Dungeness / Elwha	1270	2674	Canyon Creek; Graywolf River	31.0			
Dungeness	198						
Elwha	321			9.9	Elwha	4.9	
					Glines Canyon	13.5	

Sources: **Area and Elevation:** USGS data from University of Montana Environment Statistics Group, Hydrological Research Project (website). **Spawning Tributaries and Use:** S.P. Cramer and Associates, 1999. Washington Department of Fisheries, 1993; **Migration Barriers:** S.P. Cramer and Associates, 1999. Myers et al. 1998.

Appendix Table B-4. Releases of juvenile hatchery chinook in Puget Sound 1991–2000 (thousands of fish).

		1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Grand Total
S. Puget Sound Tribs	Fall	19,441	18,964	15,832	7,643	16,917	15,675	15,054	18,217	16,983	20,483	165,209
	Spring	-	-	-	339	337	341	343	339	203	371	2,273
Duwamish	Fall	12,149	5,302	6,067	4,424	7,915	5,886	6,403	4,786	4,348	3,971	61,250
Nooksack	Fall	5,990	9,030	5,889	7,156	7,221	6,353	4,284	2,166	1,800	1,200	51,089
	Spring	355	181	887	1,391	741	189	841	1,488	2,307	1,712	10,093
Hood Canal	Fall	1,779	2,213	1,257	863	1,862	3,768	5,265	3,959	3,980	3,402	28,348
	Spring	422	249	269	334	149	154	114	-	-	-	1,692
Nisqually	Fall	2,902	1,742	1,063	1,796	2,957	2,847	4,239	3,605	4,342	4,277	29,770
Other Puget Sound	Fall	3,491	2,041	2,357	1,995	1,935	2,717	3,507	2,576	2,704	2,859	26,181
	Spring	-	-	-	-	35	37	30	41	119	46	309
	Summer	-	-	-	-	-	-	-	-	117	185	303
Lake Washington	Fall	4,357	2,910	2,186	2,031	2,401	2,394	2,073	2,930	2,374	1,689	25,344
Elwha	Fall	2,622	3,967	632	1,955	2,443	2,579	2,375	2,176	4,025	1,803	24,577
Puyallup	Fall	3,275	2,008	2,829	2,207	3,059	2,757	1,899	1,978	2,012	2,006	24,029
Snohomish	Fall	915	430	294	709	1,468	1,361	1,376	-	-	-	6,552
	Spring	-	-	-	-	-	-	102	355	-	-	457
	Summer	212	305	618	1,004	281	1,196	1,390	1,450	778	2,224	9,457
Skagit	Fall	1,145	786	1,839	-	-	-	100	-	6	32	3,908
	Spring	419	285	642	1,043	503	484	380	388	394	398	4,935
	Summer	305	986	583	417	192	138	23	202	246	-	3,092
Strait of Georgia	Fall	555	412	420	1,379	1,375	965	1,005	2,105	998	-	9,215
White R.	Spring	451	1,115	1,027	789	728	836	867	1,107	395	684	8,001
Dungeness	Spring	-	-	-	-	-	18	1,776	2,050	1,775	1,501	7,121
Skokomish	Fall	198	1,713	294	-	-	348	96	312	234	-	3,195
W. Strait	Fall	194	223	191	235	326	319	83	240	186	279	2,277
Stillaguamish	Summer	-	202	100	235	344	35	218	95	-	367	1,596
Grand Total		61,178	55,063	45,275	37,943	53,190	51,397	53,845	52,565	50,328	49,489	510,272

Source: Pacific States Marine Fisheries Commission Regional Mark Information Service Database, December, 2002.

Appendix Table B-5. Summary of chinook exploitation rates from Fishery Regulation Assessment Model Runs (2002 Validation)

Total Adult Equivalent Mortality: All Fisheries													
	Skagit S/F Nat \1	Stillaguamish S/F	Snohomish S/F Nat \1	Nooksack Early \2	Skagit Spr Nat	White Spr \3	Nooksack S/F	Hood Canal S/F	JDF Tribs S/F	Lake Washington	Green River	Puyallup River	Nisqually River
1983	78%	73%	73%	49%	75%	59%	91%	81%	80%	82%	86%	81%	102%
1984	71%	61%	63%	43%	63%	41%	89%	69%	57%	76%	57%	68%	92%
1985	65%	46%	55%	43%	58%	33%	85%	70%	68%	79%	75%	76%	88%
1986	59%	62%	60%	43%	56%	44%	89%	82%	88%	69%	58%	70%	90%
1987	60%	47%	47%	42%	62%	35%	88%	84%	71%	79%	53%	82%	106%
1988	58%	57%	66%	50%	59%	35%	90%	75%	71%	87%	63%	77%	85%
1989	71%	47%	52%	37%	75%	36%	79%	77%	85%	77%	61%	72%	91%
1990	50%	47%	49%	32%	50%	33%	74%	71%	75%	69%	71%	66%	85%
1991	53%	38%	52%	36%	66%	48%	81%	70%	58%	82%	65%	66%	81%
1992	63%	42%	61%	34%	57%	32%	73%	79%	57%	81%	75%	68%	86%
1993	65%	28%	61%	30%	46%	24%	67%	63%	70%	61%	74%	70%	82%
1994	57%	29%	49%	28%	51%	49%	80%	69%	62%	38%	68%	69%	96%
1995	60%	43%	64%	24%	47%	34%	71%	37%	39%	31%	37%	76%	89%
1996	30%	34%	42%	18%	45%	33%	54%	33%	41%	28%	42%	67%	86%
1997	37%	31%	29%	22%	42%	22%	63%	40%	32%	29%	31%	60%	76%
1998	23%	15%	24%	15%	28%	19%	84%	16%	46%	15%	30%	35%	78%
1999	33%	20%	31%	17%	21%	28%	51%	48%	18%	20%	29%	74%	80%
2000	24%	27%	26%	17%	31%	19%	64%	51%	34%	42%	51%	72%	68%

1 Only the portion of Skagit and Snohomish fingerling and yearling stocks representing wild chinook are presented in this table.

2 "Nooksack Early" stock comprises an aggregation of North Fork and South Fork Early ("Spring" or "Native") stocks.

3 "White River Spring" stock is represented by fingerlings originating from the White River.

Source: Northwest Indian Fisheries Commission

Appendix Table B-6. Percent of harvest mortality occuring on Puget Sound chinook indicator stocks by fishing area.

		Catch Year									
Stock	Fishing Area	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Hood Canal Fall	Alaska	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.2%	2.3%	0.7%
(George Adams Hatchery)	Canada	30.7%	25.1%	54.3%	22.3%	41.0%	51.5%	25.5%	6.7%	26.5%	61.4%
	U.S. Troll	10.0%	21.7%	9.4%	0.0%	1.4%	14.1%	8.0%	5.0%	12.0%	5.9%
	U.S. Net	36.5%	8.9%	5.2%	44.4%	7.6%	0.0%	2.1%	5.5%	30.0%	0.0%
	U.S. Sport	22.7%	44.3%	31.1%	33.2%	50.0%	34.4%	64.4%	77.6%	29.1%	32.0%
Nisqually Fall	Alaska	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	1.0%	0.3%	0.4%	0.4%
	Canada	21.7%	23.4%	34.6%	13.9%	19.6%	9.2%	12.8%	6.3%	10.3%	29.6%
	U.S. Troll	20.1%	9.7%	4.7%	0.9%	3.8%	2.4%	1.3%	1.4%	5.4%	2.0%
	U.S. Net	24.3%	26.1%	30.2%	26.3%	39.9%	52.6%	29.8%	51.9%	48.5%	40.5%
	U.S. Sport	33.9%	40.8%	30.5%	59.0%	36.7%	35.4%	55.0%	40.1%	35.3%	27.5%
Nooksack Spring	Alaska	0.0%	4.9%	0.0%	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	4.3%
	Canada	75.6%	73.8%	66.7%	79.5%	62.9%	77.4%	48.3%	79.6%	74.2%	87.0%
	U.S. Troll	3.5%	1.9%	1.4%	0.4%	0.0%	1.9%	0.0%	0.0%	7.9%	0.0%
	U.S. Net	11.1%	0.7%	9.3%	11.4%	7.7%	0.0%	6.4%	1.8%	9.0%	0.0%
	U.S. Sport	9.8%	18.7%	22.6%	7.6%	29.4%	20.8%	45.2%	18.5%	9.0%	8.7%
Samish Fall	Alaska	0.0%	0.0%	0.0%	0.6%	0.3%	0.1%	1.6%	5.1%	5.4%	0.0%
	Canada	43.3%	38.7%	58.8%	45.3%	27.5%	18.4%	25.9%	22.4%	37.2%	91.4%
	U.S. Troll	12.5%	12.8%	5.1%	2.8%	4.8%	2.5%	1.7%	1.2%	2.5%	1.2%
	U.S. Net	28.5%	18.2%	19.2%	45.7%	35.1%	43.1%	52.7%	63.3%	49.1%	7.4%
	U.S. Sport	15.7%	30.3%	16.8%	5.6%	32.3%	35.9%	18.2%	7.9%	5.9%	0.0%
Skagit Spring	Alaska							0.4%	1.5%	2.3%	1.6%
	Canada							51.7%	48.0%	49.2%	62.0%
	U.S. Troll							0.0%	0.0%	0.6%	0.0%
	U.S. Net							2.6%	5.3%	3.4%	2.5%
	U.S. Sport							45.3%	45.2%	44.4%	33.9%
Sosuthern Puget Sound Fall	Alaska	0.7%	1.0%	0.5%	0.0%	0.6%	0.6%	1.6%	5.3%	2.1%	1.3%
	Canada	29.7%	33.0%	40.6%	36.9%	30.7%	23.5%	33.5%	16.8%	27.0%	43.0%
	U.S. Troll	16.4%	11.0%	7.9%	1.3%	4.2%	8.9%	5.3%	4.2%	11.6%	0.8%
	U.S. Net	33.8%	25.6%	20.2%	29.2%	16.1%	17.3%	8.7%	29.4%	31.9%	23.8%
	U.S. Sport	19.5%	29.4%	30.8%	32.6%	48.5%	49.7%	50.9%	44.3%	27.4%	31.0%
Stillaguamish Fall	Alaska	0.5%	0.0%	0.0%	7.9%	4.1%	2.0%	20.4%	48.5%	7.4%	30.6%
	Canada	41.1%	35.3%	54.9%	66.6%	52.8%	50.0%	41.0%	32.4%	73.1%	60.7%
	U.S. Troll	15.3%	6.3%	8.6%	0.0%	1.5%	0.0%	0.0%	0.0%	0.0%	2.7%
	U.S. Net	17.3%	12.4%	2.0%	6.3%	3.5%	0.4%	3.4%	7.0%	1.4%	2.2%
	U.S. Sport	25.8%	46.0%	34.4%	19.3%	38.1%	47.6%	35.2%	12.1%	18.0%	3.8%
White River Spring	Alaska	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Canada	3.5%	12.8%	2.8%	4.9%	1.4%	2.2%	0.0%	0.0%	7.3%	16.6%
	U.S. Troll	6.6%	4.0%	6.0%	0.0%	0.0%	0.0%	0.0%	3.8%	0.0%	0.0%
	U.S. Net	15.6%	11.0%	6.7%	2.8%	2.1%	0.6%	6.6%	3.8%	0.0%	8.4%
	U.S. Sport	74.3%	72.2%	84.5%	92.3%	96.5%	97.2%	93.4%	92.3%	92.7%	75.0%

Source: Pacific Salmon Commission 2002.

APPENDIX C

Technical Methods - Derivation of Chinook Management Objectives and Fishery Impact Modeling Methods

Appendix C1.

Basis for Puget Sound chinook salmon escapement goals used in determining the harvestable abundance for Alternative 2. Several of these goals were also used as standards to evaluate the predicted effects of the alternatives when they represented the best information available about the habitat capacity and productivity of the watershed in which the chinook salmon population spawns.

Nooksack early

The management unit escapement goal of 4,000 early chinook salmon implies a goal of 2,000 natural-origin early chinook salmon spawners in each of the South Fork and North Fork Nooksack Rivers. The goal is not based on current habitat capacity, or the current productivity of either population. This interim goal was established in the 2001 Harvest Management Plan (WWIT and WDFW 2001).

Skagit Summer-fall and spring – Escapement goals are defined as the level, within the framework of the Puget Sound Chinook Harvest Management Plan, most likely to maximize long-term harvest. Escapement goals were derived analytically, based on recent productivity parameters derived by the Ecosystem Diagnosis and Treatment (EDT) method (Mobrand Biometrics 1999), assuming current habitat conditions. The population simulation model and methodological assumptions are described in detail in Appendix A to the HMP, Skagit River Management Unit Profile. (Note: The HMP is Appendix A to the DEIS.) The summer-fall chinook salmon escapement goal is 14,500; i.e. 8,434 for the upper Skagit summer population, 1,926 for the lower Sauk summer population, and 4,140 for the lower Skagit fall population. The spring chinook salmon escapement goal is 2,000, comprised of 986 for the upper Sauk, 440 for the Cascade, and 574 for the Suiattle populations. These goals are considerably higher than the MSY escapement levels calculated from spawner recruit parameters, without consideration of management error or environmental variation.

Stillaguamish – The escapement goal for the North Fork Stillaguamish (600) is an estimate of optimum (Maximum Sustained Yield) escapement, derived from fitting a Ricker recruitment function to recent spawner – recruit data. Cohort reconstruction of brood-year recruitment was calculated from coded-wire tag recoveries. The goal for the South Fork Stillaguamish (300) resulted from habitat-based analysis (EDT method – Mobrand Biometrics 1999; and Mobrand 2000) of the performance of various life history trajectories in the watershed given current habitat conditions. The output represents the average performance of the population under the given conditions, and there is no adjustment for random fluctuations or for improvements or degradation of habitat conditions. Additionally, average marine survival conditions for 1989–1995 were assumed in this analysis (personal communication with Kit Rawson, Tulalip Department of Natural Resources, Senior Fishery Management Biologist, December 6, 2002). A Beverton-Holt recruitment function was fit to habitat-based productivity estimates, allowing a determination of escapement at Maximum Sustained Yield.

Snohomish – The Snohomish system escapement goal of 4,600 is a composite of population goals for the Skykomish (3,600) and Snoqualmie (1,000) systems. These goals were derived by the Ecosystem Diagnosis and Treatment method, described above for the Stillaguamish analysis. The Skykomish goal was verified using coded-wire-tag (CWT)-based cohort reconstruction, and spawner-recruit analysis. See the Puget Sound Chinook Harvest Management Plan, Appendix A, Snohomish River Management Unit Profile, for a detailed description of the derivation of these goals.

Lake Washington

The Lake Washington management unit escapement goal of 1,550 comprises goals for the Cedar River and Bear Creek of 1,200 and 350, respectively. The Cedar River escapement goal should be considered a conservative estimate. The goal is based on historical escapement estimates where an attempt is made to survey the entire known spawning area. However, in some years, chinook salmon adults spawn in tributaries to the Cedar River that are not usually part of the major spawning area. In addition, some fish are missed by the surveyors as they raft the river (personal communication with Steve Foley, Washington Department of Fish and Wildlife, Fisheries Biologist, February 18, 2004). The Bear Creek escapement goal is based on spawner counts in index reaches that have not been expanded to include chinook spawners in other known spawning areas of the river. They are based on historical counts in these areas, specifically the 1965–1969 average for the Cedar River, and the 1983–1992 average for Bear Creek. These interim goals were stated in a technical memorandum to WDFW and tribal managers (P. Hage, R. Hatch, and C. Smith. March 28, 1994. *Interim escapement goals for Lake Washington chinook salmon*). This goal was used to assess predicted impacts to escapement among the alternatives.

Green-Duwamish

The escapement goal of 5,800 for the Green – Duwamish River is based on survey of the index reach from RM 29.6 to 47.6 (17.4 stream miles). Accurate escapement estimates from this reach were expanded to the total system according to the distribution of total escapement determined from tagging studies. Corrected total escapements for the 12-year period from 1965 to 1976 averaged 5,740, so the system escapement goal was set at 5,800 (Washington Department of Fisheries Technical Report 29).

White

The interim escapement goal for the White River is for 1,000 adult chinook salmon to be captured at the Buckley Trap and transported above Mud Mountain Dam. These fish then migrate to natural spawning areas in the upper watershed. This goal was established by the inter-agency White River Recovery Team (WDFW et al. 1996. *Recovery Plan for White River Spring chinook salmon*). It is based on an analysis of habitat capacity (Warren 1994) in three tributaries to the upper mainstem, in which the majority of natural spawning now occurs. This goal was used to assess predicted impacts to escapement among the alternatives.

Puyallup

The current intent of fisheries management, for Puyallup fall chinook salmon, is to achieve escapement of at least 500 into the South Prairie/Wilkeson Creek tributary system. While the relationship between escapement to South Prairie and the entire Puyallup River system is not yet exactly quantified, the best available information suggests this level of escapement to South Prairie Creek represents an index of adequate seeding of the entire system. Uncertainty persists regarding system capacity due to the difficulty in enumerating adult chinook salmon in the mainstem, and the unknown potential of recently re-colonized habitat upstream of Electron Dam. For the purposes of catch modeling done for NEPA review, a system escapement goal was established at 1,200. This estimate is based on analysis of productivity under current habitat constraints, using the EDT method, which indicated that Maximum Sustained Yield (MSY) escapement is approximately 600, assuming a 50 percent hatchery contribution to natural spawning yields the escapement goal for the system.

Nisqually

Based on EDT habitat analysis, fitting a Beverton-Holt function to existing data on current habitat potential, Maximum Sustained Yield escapement, under current conditions, was estimated to be 1,100 (NCRT 2001, Chapter 5, p. 46, and Appendix 4 Section 3.2).

Skokomish and Mid- Hood Canal

Current natural escapement goals for the Skokomish River, and the three Mid-Canal rivers (Dosewallips, Duckabush, and Hamma Hamma) are 1,650 and 750, respectively. These goals are based on the historical average escapement from 1965–1976 (WDFW 1977 Technical Report 29). The current capacity of habitat in these systems has not been quantified. Spawning habitat in the South Fork Skokomish is severely degraded and subject to annual flood or high flow. Hydroelectric facility operations constrain spawning success in the North Fork Skokomish.

Dungeness

The Dungeness River escapement goal of 925 is based on accessible spawning habitat (i.e., 17.7 miles in the mainstem, 8.0 miles in the Gray Wolf River), historical redd density (12 redds per mile), and spawner distribution (three adults per redd) (C. Smith and B. Sele. July 12, 1994. M*emorandum: Dungeness River escapement goal*). This goal was used to assess predicted impacts to escapement among the alternatives.

Elwha

The escapement goal for the Elwha River (2,900) is a composite of 2,400 adults required for broodstock by the hatchery programs, and 500 natural spawners. The natural component is based on the capacity of habitat that currently exists in the 4.9 river miles below Elwha Dam.

Hoko

The Hoko River escapement goal of 1,050 comprises the broodstock requirement for the Hoko Hatchery supplementation program of 200 (100 pairs), and 850 natural spawners to adequately seed natural spawning habitat in the mainstem and tributaries (Washington Department of Fisheries Technical Report 29).

Appendix C2.

Basis for National Marine Fisheries Service Critical and Viable Escapement Thresholds, and Rebuilding Exploitation Rates used to assess the effects on abundance and recovery of Puget Sound chinook salmon populations.

The method used to determine critical and viable escapement thresholds and Rebuilding Exploitation Rates was developed with three objectives in mind[i]. This method is described in more detail by NMFS in a document titled Viable Risk Assessment Procedure (McElhaney et al. 1999). First, NMFS sought to evaluate the proposed fisheries using biologically-based measures of the total exploitation rate that occurred across the full range of the species. Second, NMFS sought to use an approach that was consistent with the concepts developed by NMFS' Northwest Fisheries Science Center for the purpose of defining the conservation status of populations and ESUs; i.e.,Viable Salmonid Populations (McElhaney et al. 1999). Finally, NMFS sought to develop an approach for defining target exploitation rates that could be related directly to the regulatory definition of jeopardy. The product of this approach is a set of Rebuilding Exploitation Rates for representative stocks within each Evolutionarily Significant Unit. Rebuilding Exploitation Rates were developed for a limited set of Puget Sound chinook salmon populations. The proposed fisheries were then evaluated, in part, by comparing the Rebuilding Exploitation Rates to exploitation rates anticipated as a result of the proposed fishery regime, recognizing that the jeopardy determination must be made with respect to the overall ESU. More qualitative considerations were used to extrapolate where necessary from the available Rebuilding Exploitation Rate analyses.

There are four steps involved with determining population-specific Rebuilding Exploitation Rates: 1) identify populations, 2) set critical and viable threshold abundance levels, 3) estimate population productivity as indicated by a spawner-recruit relationship, and 4) identify an appropriate Rebuilding Exploitation Rate through simulation.

As described in Subsection 3.3, Fish – Affected Environment, the population structure used for the Puget Sound chinook salmon Evoluntionarily Significant Unit is that defined by the Puget Sound and Olympic Peninsula Technical Recovery Team (Puget Sound Technical Recovery Team 2003).

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[i] This method was first used to assess the impacts from implementation of the Pacific Salmon Treaty (NMFS 1999) and has been used by NMFS to evaluate harvest actions impacting the Puget Sound chinook salmon ESU since that time (NMFS 2000 [PFMC BO], NMFS 2001 [4(d) Rule]).

The Viable Salmonid Populations document (McElhaney et al. 1999) develops the idea of threshold abundance levels as one of several indicators of population status (others being productivity, spatial structure, and diversity). The thresholds described include a critical threshold and a viable population abundance level. The critical threshold generally represents a boundary below which uncertainties about population dynamics increase and therefore extinction risk increases substantially. The viable population threshold is a higher abundance level that would generally indicate recovery or a point beyond which ESA-type protections are no longer required, with the caveat that abundance is not the only relevant or necessary indicator of recovery.

The Viable Salmonid Populations document provides several rules of thumb that are intended to serve as guidelines for setting population-specific thresholds (McElhaney et al. 1999). Unfortunately, these guidelines continue to evolve as part of the ongoing development process. Population-specific targets will be identified in the final recovery plan for the Puget Sound chinook salmon ESU. However, because the thresholds were needed to set the Rebuilding Exploitation Rates, NMFS considered the existing rules of thumb, and other relevant guidance, to make preliminary threshold determinations for Puget Sound chinook salmon populations.

The critical threshold was developed from a consideration of genetic, demographic, and spatial risk factors for each population. Genetic risks to small populations include the loss of genetic variation, inbreeding depression, and the accumulation of deleterious mutations. The risk posed to a population by genetic factors is often expressed relative to the effective population size, or the size of an idealized population that would produce the same level of inbreeding or genetic drift that is seen in an observed population. Guidance from the existing Viable Salmonid Populations document suggests that effective population sizes of less than 500 to 5,000 per generation are at increased risk. The population size range per generation was converted to an annual spawner abundance range of 125 to 1,250 by dividing by four, which is the approximate generation length. An escapement level of 200 fish was selected from this range to represent a critical threshold for genetic risk factors (Method 1), since most of the populations that were subject to the Rebuilding Exploitation Rate analysis were relatively small. For example, the interim escapement objectives for the Nooksack River stocks are 2,000 fish each. Critical escapement threshold values much larger than 200 would be out of context for the populations of concern.

The Biological Requirements Work Group (BRWG 1994) took genetic considerations and other factors into account in their effort to provide guidance with respect to a lower population threshold for Snake

River spring/summer chinook salmon. They recommended annual escapements of 150 and 300, for small and large populations, which represented levels below which survival becomes increasingly uncertain due to various risk factors and a lack of information regarding population responses at low spawning levels. This provides independent support for the use of 200 (which is within the range of 150 to 300) as a critical threshold.

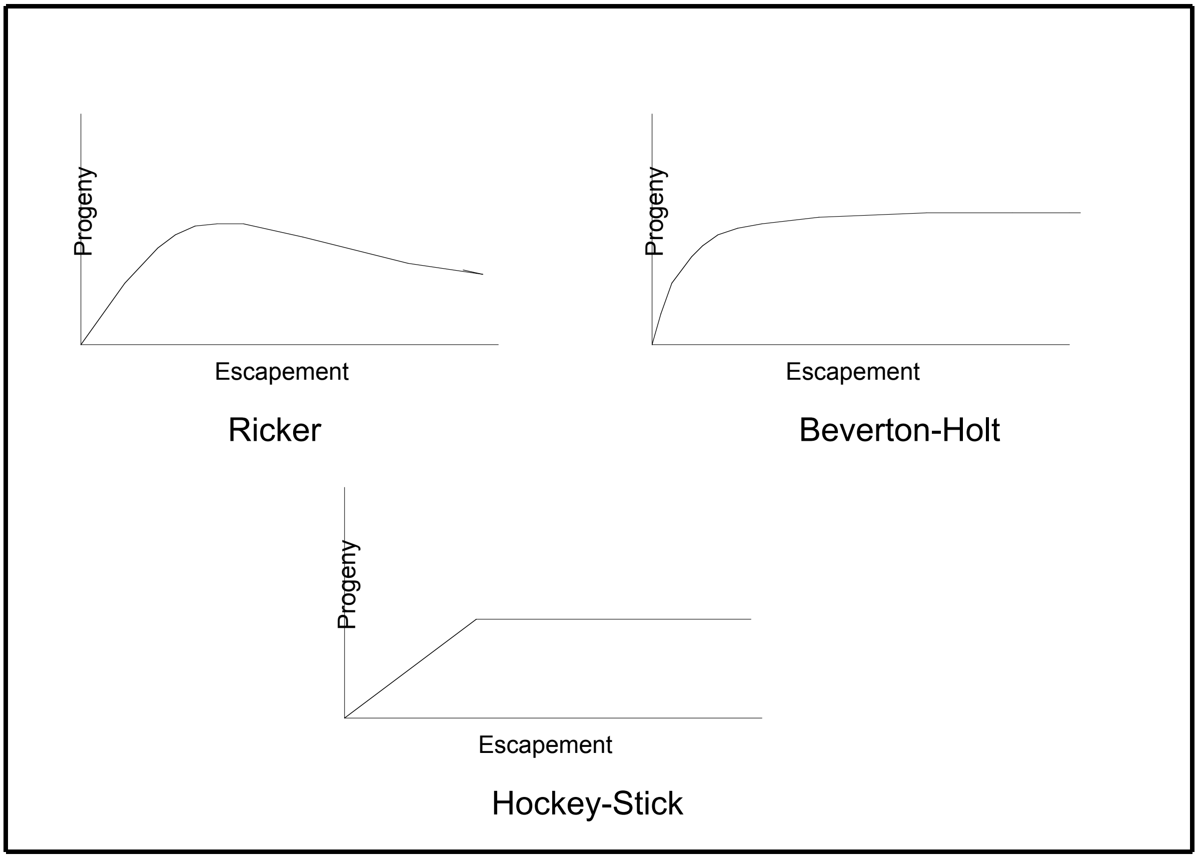
Factors associated with demographic risks include environmental variability and depensation. Depensation – a decline in the productivity of a population (e.g., smolts per spawner) as the abundance declines – can result from the uncertainty of finding a mate in a sparse population and/or increased predation rates at low abundance. Demographic risks were assessed using a Ricker stock-recruit model (Method 2). Peterman (1977 and 1987) provided a rationale for depensation and suggested relating the escapement level at which depensation occurs to the size of the population in the absence of fishing (equilibrium escapement level). NMFS set this measure of the critical threshold equal to 5 percent of the equilibrium escapement level. In cases where there were no data in the lower range of escapements, a third method (Method 3) was used. In these cases, the lowest escapement with a positive adult return was used.

Each of the measures of the preliminary critical threshold was considered in the context of the types and quality of data available, the characteristics of the watershed, and the biology of the population (Table C2-1). For "large populations," NMFS typically selected a critical threshold based on Method 2 to assure a sufficient density of spawners, or Method 3 where there were no escapements in the lower range to define the lower limb of the stock-recruit relationship. Method 1 was used for small populations or populations for which NMFS was unable to estimate the equilibrium population size or analysis is not complete at this time.

Similar methods were used to establish the viable population threshold. In this case, the criteria were 1,250 spawners (genetics, derived from the Viable Salmonid Population guideline range of 5,000 to 16,700 divided by the average generation length of approximately 4 years) (Method 1); the level of escapement required to achieve the maximum sustainable yield (demographics) under current environmental conditions (Method 2); or other information related to the productivity and capacity of the watershed (Method 3). Again, the decision concerning which method to use was based on a consideration of the context of the types and quality of data available, the characteristics of the watershed, and the biology of the population (Table C2-1).

The third step in the process of identifying population-specific Rebuilding Exploitation Rates is to estimate the stock-recruit parameters. Estimates of the stock-recruit parameters for each population were required for both establishing the escapement threshold levels (Method 2), and for the simulations of population dynamics. Several different stock-recruit relationships were examined: Ricker, Beverton-Holt and the Hockey Stick. The three functions differ primarily in the response of population abundance at higher escapement levels. The Ricker function assumes that at some level of spawners, productivity begins to decline as escapement increases; i.e., at higher escapement levels, competition for natural resources (such as spawning or rearing space and food) results in fewer progeny produced for each additional spawner. The Beverton-Holt function assumes that at some level of escapement, productivity continues to increase with increasing escapement, but only gradually. The Hockey-Stick function assumes that at some level of escapement, productivity levels off, neither increasing nor decreasing. Below this level of escapement, the relationship is density-independent; i.e., the number of progeny produced is independent of the number of spawners. Where data were sufficient to conduct spawner-recruit analyses, hatchery-origin spawners were included in the estimate of parent escapement since they contributed to the progeny produced, but were removed from the escapement of adults produced from that brood year in order to assess the natural productivity of the parental spawners.

Figure C2-1. Spawner-recruit response for each spawner-recruit function evaluated in development of escapement thresholds and Rebuilding Exploitation Rates.



The final step in determining Rebuilding Exploitation Rates is to use a simulation model to iteratively solve for an exploitation rate that meets specific criteria related to both survival and recovery given the specified thresholds and estimated spawner/recruit parameters. The consultation regulations define "jeopardize the continued existence" to mean:

> "... to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing appreciably the reproduction, numbers, or distribution of the species" (50 CFR section 402.2).

The simulation then uses a quantified level of risk associated with this definition - "... reduce appreciably the likelihood of survival and recovery ..." and the population specific threshold levels to identify an exploitation rate that meets the following criteria:

1) Did the percentage of escapements less than the critical threshold value increase by less than 5 percentage points relative to the baseline?

   and, either

2a) Does the escapement at the end of the 25-year simulation exceed the viable threshold at least 80 percent of the time?

   or

2b) Does the percentage of escapements less than the viable level at the end of the 25-year simulation differ from the baseline by less than 10 percentage points?

For comparison purposes, these simulations were measures against simulations that assumed these species were not harvested anywhere as the baseline (a zero exploitation rate). In addition, the simulation model uses available information on management error, and errors in measurement of the stock-recruit parameters used in the model to account for uncertainty in management precision and parameter estimation.

The Rebuilding Exploitation Rate is then the level of exploitation rate that results in a low probability that the proposed harvest action will endanger the survival of the population, and a relatively high probability that the proposed harvest action will not impede recovery as defined in this context. Recovery in this context means achieving the viable abundance threshold for a population, assuming current habitat conditions. That is why they are called Rebuilding and not Recovery Exploitation Rates. Recovery will require improvements in all primary sources of salmon mortality. A separate recovery planning process is currently underway that will ultimately define recovery in terms of necessary improvements in all four Hs (harvest, hatchery, habitat and hydropower), and in the context of the ESU as a whole.

The Rebuilding Exploitation Rate is the highest exploitation rate that can meet Criterion 1 and Criterion 2a or 2b. Once identified, proposed fisheries can be evaluated by considering the likelihood that they will meet the Rebuilding Exploitation Rates. It is important to emphasize that the Rebuilding Exploitation Rate analysis is made with respect to populations, while ESA determinations must be made with respect to the anticipated impacts to the ESU. For example, failure to meet the Rebuilding

Exploitation Rate standards for one population in a large ESU such as the Puget Sound chinook salmon ESU does not necessarily indicate jeopardy to the ESU as a whole.

A final step was to convert the Rebuilding Exploitation Rates based on coded-wire tags (CWT) into values that could be easily compared with output from the model used to assess the alternatives in this Environmental Impact Statement: the Fishery Regulation Assessment Model (FRAM). This step was necessary to compare the exploitation rates resulting from the fishery strategies under each alternative to the Rebuilding Exploitation Rates used to assess progress toward recovery. This was done by regressing validated FRAM exploitation rates from past years against the brood year CWT-based exploitation rates from which the Rebuilding Exploitation Rates were derived. The regression relationship was then applied to the Rebuilding Exploitation Rate CWT-based value, resulting in a Rebuilding Exploitation Rate measured in FRAM terms.

The RERs, CETs and VETs used in the DEIS, both those used as objectives and those used as standards for evaluation, were derived from several methods depending on the amount and quality of available data (DEIS Appendices A and C). For those populations where these parameters are derived from population-specific spawner-recruit relationships, the parameters will change as changing habitat conditions, both in marine and freshwater environments, are reflected in the spawner-recruit relationship. A spawner-recruit relationship describes the number of fish at a given life stage that is produced from a specific level of adult escapement (Figures C2-1 and C2-2), taking into account the amount of available habitat (capacity), and the quality of the habitat (productivity). As described previously in this section, the viable thresholds are generally defined as the number of spawners that corresponds with the point of maximum sustained yield; i.e., the largest number of fish produced per spawning adult. The critical thresholds are defined as the number of spawners that corresponds with five percent of the equilibrium escapement (the number of progeny is equal to the number of spawning adults), or as the lowest adult escapement that more than replaces itself in the subsequent generation. It is important to remember that the term “viable threshold” as used by NMFS in the context of this EIS is based on consistency with current habitat conditions and should not be confused with what would represent a recovered population.

The spawner-recruit relationship for a population may change, and thus the escapement level corresponding to the viable threshold will increase or decrease as habitat quality and quantity increase or decrease (Figure C2-2). The same may or may not be the case for the critical threshold, since it defines a minimal escapement more influenced by genetic and demographic concerns than the viable threshold (Table C2-1). For example, an increase in habitat quality and quantity will not change the critical threshold as defined by the lowest escapement that replaces itself. Increasing or decreasing habitat capacity will have less of an effect on the number of offspring produced than increasing or decreasing productivity and, when the number of spawners that the habitat can support increases, the number of offspring (recruits) produced for each additional spawner may not increase without an increase in habitat quality (Table C2-1 and Figure C2-2). Increasing or decreasing spawning or rearing habitat capacity will result in a corresponding increase or decrease in the viable escapement threshold. Increasing or decreasing habitat quality will have a larger effect on the number of offspring produced per spawner at a lower viable escapement threshold than with changes in habitat capacity (Figure C2-2). This is because, although the amount of habitat is limited, the quality of the habitat in terms of food, water quality, or other factors influences the survival of the offspring produced much more than a change in the amount of available habitat. The greatest change in the magnitude of the viable escapement threshold and the offspring produced occurs when both the capacity and the quality of the habitat changes.

Because the RER is dependent on the probability of meeting the viable and critical thresholds, it will change as these thresholds change. In general, as the habitat improves or increases, the RER will increase because more fish will be produced for each spawner and a greater surplus will be available beyond that needed to sustain the population (Table C2-1). When habitat quality and quantity decreases, the RER will decrease because less surplus will be available and the possibility of falling below the critical threshold will become more likely.

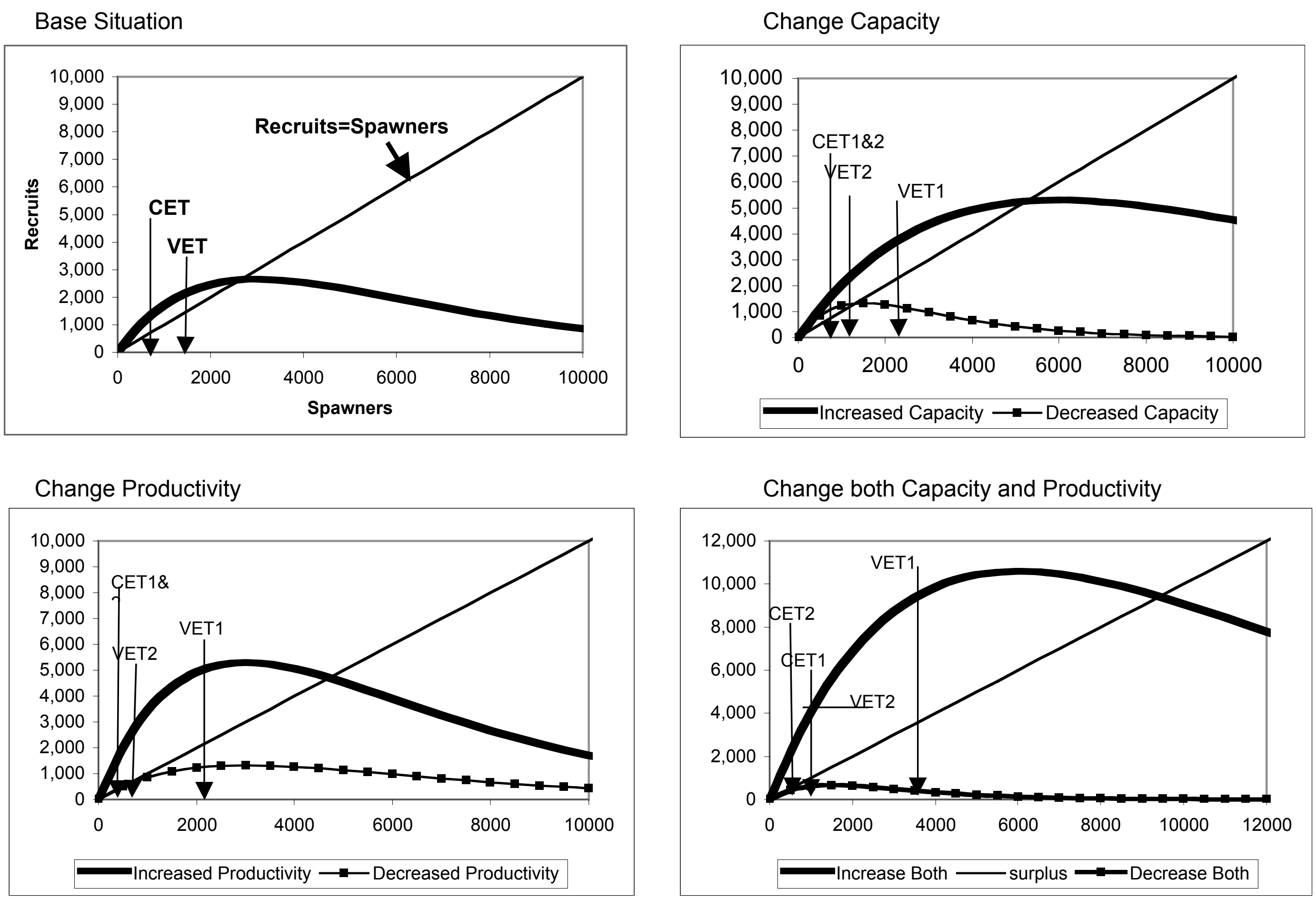
Table C2-1. Changes in the viable escapement thresholds, the critical escapement threshold, and the available surplus as a function of changes in habitat capacity (carrying capacity in terms of number of smolts rather than area) and productivity. Productivity and capacity were increased or decreased by a factor of 2. These are examples only and do not represent an actual Puget Sound Chinook salmon population.

		Capacity		Quality		Both	
	Control	Increase	Decrease	Increase	Decrease	Increase	Decrease
Viable Escapement Threshold	1,000	2,500	500	2,000	300	3,500	100
Critical Escapement Threshold	200[1]	260	200[1]	240	200[1]	470	200[1]
Offspring produced at VET	1,720	3,455	860	4,929	508	9,375	112
Recruits/spawner at VET	1.7	1.4	1.7	2.5	1.0	2.7	1.1
Surplus Available	720	1,460	360	2,930	8	5,880	0

[1] The critical threshold is lower in these situations when calculated as 5% of the equilibrium abundance, but without evidence that the spawners could replace themselves at such a low level, a generic critical threshold of 200 based on the general scientific literature would be implemented.

Source: S. Bishop, Puget Sound/Washington Coastal Harvest Management Leader, Sustainable Fisheries Division, National Marine Fisheries Service, August 2004.

Figure C2-2. Basic spawner-recruit relationship and, counter clockwise from upper right, effects on VET and CET resulting from (a) increasing (1) and decreasing (2) capacity, no change to quality; (b) increasing (1) and decreasing (2) quality, no change to capacity; (c) increasing (1) and decreasing (2) both capacity and quality.



The following tables summarize the data and methods used to determine the critical and viable thresholds and Rebuilding Exploitation Rates used in the evaluation of effects to Puget Sound chinook salmon.

Table C2-2~~1~~. Methods used to derive critical and viable thresholds for Puget Sound chinook salmon populations.

Population	Critical Threshold	Method	Viable Threshold	Method
Strait of Juan de Fuca				
Dungeness Spring	200	1	925	3
Elwha	200	1	2,900	3
North Puget Sound				
Nooksack Spring			500	2
North Fork Nooksack	200	1		
South Fork Nooksack	200	1		
Skagit Spring				
Upper Cascade	170	3	NA	
Upper Sauk	130	3	330	2
Suiattle	170	3	400	2
Skagit Summer/Fall				
Lower Sauk	200	1	681	2
Upper Skagit	967	2	7,454	2
Lower Skagit	251	2	2,182	2
Stillaguamish Summer/Fall				
North Fork Stillaguamish	300	2	552	2
South Fork Stillaguamish	200	1	300	2
Snohomish Summer/Fall				
Skykomish	1,650	3	3,500	2
Snoqualmie	400	3	NA	
South Puget Sound				
Lake Washington-Cedar R.	200	1	1,200	3
Green-Duwamish	835	2	5,523	2
Puyallup	200	1	1,200	3
Nisqually	200	1	1,100	3
White Spring	200	1	1,000	3
Hood Canal				
Mid-Canal Summer/Fall	200	1	1,250	1
Skokomish	200	1	1,250	1

Source: S. Bishop, National Marine Fisheries Service, data analysis conducted in 1999–2003.

1 = Generic guidelines from Viable Salmonid Population document (McElhaney et al. 2000).
2 = Spawner-recruit analysis.
3 = Critical: lowest escapement with a positive adult return.
4 = Viable: other sources of information related to population productivity/capacity (see Appendix C1).

Table C2-3~~2~~. Data used to derive critical and viable escapement thresholds and Rebuilding Exploitation Rates.

	Escapement	Age	Environmental Variables	
			Freshwater	Marine
Nooksack Spring	1984–2001	1992,93,95,99,2001	1984–1997	1984–1997 BY
Skagit Spring				
Upper Cascade	1980–2001			
Upper Sauk	1980–2001	1986,92-95,1997–2001	1981-1997	1981–97 BY
Suiattle	1980–2001	1986–90,1992–2001	1986-1997	none (Skagit spring yearling indicator stock)
Skagit Summer/Fall				
Lower Sauk	1974–1997	Area 8/Skagit River	1970–1996	1979, 1981–1992 BY
Upper Skagit	1974–1997	1965–72,74–77,80–89, 1992–1993	1970–1996	1979, 1981–1992 BY
Lower Skagit	1974–1997		1970–1996	1979, 1981–1992 BY (Stillaguamish and Samish indicator stocks)
Stillaguamish Summer/Fall				
North Fork Stillaguamish	1974–1997	none	No relationship	1983–1992 BY
South Fork Stillaguamish	1985–1997	none	No relationship	1983–1992 BY (Stillaguamish and Samish used for marine survival pre-1986)
Snohomish Summer/Fall				
Skykomish	1979–2000	1989,1997–1999 (1979–1988, 1990–1996 simulated)	1979–1996	1979–1994 BY (Stillaguamish, Samish, Quinsam, CHI indicator stocks)
Green-Duwamish	1971–1996	none	No relationship	1983–1992 BY

Source: Susan Bishop, Puget Sound/Washington Coastal Harvest Management Leader, Sustainable Fisheries Division, National Marine Fisheries Service, data analysis conducted 1999-2003.

Table C2-4~~3~~. Data used to derive critical and viable escapement thresholds and Rebuilding Exploitation Rates.

	Fishery Mortality	**Management Error**	**Spawner-Recruit Function**	**Indicator Stock**
Nooksack Spring	1984–1997 BY	1988–1993	Ricker, Bev-H, Hockey Stick	1984–1987 South Fork Nooksack fingerling 1989–1997 North Fork Nooksack yearling
Skagit Spring Upper Sauk Suiattle	 1981–1997 BY 1981–1997 BY	 1988–1993 1988–1993	 Ricker Ricker, Bev-H, Hockey Stick	 1981–1997 BY (Skagit spring yearling indicator stocks)
Skagit Summer/Fall Lower Sauk Upper Skagit Lower Skagit	 1971–1992 BY 1971–1992 BY 1971–1992 BY	 1988–1993 1988–1993 1988–1993	 Ricker Ricker Ricker	 Stillaguamish and Samish
Stillaguamish Summer/Fall North Fork Stillaguamish South Fork Stillaguamish	 1974–1993 BY 1974–1993 BY	 1988–1993 1988–1993	 Ricker Ricker	 Stillaguamish
Snohomish Summer/Fall Skykomish	 1979–1996 BY	 1988–1993	 Beverton-Holt	 PS aggregate for preterminal fishing rates; terminal run reconstruction for terminal fishing rates
Green-Duwamish	1973–1975, 1978–1981, 1985–1993	1988–1993	Ricker	Soos Creek (Nisqually and Grovers also used for marine survival in 1984–1985)

Source: Susan Bishop, Puget Sound/Washington Coastal Harvest Management Leader, Sustainable Fisheries Division, National Marine Fisheries Service, data analysis conducted 1999-2003.
Age Data: Based on scales sampled from spawning grounds. If insufficient samples were available, age data was simulated.
Management Error: Uses management error from several Puget Sound chinook salmon indicator stocks (J. Gutmann, 1998).
BY = Brood year or the year in which the parents spawned.

Appendix C3. Modeling Assumptions and Inputs for EIS Alternatives and Scenarios

The effects on listed and unlisted salmon and socio-economic impacts evaluated in the Environmental Impact Statement were determined by the distribution and magnitude of catch, fishing opportunity (sport angler trips) and escapement. The Fisheries Regulation Assessment Model (FRAM) and other sources of data were used to predict catch, exploitation rates, angler trips and escapement. Results were reported for five regional fisheries consistent with the available FRAM model output:

Regional Fishery	Washington Catch Areas
Strait of Juan de Fuca	4B (except May-September when area is under the jurisdiction of the Pacific Fisheries Management Council), 5, 6, 6A, 6C Dungeness Bay (6D) All freshwater rivers flowing into the Strait of Juan de Fuca.
North Puget Sound	7, 7A Bellingham Bay (7B, 7C, 7D) All freshwater rivers flowing into these marine areas.
Central Puget Sound	8, , 8A, 9 Skagit Bay (8) Tulalip Bay (8D) All freshwater rivers flowing into these marine areas.
South Puget Sound	Marine areas 10,11,13, 13A-13K Eliott Bay (10A) Sinclair Inlet (10E) Commencement Bay (11A) Lake Washington and a freshwater rivers flowing into South Puget Sound marine areas.
Hood Canal	Marine areas 12, 12B, 12C Port Gamble Bay (9A) Quilcene/Dabob Bays (12A) All freshwater rivers flowing into these marine areas.

The following sections describes the assumptions made regarding the abundance of contributing salmon stocks and the structure of fisheries, in order to predict the catch and escapement of the five species of salmon associated with each alternative. As described below (C4), the FRAM allows a very detailed assessment of commercial and recreational harvest of chinook and coho salmon in Puget Sound, based on equally detailed input of expected stock abundance and the expected fishery regime, and predicts natural and hatchery escapement for management units or, with subsequent analysis, individual populations. Chinook catch and escapement were analyzed in greater detail (four scenarios), to consider the effects of variable northern (Canadian/Alaskan) intercepting fisheries and of variable abundance.

Fisheries for other species (i.e., pink, sockeye, coho, and chum salmon) are managed to achieve escapement goals established for management units. Their harvest distribution is analyzed in less detail because the structure of fisheries, which are primarily commercial, is much less complex. For species other than chinook salmon the effects of variable abundance were not modeled or described.

Catch and escapement for each species of salmon was reported for each Puget Sound management unit, with catch in regional fisheries detailed where applicable. Total exploitation rates were estimated for each management unit. Estimates of total mortality and escapement were also reported for hatchery and naturally-spawning components where applicable. Exploitation rates were assumed to be the same for hatchery- and naturally-spawning components since the information is not available to distinguish between the two components.

With the forecast abundance of hatchery production and natural components, and the expected catch in all fisheries as input, the FRAM estimates catch by fishery and escapement for individual management units of chinook and coho salmon. Catch was reported either as catch of all populations within a region, or catch of a mangement unit across all regional fisheries.

For management units with multiple populations, the exploitation rate for each population was assumed to be the same as that of the management unit because the available model does not distinguish among populations. At this time, one coded-wire tag indicator stock is used to represent the exploitation rate on all populations within a management unit. A more detailed description of the FRAM is provided below in C4.

Chinook Salmon

Alternative 1

To simplify the analysis, and yet give a current perspective on the outcome of fisheries, modeling chinook salmon catch and escapement for the four alternative fishing regimes was based on the forecasts of abundance developed for pre-season planning in 2003. Modeling of Alternative 1 was based on the 2003 pre-season FRAM run, with some adjustments in the harvest objectives (e.g, Exploitation Rate [ER] ceilings) for some management units to reflect the ~~proposed 2004–2009~~ Puget Sound Chinook Harvest Management Plan (HMP) proposed for implementation during the 2005–2009 fishing seasons, and consequent shaping of fisheries to achieve all those objectives. The pre-season (prior to implementation of the fisheries) expectations in 2003 were used to assess Alternative 1 because: 1) 2003 is generally representative of status quo conditions – management objectives were identical to the proposed Puget Sound chinook harvest plan; 2) it includes impacts to chinook that occur in pink fisheries that do not occur in even-numbered years, and; 3) pre-season expectations better reflect the intended implementation of the HMP.

The pre-season 2003 fishing regime provides a valid general example of management intent under the HMP. Because chinook salmon from critical and non-critical units commingle in many marine areas, meeting the objectives for the weak stocks implies that otherwise-surplus chinook from strong units will not be harvested. In principle, this surplus could be harvested selectively in freshwater areas. However, the HMP states that stronger stocks will only be harvested 'down' to their escapement goals, or 'up' to their ER ceilings, if they meet stringent criteria defining harvestable surplus. It was assumed that these conditions would not be met during the term of the proposed HMP, so for many units (e.g., Skagit spring, Stillaguamish, Snohomish), the surplus was accrued to escapement. For other units (e.g., Green, Nisqually, Puyallup), harvestable surplus was forecasted, so the pre-season FRAM was configured to harvest that surplus, 'up' to the Recovery Exploitation Rate (RER), or 'down' to the stated escapement goal.

Chinook salmon escapement estimates for each Puget Sound management unit were taken from FRAM runs that simulated each scenario under Alterative 1. The FRAM subtracts fishery-related mortality that occurs through the month of September from the initial (i.e., unfished) abundance of each unit, then discounts the contribution of surviving 2-, 3-, and 4-year-old fish, according to their maturation rates.

<u>Alternatives 2 and 3</u>

Due to the implications of escapement goal management, Alternatives 2 and 3 involved similar, very sweeping changes in the distribution of fisheries, relative to Alternative 1. Under Alternative 3, terminal-area fisheries were defined as those harvesting only local-origin chinook. For example, the terminal area for the Skagit River would be defined where only Skagit-origin chinook would be caught. However, it was determined at the outset that virtually all marine area fisheries in Puget Sound encounter a mixture of Puget Sound chinook stocks. Since the abundance of one or more of these commingled stocks was below their escapement goals, marine area fishing was precluded under both Alternative 2 and 3. It was assumed that freshwater fishing areas harvested only the local management unit, and, in the case of the Skagit River where spring and summer/fall chinook units are present, they could be selectively harvested in management periods. In actuality, straying probably occurs naturally in all systems, so that even freshwater fisheries may encounter small numbers of non-local chinook. The fisheries regime developed to model Alternatives 2 and 3 allowed freshwater chinook fisheries to occur where abundance exceeded the escapement goals. Where chinook abundance was less than the escapement goals, chinook fisheries, and fisheries directed at other salmon species that incur incidental chinook mortality, were precluded.

With commercial and recreational fishing limited to freshwater areas, the technical workgroup assessed the extent to which harvestable surplus could be caught. It was assumed that treaty commercial and recreational fisheries would operate at their current scale of effort (i.e., fleet sizes, recreational trips), use existing gear types and season structure, and occur only in rivers where such commercial or recreational fishing has occurred in recent years. For example, if a large harvestable surplus was forecast to occur for a given stock, a priori judgment determined whether the local tribal commercial fleet effort (operating within their defined 'usual and accustomed area') and recent freshwater recreational angling effort could reasonably catch the harvestable surplus. Based on past harvest rates and harvest rates in areas of similar fleet size and fishery structure, the workgroup concluded that the Green River fishery was capable of harvesting the full amount of chinook (11,500) above the escapement goal. In contrast, it was determined that the current fleet size and fishery structure in the Nooksack-Samish area would not be capable of harvesting the total surplus of fall chinook (41,900) above its hatchery escapement goal.

If the lack of harvestable surplus chinook precluded freshwater fisheries that would directly or incidentally harvest chinook, late-season chum and steelhead fisheries (i.e., those occurring from December through March) were assumed free of incidental impacts to listed chinook, and thus included in Alternative 2 and 3. The co-managers' fish ticket database provided support for this assumption.

No new fisheries were envisioned for Alternative 2 or 3. For example, non-tribal commercial fisheries have not occurred in the Strait of Juan de Fuca (Marine Catch Areas 4B, 5, and 6C), deep South Puget Sound (Marine Catch Areas 13 through 13I), or freshwater areas for at least two decades, based on agreements with the tribes and to meet allocation objectives among non-tribal commercial and recreational users. It was assumed that the size of treaty gillnet fishing fleets that have operated recently in these freshwater areas would not expand. Fishing was not expanded to any freshwater areas that have not been recently opened to commercial or freshwater salmon harvest, even though, with the closure of marine areas, substantial harvestable surplus was projected to occur in some such areas. Similarly, it was assumed that recreational effort or regulatory bag limits would not increase, and the current scale of mark selective fisheries would not expand. These somewhat qualitative assessments of the harvest capability of existing commercial and recreational fisheries were made by a small group of WDFW and tribal fisheries management biologists.

With forecasts of which stocks would return with harvestable abundance, and having determined the potential for current fishing effort to harvest that surplus, harvest scalars or catch levels were input accordingly to the FRAM. The primary distinction between the structure of fisheries in Alternatives 2 and 3 was due to different escapement goals. When more than one population returns to a given river, for some management units Alternative 3 would set a more constraining escapement goal for the management units appropriate to its weakest population.

The principle difference between the chinook salmon harvest allowed under Alternatives 2 and 3, and consequently the difference in allowable harvest of other species, was due to the harvestable surplus of listed chinook in the Snohomish and Stillaguamish units associated with Alternative 2. The chinook surplus also enabled harvest of pink, coho, and chum salmon in the Stillaguamish River and in Tulalip Harbor (Area 8D). Area 8D is an isolated marine area, adjacent to the hatchery facilities of the Tulalip Tribes; harvest in that area is believed not to harvest non-local chinook.

Chinook escapement was estimated as the catch subtracted from the predicted abundance, i.e., those fish that escaped the fishery to spawn. It should be noted that the escapement does not increase by the same amount as the difference in catch between Alternatives 2 or 3 and Alternative 1. This is because escapement is comprised of those fish that escape fisheries to spawn. In the absence of fisheries, not all fish would escape. Some would die of natural causes, and some fish would remain in marine waters to mature and return to spawn in future years.

<u>Alternative 4</u>

Alternative 4 involves the closure of all fisheries that would harvest any listed Puget Sound chinook salmon, regardless of their forecast abundance status, precluding all marine area fisheries, and all freshwater fisheries except those late-season chum and steelhead fisheries (operating from December through March) that would have no incidental impact to chinook.

<u>Abundance and Northern (Canadian/Alaskan) Fishery Scenarios</u>

NMFS decided early in the DEIS analysis to examine the contingent effects of variable abundance, and increasing northern (Canadian/Alaskan) fishery interceptions, on harvest and escapement of Puget Sound chinook. As explained in DEIS Section 2, Alternatives Including the Proposed Action, the two abundance conditions modeled for Puget Sound chinook were the 2003 forecast level, and 30 percent reduced abundance (Table C3-1). The need to examine the effects of variable abundance was driven, in part, by the widely accepted view that marine survival has varied in a cyclic manner (Mantua et al. 1997), and evidence that freshwater survival has also varied widely under the primary influence of incubation period flows (Seiler et al. 2002). The reduced abundance condition was based on observations of the period 1990 through 1999, for which average, aggregate abundance of all Puget Sound salmon stocks, natural and hatchery production combined, was approximately 30 percent lower than forecast for 2003. Individual natural and hatchery stocks varied independently to a greater or lesser extent

Table C3-1. Annual abundance of Puget Sound chinook salmon management units under 2003 forecasted and 30 percent reduced conditions, expressed as AEQ catch and escapement from the FRAM.

	2003	-30%
Nooksack	1849	1294
Skagit S/F	23287	16301
Skagit Spr	1475	1032
Stillaguamish	2849	1994
Snohomish	6356	4449
L. Washngton	8809	6166
Green	31128	21789
White	1858	1301
Puyallup	11548	8084
Nisqually	27040	18928
Hood Can	47542	33279
JDF	4234	2964

Chinook salmon abundance during the term of the proposed HMP cannot be forecasted exactly, and may in fact increase from the 2003 level. However, the average of the previous decade provides a reasonable view of the potential for abundance to decline.

It was necessary to examine the effects of higher northern (Canadian/Alaskan) fishery interceptions because the stated intent of the Canada Department of Fisheries and Oceans, and recent-year catch estimates support this likelihood. The modeled high northern fishery condition comprised different assumptions for the various areas. The west coast Vancouver Island troll fishery, and troll fisheries in Southeast Alaska were modeled at the maximum levels allowed by the current Chinook Annex to the Pacific Salmon Treaty (PST). Canadian fisheries in the Strait of Georgia and the Strait of Juan de Fuca were modeled as the observed catch in 1996 and 2002, respectively. Other northern fisheries were modeled at the level forecast for 2003.

Recreational Effort

To assess economic consequences, it was necessary to estimate recreational fishing effort for each alternative. To estimate the number of recreational trips corresponding to modeled harvest, catches of all salmon, whether caught in marine areas or freshwater, and including chinook and coho from FRAM runs, were multiplied by 4. This generic estimate of salmon 'angler success' (i.e., 0.25 fish per trip) was derived from the WDFW Catch Record Card Analysis used to estimate recreational catch and effort on an annual basis.

Other Salmon Species

Modeled catch only differed among alternatives, and was not specified differently for the abundance / northern (Canadian/Alaskan) fishery scenarios, which were intended to assess only the effect of variable chinook abundance and northern fisheries on chinook catch. The high and 2003 northern fishery conditions included in the scenarios may imply a different level of coho catch in Canada, and therefore affect coho catch in Puget Sound, but these indirect effects could not be reliably predicted.

Coho

Commercial and recreational coho salmon harvest was extracted directly from the final 2003 pre-season coho FRAM model for Alternative 1. For Alternatives 2 and 3, marine area fisheries were closed, and only those freshwater fisheries left open where harvestable chinook abundance also enabled coho harvest. These open fisheries corresponded to those in the chinook models created to simulate Alternatives 2 and 3. No coho fishing was allowed under Alternative 4.

Coho escapement estimates for each Puget Sound management unit extracted from FRAM 0319 (April 2003) for Alternative 1, and modified as necessary to simulate the freshwater fisheries associated with Alternatives 2, 3, and 4.

Sockeye

Sockeye salmon are primarily caught by commercial fisheries in marine fishing areas, in particular those fisheries directed at Fraser River (British Columbia) stocks that occur in the Strait of Juan de Fuca (SJDF) and San Juan Islands (SJI). However, in years when the Lake Washington sockeye run exceeds its escapement goal (325,000), commercial and recreational fisheries occur in the Lake Washington Ship Canal and Lake Washington, respectively. Relatively small tribal commercial fisheries, intended to harvest Lake Washington sockeye salmon, also occur in Central Puget Sound under this circumstance. The Baker River (Skagit system) sockeye salmon stock has occasionally returned at levels slightly above the escapement goal, but the small surplus has been harvested in the river by tribes for ceremonial and subsistence purposes. This Baker River fishery was not included in any alternative model.

For Alternative 1, Fraser sockeye catch in the SJDF and SJI areas was modeled as the average of actual catch in 1998–2002. Lake Washington sockeye catch in marine and freshwater areas was modeled as the average of three recent years in which these fisheries occurred – 1996, 2000, and 2002. For Alternatives 2, 3 and 4, no sockeye catch was modeled, because the marine areas were closed due to commingled weak chinook stocks, and the terminal (freshwater) areas were closed because the forecast abundance of Lake Washington (Cedar River) chinook was below the escapement goal.

Pink

Pink salmon harvest occurs primarily in odd-numbered years in Puget Sound, due to the predominance of odd-year returning stocks in Puget Sound and southern British Columbia. The majority of pink salmon harvest occurs in treaty and non-Indian commercial fisheries directed at Fraser River stocks that occur in the SJDF and SJI in August and September. For Alternative 1, pink harvest in these marine areas was modeled as the average of the last three fisheries (i.e., 1997, 1999, and 2001).

A subset of pink salmon stocks in Puget Sound systems has consistently reached harvestable abundance, so models of Alternatives 1, 2, and 3 included terminal-area marine and/or freshwater, commercial and recreational fisheries to harvest that surplus. These abundant stocks include those in the Skagit, Stillaguamish, Snohomish, and Puyallup Rivers. These fisheries were modeled for Alternative 1 as they were projected during 2001 pre-season planning from forecast abundance.

Pink salmon stocks in Puget Sound are managed to achieve escapement goals. Harvestable surplus is projected to occur, during pre-season planning, based on the surplus in excess of escapement goals, allocated to treaty and non-Indian fisheries.

Chum

Commercial fisheries directed at fall chum salmon occur throughout Puget Sound in marine and freshwater areas. Harvestable surplus was modeled for Alternative 1 according to 2001 forecast abundance in excess of escapement goals. Fall chum fisheries generally extend from the last week of October through mid-December in freshwater areas, so harvest in December comprises a small proportion of the total harvestable abundance. Recreational chum salmon catch in marine and freshwater areas was modeled as the 1997–1999 average, from Catch Record Card estimates. For

Alternatives 2 and 3, chum salmon harvest was precluded in some rivers due to the lack of surplus chinook that would be caught incidentally, except in the late season (December) when chinook are absent. The late chum stock that returns to the Nisqually River supports commercial and recreational fisheries that extend from December through January, so it is the only salmon population that would be harvested as usual under Alternative 4.

For Alternatives 2 and 3, chum salmon fisheries in freshwater were modeled to harvest surplus chum, subject to the availability of surplus chinook that would be caught incidentally.

Steelhead

Small-scale commercial fisheries for winter steelhead are promulgated by the tribes in many freshwater areas, and usually extend from December through April. Recreational steelhead fisheries are not included in the Proposed Action. Commercial steelhead catch was modeled according to pre-season forecasts (Status Reports) in some areas, and from recent-year average catch in other areas. Summer steelhead fisheries, defined for the purpose of this modeling exercise as those occurring from June through November, were included in the model for Alternative 1, but not in models for Alternatives 2, 3, or 4.

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-1. Total fishing related mortality of Puget Sound hatchery and natural chinook stocks: Scenario A

Alternative 1--Proposed Action

Chinook (by MU/Pop)	Objective		Regional Stocks Only: All Fisheries						SUS Sport Mortality		SUS Net &Troll Mortality		AK and BC Mortality	
				AEQ Mortality		Escapement								
	Exp. Rate	Escapement	Exp.Rate	Hatchery	Natural	Hatchery	Natural	SUS ER	Total AEQ	Landed	Total AEQ	Landed	Total AEQ	Landed
Juan de Fuca (Area 5, 6)									135	80	67	70	743	797
Dungeness Spring	10% SUS ER		0.22	--	100	--	352	0.05	14	8	7	7	79	85
Western Strait-Hoko	10% SUS ER		0.23	--	230	--	785	0.05	33	20	16	17	181	194
Elwha	10% SUS ER		0.22	--	615	--	2,125	0.05	88	52	43	46	483	518
North Sound (Area 7)														
Nooksack Spring	7% SUS ER		0.20	--	96	--	388	0.07	5	4	30	33	60	51
Nooksack/Samish summer-fall			0.84	54,124	--	10,044	--	0.84	6,049	5,868	40,602	40,675	7,473	9,079
Central Sound (Area 8, 9)														
Skagit														
Spring	38% Total ER		0.23	341	577	1,136	1,921	0.14	336	348	233	222	349	408
Upper Sauk														
Suiattle														
Upper Cascade														
Summer/Fall	50% Total ER		0.48	108	10,662	118	11,633	0.18	1,443	1,310	2,516	2,584	6,811	9,704
Lower Sauk														
Upper Skagit														
Lower Skagit														
Stillaguamish	25% Total ER		0.17	--	471	--	2,322	0.11	153	142	166	171	152	212
Snohomish	21% Total ER		0.19	2,117	1,218	4,564	5,073	0.14	1,435	1,377	914	948	986	1,238
Tulalip Tribal Hatchery			0.99	9,175	--	98	--	0.99	1,795	2,100	6,969	6,918	411	462
South Sound (Area 10,11,13)														
Lake Washington (w Cedar River index)	15% pre-terminal SUS ER		0.31	3,118	272	4,937	305	0.20	835	738	1,267	1,300	1,289	1,709
Green-Duwamish	15% pre-terminal SUS ER	5800	0.62	10,415	9,397	5,016	5,819	0.51	4,042	3,776	11,897	12,125	3,873	5,134
Puyallup	50% Total ER		0.49	4,284	2,338	2,338	2,392	0.39	1,825	1,718	3,278	3,308	1,518	2,013
Nisqually		1100	0.76	16,467	3,487	4,911	1,106	0.68	6,421	5,774	11,542	11,651	1,991	2,639
White Spring	20% Total ER		0.20	--	366	--	1,468	0.19	105	103	250	253	11	14
Gorst, Grovers, Minter, Chambers & McAllister, Deschutes			0.54	35,136		29,528	--	0.44	11,573	10,406	17,106	15,382	6,458	8,562
Hood Canal (Area 12)														
Mid-Canal	15% pre-terminal SUS ER		0.26	--	188	--	531	0.13	56	50	39	45	95	127
Skokomish	15% pre-terminal SUS ER	1200 nat.	0.63	9,792	2,020	6,104	1,211	0.50	4,116	3,952	5,198	5,420	2,497	3,361
Hoodsport H, Dewato, Union, Tahuya tribs.			0.76	19,272	225	5,594	591	0.63	2,286	2,030	13,909	14,202	3,301	4,443

LA WA components:									
all natural (cedar plus N trib)	**0.31**	**0**	**272**	**0**	**610**		**49**	**131**	**92**
cedar only natural	**0.31**	**0**	**136**	**0**	**305**		**25**	**65**	**46**
all hatchery	**0.40**	**3,118**	**0**	**4,632**	**0**		**785**	**1,136**	**1,197**
Combined	**0.39**	**3,118**	**272**	**4,632**	**610**		**835**	**1,267**	**1,289**

Table C3-2. Total fishing-related mortality of all chinook (U.S. and Canadian) by Puget Sound regional fishery: Scenario A

Alternative 1--Proposed Action

Region	All Stocks in Regional Fisheries: Sport				Net and Troll		
	Mortality		Salmon Angler Trips		Mortality	Landed Catch	
	Total AEQ	Landed	Marine	Freshwater	AEQ	Treaty	NonTreaty
Juan de Fuca (Area 5, 6)	10,840	6,465	268,418	21,030	2,580	2,363	0
North Sound (Area 7)	9,740	7,999	41,857	55,261	47,180	22,648	23,853
Central Sound (Area 8, 9)	21,552	8,608	170,440	351,773	9,514	9,165	250
South Sound (Area 10,11,13)	41,060	27,393	188,834	277,041	37,063	35,026	1,939
Hood Canal (Area 12)	4,509	3,696	54,014	13,946	9,371	16,962	140
TOTAL	87,700	54,160	723,563	719,051	105,707	86,163	26,182

Angler trips during "base" Sport Catch Area	**Marine**	**Freshwater**
Area 5	42,841	89
Area 6	19,275	4,777
Area 7	33,132	43,741
Area 8	51,743	218,796
Area 9	54,268	0
Area 10	40,291	188,282
Area 11	75,935	21,832
Area 12	19,588	5,057
Area 13	34,875	11,569

Angler-trips this run	
Juan de Fuca (Area 5, 6)	289,448
North Sound (Area 7)	97,119
Central Sound (Area 8, 9)	522,213
South Sound (Area 10,11,13)	465,874
Hood Canal (Area 12)	67,960
	1,442,614

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-3. Total fishing related mortality of Puget Sound hatchery and natural chinook stocks: Scenario A

Alternative 2-Escapement Goal Management at the Management Unit Level

Chinook (by MU/Pop)	Regional Stocks Only													
	Objective		All Fisheries						SUS Sport		SUS Net &Troll		AK and BC	
				AEQ Mortality		Escapement			Mortality		Mortality		Mortality	
	Exp. Rate	**Escapement**	**Exp.Rate**	**Hatchery**	**Natural**	**Hatchery**	**Natural**	**SUS ER**	**Total AEQ**	**Landed**	**Total AEQ**	**Landed**	**Total AEQ**	**Landed**
Juan de Fuca (Area 5, 6)									0	0	24	24	746	801
Dungeness Spring		**925**	0.19	--	82	--	360	0.01	0	0	3	3	79	85
Western Strait-Hoko		**850**	0.19	--	184	--	807	0.01	0	0	6	6	178	192
Elwha		**2,900**	0.19	--	504	--	2,172	0.01	0	0	16	16	488	524
North Sound (Area 7)														
Nooksack Spring	7% SUS ER	**4,000**	0.14	--	70	--	422	0.01	0	0	6	8	64	54
Nooksack/Samish summer-fall		**8,900**	0.44	26,496	--	33,887	--	0.44	16,384	16,388	2,601	2,858	7,511	9,123
Central Sound (Area 8, 9)														
Skagit														
Spring		**2,000**	0.12	162	273	1,229	2,073	0.02	0	0	69	73	365	420
Upper Sauk														
Suiattle														
Upper Cascade														
Summer/Fall		**14,500**	0.32	69	6,879	147	14,656	0.01	41	55	74	92	6,833	9,719
Lower Sauk														
Upper Skagit														
Lower Skagit														
Stillaguamish		**900**	0.66	--	1,768	--	903	0.60	782	782	829	832	157	219
Snohomish		**4,600**	0.22	2,306	1,313	4,024	4,634	0.16	1,104	1,105	1,491	1,501	1,025	1,286
Tulalip Tribal Hatchery		--	0.98	8,676	--	195	--	0.98	20	17	8,235	8,139	421	474
South Sound (Area 10,11,13)														
Lake Washington (w Cedar River index)		**1,200**	0.18	1,589	133	5,755	307	0.05	14	18	398	473	1,309	1,736
Green-Duwamish		**5,800**	0.55	7,937	7,036	5,948	5,800	0.42	4,532	4,543	6,510	6,769	3,931	5,213
Puyallup		**1,200**	0.70	4,916	2,795	1,100	1,200	0.57	963	968	5,206	5,303	1,541	2,044
Nisqually		**1,100**	0.72	13,197	2,885	4,913	1,100	0.63	1,822	1,847	12,205	12,528	2,054	2,724
White Spring		**1,000**	0.46	--	860	--	1,000	0.46	416	0	432	434	13	15
Gorst, Grovers, Minter, Chambers & McAllister, Deschutes		**9,600**	0.30	16,604		38,545	--	0.18	2,805	2,843	7,193	7,291	6,606	8,762
Hood Canal (Area 12)														
Mid-Canal		**750**	0.19	--	127	--	552	0.05	6	7	27	32	96	129
Skokomish		**1200**	0.60	8,850	1,816	6,174	1,218	0.46	3,197	3,242	4,939	5,092	2,530	3,403
Hoodsport H, Dewato, Union, Tahuya tribs.		**1,850**	0.90	21,315	144	1,851	625	0.76	202	261	17,912	18,115	3,345	4,498

LA WA components:									
all natural (cedar plus N trib)	**0.18**	**0**	**133**	**0**	**614**		**1**	**38**	**93**
cedar only natural	**0.18**	**0**	**66**	**0**	**307**		**0**	**19**	**47**
all hatchery	**0.23**	**1,589**	**0**	**5,448**	**0**		**13**	**360**	**1,215**
Combined	**0.22**	**1,589**	**133**	**5,448**	**614**		**14**	**398**	**1,309**

Table C3-4. Total fishing-related mortality of all chinook (U.S. and Canadian) by Puget Sound regional fishery: Scenario A

Alternative 2-Escapement Goal Management at the Management Unit Level

Region	All Stocks in Regional Fisheries						
	Sport				Net and Troll		
	Mortality		Salmon Angler Trips		Mortality	Landed Catch	
	Total AEQ	**Landed**	**Marine**	**Freshwater**	**AEQ**	**Treaty**	**NonTreaty**
Juan de Fuca (Area 5, 6)	0	0	0	0	0	0	0
North Sound (Area 7)	16,147	16,147	0	69,659	0	0	0
Central Sound (Area 8, 9)	1,100	1,100	0	55,875	9,730	8,531	2
South Sound (Area 10,11,13	9,800	9,800	0	85,277	23,734	24,150	0
Hood Canal (Area 12)	3,044	3,044	0	21,130	9,371	21,213	0
TOTAL	30,091	30,091	0	231,940	42,835	53,893	2

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-5. Total fishing related mortality of Puget Sound hatchery and natural chinook stocks: Scenario B

Alternative 3--Escapement Goal Management at the Population Level

Chinook (by MU/Pop)	Regional Stocks Only													
	Objective		All Fisheries						SUS Sport		SUS Net &Troll		AK and BC	
				AEQ Mortality		Escapement			Mortality		Mortality		Mortality	
	Exp. Rate	Escapement	Exp.Rate	Hatchery	Natural	Hatchery	Natural	SUS ER	Total AEQ	Landed	Total AEQ	Landed	Total AEQ	Landed
Juan de Fuca (Area 5, 6)									0	0	24	24	746	801
Dungeness Spring		**925**	0.19	--	82	--	360	0.01	0	0	3	3	79	85
Western Strait-Hoko		**850**	0.19	--	184	--	807	0.01	0	0	6	6	178	192
Elwha		**2,900**	0.19	--	504	--	2,172	0.01	0	0	16	16	488	524
North Sound (Area 7)														
Nooksack Spring	7% SUS ER	**4,000**	0.14	--	70	--	422	0.01	0	0	6	8	64	54
Nooksack/Samish summer-fall		**8,900**	0.44	26,496	--	33,887	--	0.44	16,384	16,388	2,601	2,858	7,511	9,123
Central Sound (Area 8, 9)														
Skagit														
Spring		**2,000**	0.12	161	272	1,230	2,074	0.02	0	0	67	71	366	420
Upper Sauk		**986**												
Suiattle		**574**												
Upper Cascade		**440**												
Summer/Fall		**14,500**	0.32	69	6,879	147	14,656	0.01	41	55	74	92	6,833	9,719
Lower Sauk		**1,926**												
Upper Skagit		**8,434**												
Lower Skagit		**4,140**												
NF Stillaguamish		**600**	0.08	--	201	--	2,468	0.02	0	0	44	47	157	219
SF Stillaguamish		**300**												
Skykomish		**3,600**	0.10	1,253	617	4,933	5,475	0.04	531	532	314	325	1,025	1,286
Snoqualmie		**1,000**												
Tulalip Tribal Hatchery		--	0.10	842	--	7,906	--	0.10	20	17	401	459	421	474
South Sound (Area 10,11,13)														
Lake Washington (w Cedar River index)		**1,200**	0.18	1,588	132	5,756	307	0.05	14	18	397	473	1,309	1,736
Green-Duwamish		**5,800**	0.55	7,937	7,036	5,948	5,800	0.42	4,532	4,544	6,510	6,768	3,931	5,213
Puyallup		**1,200**	0.70	4,916	2,795	1,100	1,200	0.57	963	968	5,206	5,303	1,541	2,044
Nisqually		**1,100**	0.72	13,197	2,885	4,913	1,100	0.63	1,822	1,847	12,205	12,528	2,054	2,724
White Spring		**1,000**	0.46	--	860	--	1,000	0.46	416	0	432	434	13	15
Gorst, Grovers, Minter, Chambers & McAllister, Deschutes		**9,600**	0.30	16,602		38,547	--	0.18	2,805	2,843	7,191	7,289	6,606	8,762
Hood Canal (Area 12)														
Mid-Canal		**750**	0.19	--	127	--	552	0.05	6	7	27	32	96	129
Skokomish		**1200**	0.60	8,849	1,816	6,175	1,218	0.46	3,197	3,242	4,938	5,091	2,530	3,403
Hoodsport H, Dewato, Union, Tahuya tribs.		**1,850**	0.90	21,315	144	1,851	625	0.76	202	261	17,912	18,114	3,345	4,498

LA WA components:	Exp.Rate	AEQ Mortality Hatchery	AEQ Mortality Natural	Escapement Hatchery	Escapement Natural	SUS ER	SUS Sport Total AEQ	SUS Net &Troll Total AEQ	AK and BC Total AEQ
all natural (cedar plus N trib)	**0.18**	**0**	**132**	**0**	**614**		**1**	**38**	**93**
cedar only natural	**0.18**	**0**	**66**	**0**	**307**		**0**	**19**	**47**
all hatchery	**0.23**	**1,588**	**0**	**5,449**	**0**		**13**	**359**	**1,215**
Combined	**0.22**	**1,588**	**132**	**5,449**	**614**		**14**	**397**	**1,309**

Table C3-6. Total fishing-related mortality of all chinook (U.S. and Canadian) by Puget Sound regional fishery: Scenario B

Alternative 3--Escapement Goal Management at the Population Level

Region	All Stocks in Regional Fisheries						
	Sport				Net and Troll		
	Mortality		Salmon Angler Trips		Mortality	Landed Catch	
	Total AEQ	Landed	Marine	Freshwater	AEQ	Treaty	NonTreaty
Juan de Fuca (Area 5, 6)	0	0	0	0	0	0	0
North Sound (Area 7)	16,147	16,147	0	69,659	0	0	0
Central Sound (Area 8, 9)	29	29	0	1,461	0	0	0
South Sound (Area 10,11,13)	9,801	9,801	0	85,279	23,737	24,153	0
Hood Canal (Area 12)	3,044	3,044	0	21,130	9,371	21,215	0
TOTAL	29,021	29,021	0	177,529	33,108	45,368	0

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-7. Total fishing related mortality of Puget Sound hatchery and natural chinook stocks: Scenario A

Alternative 4--No Action/No Authorized Take

Chinook (by MU/Pop)	Objective		Regional Stocks Only: All Fisheries						SUS Sport Mortality		SUS Net &Troll Mortality		AK and BC Mortality	
				AEQ Mortality		Escapement								
	Exp. Rate	Escapement	Exp.Rate	Hatchery	Natural	Hatchery	Natural	SUS ER	Total AEQ	Landed	Total AEQ	Landed	Total AEQ	Landed
Juan de Fuca (Area 5, 6)									0	0	24	24	746	801
Dungeness Spring	10% SUS ER		0.19	--	82	--	360	0.01	0	0	3	3	79	85
Western Strait-Hoko	10% SUS ER		0.19	--	184	--	807	0.01	0	0	6	6	178	192
Elwha	10% SUS ER		0.19	--	504	--	2,172	0.01	0	0	16	16	488	524
North Sound (Area 7)														
Nooksack Spring	7% SUS ER		0.14	--	70	--	422	0.01	0	0	6	8	64	54
Nooksack/Samish summer-fall			0.51	10,349	--	10,083	--	0.51	237	241	2,601	2,858	7,511	9,123
Central Sound (Area 8, 9)														
Skagit														
Spring	42% Total ER		0.12	161	272	1,230	2,074	0.02	0	0	67	71	366	420
Upper Sauk														
Suiattle														
Upper Cascade														
Summer/Fall	52% Total ER		0.32	69	6,879	147	14,656	0.01	41	55	74	92	6,833	9,719
Lower Sauk														
Upper Skagit														
Lower Skagit														
Stillaguamish	25% Total ER		0.08	--	201	--	2,468	0.02	0	0	44	47	157	219
Snohomish	24% Total ER		0.09	778	564	5,432	5,504	0.03	3	4	314	325	1,025	1,286
Tulalip Tribal Hatchery			0.10	842	--	7,906	--	0.10	20	17	401	459	421	474
South Sound (Area 10,11,13)														
Lake Washington (w Cedar River index)	15% pre-terminal SUS ER	1200	0.18	1,588	132	5,756	307	0.05	14	18	397	473	1,309	1,736
Green-Duwamish	15% pre-terminal SUS ER	5800 spawners?	0.18	3,058	2,278	10,827	10,558	0.05	41	53	1,363	1,622	3,931	5,213
Puyallup	50% Total ER		0.18	1,359	709	4,656	3,286	0.05	16	21	511	608	1,541	2,044
Nisqually		1100 spawners?	0.16	3,201	647	14,908	3,338	0.07	89	114	1,705	2,028	2,054	2,724
White Spring	20% Total ER		0.02	--	29	--	1,831	0.01	0	0	16	18	13	15
Gorst, Grovers, Minter, Chambers & McAllister, Deschutes			0.20	10,577		41,786	--	0.08	175	224	3,796	4,861	6,606	8,762
Hood Canal (Area 12)														
Mid-Canal	15% pre-terminal SUS ER	750 spawners??	0.19	--	127	--	552	0.05	6	7	27	32	96	129
Skokomish	15% pre-terminal SUS ER	**1200**	0.19	2,811	577	12,214	2,482	0.05	153	197	704	857	2,530	3,403
Hoodsport H, Dewato, Union, Tahuya tribs.			0.19	4,334	144	18,833	625	0.05	202	261	930	1,133	3,345	4,498

LA WA components:	Exp.Rate	AEQ Hatchery	AEQ Natural	Esc. Hatchery	Esc. Natural	SUS ER	SUS Sport Total AEQ	SUS Net &Troll Total AEQ	AK and BC Total AEQ
all natural (cedar plus N trib)	**0.18**	**0**	**132**	**0**	**614**		**1**	**38**	**93**
cedar only natural	**0.18**	**0**	**66**	**0**	**307**		**0**	**19**	**47**
all hatchery	**0.23**	**1,588**	**0**	**5,449**	**0**		**13**	**359**	**1,215**
Combined	**0.22**	**1,588**	**132**	**5,449**	**614**		**14**	**397**	**1,309**

Table C3-8. Total fishing-related mortality of all chinook (U.S. and Canadian) by Puget Sound regional fishery: Scenario A

Alternative 4--No Action/No Authorized Take

Region	All Stocks in Regional Fisheries: Sport				Net and Troll		
	Mortality		Salmon Angler Trips		Mortality	Landed Catch	
	Total AEQ	Landed	Marine	Freshwater	AEQ	Treaty	NonTreaty
Juan de Fuca (Area 5, 6)	0	0	0	0	0	0	0
North Sound (Area 7)	0	0	0	840	0	0	0
Central Sound (Area 8, 9)	0	0	0	1,344	0	0	0
South Sound (Area 10,11,13)	0	0	0	2,092	0	0	0
Hood Canal (Area 12)	0	0	0	32	9,371	0	0
TOTAL	0	0	0	4,308	9,371	0	0

Sport Catch Area	Salmon Angler Trips Marine	Freshwater
Area 5	42,841	89
Area 6	19,275	4,777
Area 7	33,132	43,741
Area 8	51,743	218,796
Area 9	54,268	0
Area 10	40,291	8,682
Area 11	75,935	21,832
Area 12	19,588	5,057
Area 13	34,875	11,569

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-9. Total fishing related mortality of Puget Sound hatchery and natural chinook stocks: Scenario B

Alternative 1--Proposed Action

Chinook (by MU/Pop)	Objective		Regional Stocks Only: All Fisheries												
				AEQ Mortality		Escapement			SUS Sport Mortality		SUS Net &Troll Mortality		AK and BC Mortality	
	Exp. Rate	Escapement	Exp.Rate	Hatchery	Natural	Hatchery	Natural	SUS ER	Total AEQ	Landed	Total AEQ	Landed	Total AEQ	Landed
Juan de Fuca (Area 5, 6)									134	79	67	70	998	1,085
Dungeness Spring	10% SUS ER		0.27	--	127	--	336	0.05	14	8	7	7	106	115
Western Strait-Hoko	10% SUS ER		0.28	--	293	--	750	0.05	33	19	16	17	243	265
Elwha	10% SUS ER		0.28	--	780	--	2,031	0.05	87	51	43	46	649	705
North Sound (Area 7)														
Nooksack Spring	7% SUS ER		0.25	--	121	--	365	0.07	5	4	31	34	85	50
Nooksack/Samish summer-fall			0.85	56,201	--	9,855	--	0.85	5,969	5,802	36,076	36,211	14,156	17,025
Central Sound (Area 8, 9)														
Skagit														
Spring	38% Total ER		0.27	397	672	1,088	1,845	0.14	334	345	234	222	501	574
Upper Sauk														
Suiattle														
Upper Cascade														
Summer/Fall	50% Total ER		0.55	132	13,219	110	11,029	0.16	1,411	1,279	2,396	2,458	9,544	13,999
Lower Sauk														
Upper Skagit														
Lower Skagit														
Stillaguamish	25% Total ER		0.19	--	532	--	2,281	0.11	152	142	168	172	212	291
Snohomish	21% Total ER		0.22	2,417	1,377	4,342	4,901	0.13	1,399	1,341	909	945	1,487	1,826
Tulalip Tribal Hatchery			0.99	9,179	--	96	--	0.99	1,794	2,101	6,781	6,738	604	684
South Sound (Area 10,11,13)														
Lake Washington (Cedar River portion)	15% pre-terminal SUS ER		0.35	3,759	320	4,743	294	0.20	826	731	1,267	1,300	1,986	2,635
Green-Duwamish	15% pre-terminal SUS ER	5800	0.63	11,267	9,805	5,019	5,816	0.47	3,628	3,367	11,507	11,736	5,937	7,877
Puyallup	50% Total ER		0.50	4,592	2,437	2,424	2,419	0.35	1,724	1,618	2,975	3,005	2,332	3,094
Nisqually		1100	0.76	16,975	3,590	5,007	1,126	0.65	6,373	5,731	11,087	11,198	3,105	4,119
White Spring	20% Total ER		0.20	--	356	--	1,459	0.18	105	103	217	220	34	40
Gorst, Grovers, Minter, Chambers & McAllister, Deschutes			0.57	37,998		28,954	--	0.42	10,661	9,587	17,356	17,530	9,982	13,245
Hood Canal (Area 12)														
Mid-Canal	15% pre-terminal SUS ER		0.32	--	238	--	504	0.13	55	49	38	45	147	204
Skokomish	15% pre-terminal SUS ER	1200 nat.	0.63	10,228	2,109	6,213	1,237	0.44	3,699	3,531	4,758	4,978	3,880	5,390
Hoodsport H, Dewato, Union, Tahuya tribs.			0.78	20,326	282	5,372	562	0.58	2,252	1,991	13,228	13,518	5,129	7,125

LA WA components:									
all natural (cedar plus N trib)	**0.35**	**0**	**320**	**0**	**588**		**49**	**131**	**140**
cedar only natural	**0.35**	**0**	**160**	**0**	**294**		**24**	**65**	**70**
all hatchery	**0.46**	**3,759**	**0**	**4,449**	**0**		**778**	**1,136**	**1,846**
Combined	**0.45**	**3,759**	**320**	**4,449**	**588**		**826**	**1,267**	**1,986**

Table C3-10. Total fishing-related mortality of all chinook (U.S. and Canadian) by Puget Sound regional fishery: Scenario B

Alternative 1--Proposed Action

Region	All Stocks in Regional Fisheries: Sport				Net and Troll		
	Mortality		Salmon Angler Trips		Mortality	Landed Catch	
	Total AEQ	Landed	Marine	Freshwater	AEQ	Treaty	NonTreaty
Juan de Fuca (Area 5, 6)	10,850	6,430	268,288	21,020	2,584	2,363	0
North Sound (Area 7)	9,605	7,874	41,642	54,977	42,289	20,381	21,301
Central Sound (Area 8, 9)	21,449	8,551	170,366	351,620	9,200	8,857	247
South Sound (Area 10,11,13)	39,570	25,912	186,432	273,517	36,137	34,070	1,939
Hood Canal (Area 12)	4,077	3,267	52,650	13,594	9,371	15,848	140
TOTAL	85,550	52,033	719,378	714,728	99,581	81,520	23,627

Angler trips during "base" Sport Catch Area	Marine	Freshwater
Area 5	42,841	89
Area 6	19,275	4,777
Area 7	33,132	43,741
Area 8	51,743	218,796
Area 9	54,268	0
Area 10	40,291	188,282
Area 11	75,935	21,832
Area 12	19,588	5,057
Area 13	34,875	11,569

Angler-trips this run	
Juan de Fuca (Area 5, 6)	289,308
North Sound (Area 7)	96,619
Central Sound (Area 8, 9)	521,985
South Sound (Area 10,11,13)	459,949
Hood Canal (Area 12)	66,244
	1,434,105

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-11. Total fishing related mortality of Puget Sound hatchery and natural chinook stocks: Scenario B

Alternative 2-Escapement Goal Management at the Management Unit Level

Chinook (by MU/Pop)	Regional Stocks Only: Objective Exp. Rate	Objective Escapement	All Fisheries Exp.Rate	AEQ Mortality Hatchery	AEQ Mortality Natural	Escapement Hatchery	Escapement Natural	SUS ER	SUS Sport Mortality Total AEQ	SUS Sport Mortality Landed	SUS Net & Troll Mortality Total AEQ	SUS Net & Troll Mortality Landed	AK and BC Mortality Total AEQ	AK and BC Mortality Landed
Juan de Fuca (Area 5, 6)									0	0	24	24	1,000	1,086
Dungeness Spring		**925**	0.24	--	108	--	344	0.01	0	0	3	3	106	115
Western Strait-Hoko		**850**	0.24	--	246	--	772	0.01	0	0	6	6	241	261
Elwha		**2,900**	0.24	--	669	--	2,079	0.01	0	0	16	16	654	710
North Sound (Area 7)														
Nooksack Spring	7% SUS ER	**4,000**	0.19	--	99	--	412	0.01	0	0	6	9	93	55
Nooksack/Samish summer-fall		**8,900**	0.76	31,437	--	9,906	--	0.76	14,683	14,689	2,559	2,811	14,195	17,070
Central Sound (Area 8, 9)														
Skagit														
Spring		**2,000**	0.16	223	378	1,188	2,009	0.02	0	0	71	74	530	592
Upper Sauk														
Suiattle														
Upper Cascade														
Summer/Fall		**14,500**	0.41	96	9,584	139	13,935	0.00	39	53	75	94	9,567	14,013
Lower Sauk														
Upper Skagit														
Lower Skagit														
Stillaguamish		**900**	0.67	--	1,807	--	904	0.59	770	770	819	821	219	301
Snohomish		**4,600**	0.23	2,485	1,404	3,947	4,603	0.15	1,082	1,083	1,254	1,264	1,553	1,905
Tulalip Tribal Hatchery		--	0.98	8,712	--	192	--	0.98	20	17	8,073	7,978	619	699
South Sound (Area 10,11,13)														
Lake Washington (Cedar River portion)		**1,200**	0.23	2,249	181	5,568	295	0.05	15	18	401	477	2,015	2,673
Green-Duwamish		**5,800**	0.56	8,804	7,469	5,982	5,800	0.38	4,372	4,384	5,880	6,142	6,022	7,987
Puyallup		**1,200**	0.71	5,322	2,929	1,109	1,200	0.53	965	970	4,922	5,020	2,365	3,137
Nisqually		**1,100**	0.73	13,835	3,017	4,920	1,100	0.60	1,784	1,808	11,869	12,202	3,199	4,242
White Spring		**1,000**	0.46	--	844	--	1,000	0.44	396	0	412	414	36	41
Gorst, Grovers, Minter, Chambers & McAllister, Deschutes		**9,600**	0.35	20,095		37,477	--	0.17	2,748	2,786	7,147	7,347	10,201	13,530
Hood Canal (Area 12)														
Mid-Canal		**750**	0.25	--	179	--	527	0.05	6	7	27	32	149	206
Skokomish		**1200**	0.61	9,412	1,931	6,220	1,231	0.40	3,038	3,081	4,379	4,531	3,926	5,454
Hoodsport H, Dewato, Union, Tahuya tribs.		**1,850**	0.90	22,254	203	1,850	597	0.69	202	259	17,065	17,267	5,190	7,209

LA WA components:	Exp.Rate	AEQ Hatchery	AEQ Natural	Esc. Hatchery	Esc. Natural	SUS ER	SUS Sport	SUS Net & Troll	AK and BC
all natural (cedar plus N trib)	**0.23**	**0**	**181**	**0**	**590**		**1**	**38**	**142**
cedar only natural	**0.23**	**0**	**91**	**0**	**295**		**0**	**19**	**71**
all hatchery	**0.30**	**2,249**	**0**	**5,273**	**0**		**14**	**363**	**1,873**
Combined	**0.29**	**2,249**	**181**	**5,273**	**590**		**15**	**401**	**2,015**

Table C3-12. Total fishing-related mortality of all chinook (U.S. and Canadian) by Puget Sound regional fishery: Scenario B

Alternative 2-Escapement Goal Management at the Management Unit Level

Region	All Stocks in Regional Fisheries: Sport Mortality Total AEQ	Sport Mortality Landed	Salmon Angler Trips Marine	Salmon Angler Trips Freshwater	Net and Troll Mortality AEQ	Landed Catch Treaty	Landed Catch NonTreaty
Juan de Fuca (Area 5, 6)	0	0	0	0	0	0	0
North Sound (Area 7)	14,454	14,454	0	62,889	0	0	0
Central Sound (Area 8, 9)	1,090	1,090	0	55,833	9,330	8,349	2
South Sound (Area 10,11,13)	9,547	9,547	0	84,265	22,342	22,738	0
Hood Canal (Area 12)	2,885	2,885	0	20,495	9,371	19,802	0
TOTAL	27,976	27,976	0	223,482	41,043	50,888	2

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-13. Total fishing related mortality of Puget Sound hatchery and natural chinook stocks: Scenario B

Alternative 3--Escapement Goal Management at the Population Level

Chinook (by MU/Pop)	Regional Stocks Only Objective Exp. Rate	Escapement	All Fisheries Exp.Rate	AEQ Mortality Hatchery	AEQ Mortality Natural	Escapement Hatchery	Escapement Natural	SUS ER	SUS Sport Mortality Total AEQ	SUS Sport Landed	SUS Net &Troll Mortality Total AEQ	SUS Net &Troll Landed	AK and BC Mortality Total AEQ	AK and BC Landed
Juan de Fuca (Area 5, 6)									0	0	24	24	1,000	1,086
Dungeness Spring		**925**	0.24	--	108	--	344	0.01	0	0	3	3	106	115
Western Strait-Hoko		**850**	0.24	--	246	--	772	0.01	0	0	6	6	241	261
Elwha		**2,900**	0.24	--	669	--	2,079	0.01	0	0	16	16	654	710
North Sound (Area 7)														
Nooksack Spring	7% SUS ER	**4,000**	0.19	--	99	--	412	0.01	0	0	6	9	93	55
Nooksack/Samish summer-fall		**8,900**	0.76	31,438	--	9,906	--	0.76	14,684	14,690	2,559	2,811	14,195	17,070
Central Sound (Area 8, 9)														
Skagit														
Spring		**2,000**	0.16	223	377	1,189	2,010	0.02	0	0	69	72	530	592
Upper Sauk		**986**												
Suiattle		**574**												
Upper Cascade		**440**												
Summer/Fall		**14,500**	0.41	96	9,584	139	13,935	0.00	39	53	75	94	9,567	14,013
Lower Sauk		**1,926**												
Upper Skagit		**8,434**												
Lower Skagit		**4,140**												
NF Stillaguamish		**600**	0.10	--	265	--	2,446	0.02	0	0	46	48	219	301
SF Stillaguamish		**300**												
Skykomish		**3,600**	0.12	1,130	739	5,203	5,368	0.03	3	4	313	324	1,553	1,905
Snoqualmie		**1,000**												
Tulalip Tribal Hatchery		--	0.12	1,050	--	7,730	--	0.12	20	17	411	466	619	699
South Sound (Area 10,11,13)														
Lake Washington (Cedar River portion)		**1,200**	0.23	2,249	181	5,569	295	0.05	15	18	400	477	2,015	2,673
Green-Duwamish		**5,800**	0.56	8,804	7,469	5,981	5,800	0.38	4,372	4,384	5,879	6,142	6,022	7,987
Puyallup		**1,200**	0.71	5,322	2,929	1,109	1,200	0.53	965	970	4,922	5,020	2,365	3,137
Nisqually		**1,100**	0.73	13,835	3,017	4,920	1,100	0.60	1,784	1,808	11,869	12,202	3,199	4,242
White Spring		**1,000**	0.46	--	844	--	1,000	0.44	396	0	412	414	36	41
Gorst, Grovers, Minter, Chambers & McAllister, Deschutes		**9,600**	0.35	20,093		37,479	--	0.17	2,748	2,786	7,145	7,345	10,201	13,530
Hood Canal (Area 12)														
Mid-Canal		**750**	0.25	--	179	--	527	0.05	6	7	27	32	149	206
Skokomish		**1200**	0.61	9,411	1,931	6,221	1,231	0.40	3,038	3,081	4,378	4,530	3,926	5,454
Hoodsport H, Dewato, Union, Tahuya tribs.		**1,850**	0.90	22,254	203	1,850	597	0.69	202	259	17,066	17,267	5,190	7,209

LA WA components:	Exp.Rate	AEQ Mortality Hatchery	AEQ Mortality Natural	Escapement Hatchery	Escapement Natural	SUS ER	SUS Sport	SUS Net &Troll	AK and BC
all natural (cedar plus N trib)	**0.23**	**0**	**181**	**0**	**590**		**1**	**38**	**142**
cedar only natural	**0.23**	**0**	**91**	**0**	**295**		**0**	**19**	**71**
all hatchery	**0.30**	**2,249**	**0**	**5,274**	**0**		**14**	**362**	**1,873**
Combined	**0.29**	**2,249**	**181**	**5,274**	**590**		**15**	**400**	**2,015**

Table C3-14. Total fishing-related mortality of all chinook (U.S. and Canadian) by Puget Sound regional fishery: Scenario B

Alternative 3--Escapement Goal Management at the Population Level

All Stocks in Regional Fisheries

Region	Sport Mortality Total AEQ	Sport Landed	Salmon Angler Trips Marine	Salmon Angler Trips Freshwater	Net and Troll Mortality AEQ	anded Catch Treaty	NonTreaty
Juan de Fuca (Area 5, 6)	0	0	0	0	0	0	0
North Sound (Area 7)	14,455	14,455	0	62,891	0	0	0
Central Sound (Area 8, 9)	0	0	0	1,344	0	0	0
South Sound (Area 10,11,13)	9,548	9,548	0	84,266	22,344	22,740	0
Hood Canal (Area 12)	2,885	2,885	0	20,495	9,371	19,805	0
TOTAL	26,887	26,887	0	168,996	31,715	42,545	0

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-15. Total fishing related mortality of Puget Sound hatchery and natural chinook stocks: Scenario B

Alternative 4--No Action/No Authorized Take

Chinook (by MU/Pop)	Regional Stocks Only													
	Objective		All Fisheries						SUS Sport		SUS Net &Troll		AK and BC	
				AEQ Mortality		Escapement			Mortality		Mortality		Mortality	
	Exp. Rate	Escapement	Exp.Rate	Hatchery	Natural	Hatchery	Natural	SUS ER	Total AEQ	Landed	Total AEQ	Landed	Total AEQ	Landed
Juan de Fuca (Area 5, 6)									0	0	24	24	1,000	1,086
Dungeness Spring	10% SUS ER		0.24	--	108	--	344	0.01	0	0	3	3	106	115
Western Strait-Hoko	10% SUS ER		0.24	--	246	--	772	0.01	0	0	6	6	241	261
Elwha	10% SUS ER		0.24	--	669	--	2,079	0.01	0	0	16	16	654	710
North Sound (Area 7)														
Nooksack Spring	7% SUS ER		0.19	--	99	--	412	0.01	0	0	6	9	93	55
Nooksack/Samish summer-fall			0.63	16,983	--	9,906	--	0.63	229	235	2,559	2,811	14,195	17,070
Central Sound (Area 8, 9)														
Skagit														
Spring	42% Total ER		0.16	223	377	1,189	2,010	0.02	0	0	69	72	530	592
Upper Sauk														
Suiattle														
Upper Cascade														
Summer/Fall	52% Total ER		0.41	96	9,584	139	13,935	0.00	39	53	75	94	9,567	14,013
Lower Sauk														
Upper Skagit														
Lower Skagit														
Stillaguamish	25% Total ER		0.10	--	265	--	2,446	0.02	0	0	46	48	219	301
Snohomish	24% Total ER		0.12	1,130	739	5,203	5,368	0.03	3	4	313	324	1,553	1,905
Tulalip Tribal Hatchery			0.12	1,050	--	7,730	--	0.12	20	17	411	466	619	699
South Sound (Area 10,11,13)														
	15% pre-terminal SUS ER	1,200	0.23	2,249	181	5,569	295	0.05	15	18	400	477	2,015	2,673
Green-Duwamish	15% pre-terminal SUS ER	5800	0.23	4,316	3,117	10,470	10,153	0.05	42	53	1,369	1,631	6,022	7,987
Puyallup	50% Total ER		0.23	1,925	970	4,506	3,160	0.05	17	21	513	612	2,365	3,137
Nisqually		1100	0.21	4,168	856	14,587	3,261	0.07	88	113	1,737	2,070	3,199	4,242
White Spring	20% Total ER		0.03	--	52	--	1,792	0.01	0	0	16	18	36	41
Gorst, Grovers, Minter, Chambers & McAllister, Deschutes			0.26	14,227		40,641	--	0.07	175	223	3,851	4,589	10,201	13,530
Hood Canal (Area 12)														
Mid-Canal	15% pre-terminal SUS ER	750 spawners???	0.25	--	179	--	527	0.05	6	7	27	32	149	206
Skokomish	15% pre-terminal SUS ER	1200	0.25	3,970	815	11,662	2,370	0.05	153	196	706	858	3,926	5,454
Hoodsport H, Dewato, Union, Tahuya tribs.			0.25	6,122	203	17,983	597	0.05	202	259	933	1,134	5,190	7,209

LA WA components:												
all natural (cedar plus N trib)	**0.23**	**0**	**181**	**0**	**590**		**1**		**38**		**142**	
cedar only natural	**0.23**	**0**	**91**	**0**	**295**		**0**		**19**		**71**	
all hatchery	**0.30**	**2,249**	**0**	**5,274**	**0**		**14**		**362**		**1,873**	
Combined	**0.29**	**2,249**	**181**	**5,274**	**590**		**15**		**400**		**2,015**	

Table C3-16. Total fishing-related mortality of all chinook (U.S. and Canadian) by Puget Sound regional fishery: Scenario B

Alternative 4--No Action/No Authorized Take

Region	All Stocks in Regional Fisheries						
	Sport				Net and Troll		
	Mortality		Salmon Angler Trips		Mortality	Landed Catch	
	Total AEQ	Landed	Marine	Freshwater	AEQ	Treaty	NonTreaty
Juan de Fuca (Area 5, 6)	0	0	0	0	0	0	0
North Sound (Area 7)	0	0	0	840	0	0	0
Central Sound (Area 8, 9)	0	0	0	1,344	0	0	0
South Sound (Area 10,11,13)	0	0	0	2,092	0	0	0
Hood Canal (Area 12)	0	0	0	32	0	0	0
TOTAL	0	0	0	4,308	0	0	0

	Salmon Angler Trips	
Sport Catch Area	**Marine**	**Freshwater**
Area 5	42,841	89
Area 6	19,275	4,777
Area 7	33,132	43,741
Area 8	51,743	218,796
Area 9	54,268	0
Area 10	40,291	8,682
Area 11	75,935	21,832
Area 12	19,588	5,057
Area 13	34,875	11,569

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-17. Total fishing related mortality of Puget Sound hatchery and natural chinook stocks: Scenario C

Alternative 1--Proposed Action

	Regional Stocks Only													
Chinook (by MU/Pop)	**Objective**		**All Fisheries**						**SUS Sport**		**SUS Net &Troll**		**AK and BC**	
				AEQ Mortality		**Escapement**			**Mortality**		**Mortality**		**Mortality**	
	Exp. Rate	**Escapement**	**Exp.Rate**	**Hatchery**	**Natural**	**Hatchery**	**Natural**	**SUS ER**	**Total AEQ**	**Landed**	**Total AEQ**	**Landed**	**Total AEQ**	**Landed**
Juan de Fuca (Area 5, 6)									89	52	51	55	530	568
Dungeness Spring	10% SUS ER		0.22	--	71	--	245	0.05	9	6	5	6	56	60
Western Strait-Hoko	10% SUS ER		0.23	--	165	--	545	0.05	22	13	12	14	131	140
Elwha	10% SUS ER		0.23	--	434	--	1,480	0.05	58	34	33	36	343	368
North Sound (Area 7)														
Nooksack Spring	7% SUS ER		0.20	--	69	--	278	0.07	3	3	22	23	44	52
Nooksack/Samish summer-fall			0.80	37,544	--	9,528	--	0.80	5,378	5,271	26,731	26,887	5,435	6,616
Central Sound (Area 8, 9)														
Skagit														
Spring	38% Total ER		0.23	238	402	788	1,331	0.14	207	219	187	174	245	288
Upper Sauk														
Suiattle														
Upper Cascade														
Summer/Fall	50% Total ER		0.49	77	7,717	80	8,033	0.18	949	871	1,850	1,907	4,995	7,159
Lower Sauk														
Upper Skagit														
Lower Skagit														
Stillaguamish	25% Total ER		0.17	--	342	--	1,620	0.12	93	85	137	140	112	157
Snohomish	21% Total ER		0.20	1,497	868	3,185	3,543	0.14	918	878	730	755	716	899
Tulalip Tribal Hatchery			0.99	6,538	--	58	--	0.99	1,681	2,008	4,561	4,531	296	335
South Sound (Area 10,11,13)														
Lake Washington (Cedar River portion)	15% pre-terminal SUS ER		0.33	2,370	219	3,305	223	0.23	522	462	1,108	1,128	960	1,274
Green-Duwamish	15% pre-terminal SUS ER	5800	0.49	6,396	5,684	4,558	5,801	0.39	1,427	1,265	7,774	7,920	2,880	3,823
Puyallup	50% Total ER		0.50	3,177	1,772	1,478	1,798	0.39	1,401	1,336	2,418	2,436	1,129	1,499
Nisqually		1100	0.64	9,342	1,978	4,972	1,119	0.56	3,776	3,406	6,070	6,138	1,474	1,957
White Spring	20% Total ER		0.20	--	254	--	1,011	0.19	58	54	188	189	8	9
Gorst, Grovers, Minter, Chambers & McAllister, Deschutes			0.58	25,723		18,808	--	0.47	6,249	5,637	14,682	13,244	4,792	6,362
Hood Canal (Area 12)														
Mid-Canal	15% pre-terminal SUS ER		0.26	--	132	--	367	0.12	32	29	30	36	71	96
Skokomish	15% pre-terminal SUS ER	1200 nat.	0.45	4,930	1,017	6,147	1,239	0.31	1,656	1,566	2,420	2,600	1,871	2,539
Hoodsport H, Dewato, Union, Tahuya tribs.			0.74	13,074	158	4,209	410	0.60	1,338	1,199	9,421	9,659	2,474	3,356

LA WA components:									
all natural (cedar plus N trib)	**0.33**	**0**	**219**	**0**	**446**		**31**	**120**	**68**
cedar only natural	**0.33**	**0**	**110**	**0**	**223**		**15**	**60**	**34**
all hatchery	**0.43**	**2,370**	**0**	**3,082**	**0**		**491**	**987**	**891**
Combined	**0.42**	**2,370**	**219**	**3,082**	**446**		**522**	**1,108**	**960**

Table C3-18. Total fishing-related mortality of all chinook (U.S. and Canadian) by Puget Sound regional fishery: Scenario C

Alternative 1--Proposed Action

	All Stocks in Regional Fisheries						
Region	**Sport**				**Net and Troll**		
	Mortality		**Salmon Angler Trips**		**Mortality**	**Landed Catch**	
	Total AEQ	**Landed**	**Marine**	**Freshwater**	**AEQ**	**Treaty**	**NonTreaty**
Juan de Fuca (Area 5, 6)	9,881	5,417	257,620	20,184	2,577	2,363	0
North Sound (Area 7)	8,232	6,922	39,590	52,268	33,639	16,259	16,901
Central Sound (Area 8, 9)	12,892	5,336	161,151	332,601	6,455	6,175	228
South Sound (Area 10,11,13)	26,750	17,738	172,509	253,091	27,187	25,099	1,939
Hood Canal (Area 12)	1,863	1,391	46,677	12,052	9,371	10,166	140
TOTAL	59,619	36,805	677,547	670,196	79,228	60,062	19,208

Angler trips during "base" Sport Catch Area	**Marine**	**Freshwater**
Area 5	42,841	89
Area 6	19,275	4,777
Area 7	33,132	43,741
Area 8	51,743	218,796
Area 9	54,268	0
Area 10	40,291	188,282
Area 11	75,935	21,832
Area 12	19,588	5,057
Area 13	34,875	11,569

Angler-trips this run	
Juan de Fuca (Area 5, 6)	277,804
North Sound (Area 7)	91,859
Central Sound (Area 8, 9)	493,752
South Sound (Area 10,11,13)	425,600
Hood Canal (Area 12)	58,729
	1,347,743

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-19. Total fishing related mortality of Puget Sound hatchery and natural chinook stocks: Scenario C

Alternative 2-Escapement Goal Management at the Management Unit Level

Chinook (by MU/Pop)	Regional Stocks Only													
	Objective		All Fisheries						SUS Sport Mortality		SUS Net &Troll Mortality		AK and BC Mortality	
				AEQ Mortality		Escapement								
	Exp. Rate	Escapement	Exp.Rate	Hatchery	Natural	Hatchery	Natural	SUS ER	Total AEQ	Landed	Total AEQ	Landed	Total AEQ	Landed
Juan de Fuca (Area 5, 6)									0	0	17	17	535	573
Dungeness Spring		**925**	0.19	--	58	--	251	0.01	0	0	2	2	57	61
Western Strait-Hoko		**850**	0.19	--	133	--	564	0.01	0	0	4	4	129	138
Elwha		**2,900**	0.19	--	360	--	1,516	0.01	0	0	11	11	349	374
North Sound (Area 7)														
Nooksack Spring	7% SUS ER	**4,000**	0.14	--	51	--	304	0.01	0	0	5	6	46	55
Nooksack/Samish summer-fall		**8,900**	0.66	18,809	--	9,571	--	0.66	11,428	11,432	1,907	2,095	5,474	6,659
Central Sound (Area 8, 9)														
Skagit														
Spring		**2,000**	0.12	114	192	865	1,460	0.02	0	0	49	53	257	298
Upper Sauk														
Suiattle														
Upper Cascade														
Summer/Fall		**14,500**	0.33	50	5,047	102	10,215	0.01	29	38	54	67	5,014	7,180
Lower Sauk														
Upper Skagit														
Lower Skagit														
Stillaguamish		**900**	0.52	--	979	--	909	0.46	414	414	448	450	117	161
Snohomish		**4,600**	0.10	569	414	3,812	3,875	0.03	3	3	232	241	748	939
Tulalip Tribal Hatchery		--	0.10	612	--	5,531	--	0.10	14	12	294	334	304	344
South Sound (Area 10,11,13)														
Lake Washington (Cedar River portion)		**1,200**	0.19	1,180	98	4,018	214	0.05	10	13	291	346	977	1,295
Green-Duwamish		**5,800**	0.36	3,879	3,255	5,950	5,800	0.23	1,597	1,606	2,607	2,797	2,930	3,886
Puyallup		**1,200**	0.57	3,160	1,618	1,100	1,200	0.44	959	962	2,670	2,741	1,149	1,524
Nisqually		**1,100**	0.61	7,873	1,712	4,914	1,100	0.51	1,274	1,294	6,788	7,030	1,522	2,019
White Spring		**1,000**	0.23	--	304	--	1,000	0.23	142	0	154	156	9	10
Gorst, Grovers, Minter, Chambers & McAllister, Deschutes		**9,600**	0.30	11,654		27,007	--	0.17	1,963	1,993	4,781	4,856	4,912	6,515
Hood Canal (Area 12)														
Mid-Canal		**750**	0.20	--	95	--	385	0.05	4	5	19	24	72	98
Skokomish		**1200**	0.43	4,528	929	6,080	1,221	0.29	1,566	1,597	1,990	2,104	1,901	2,576
Hoodsport H, Dewato, Union, Tahuya tribs.		**1,850**	0.86	14,501	107	1,857	436	0.72	146	187	11,950	12,100	2,512	3,406

LA WA components:									
all natural (cedar plus N trib)	**0.19**	**0**	**98**	**0**	**428**		**1**	**28**	**70**
cedar only natural	**0.19**	**0**	**49**	**0**	**214**		**0**	**14**	**35**
all hatchery	**0.24**	**1,180**	**0**	**3,804**	**0**		**10**	**263**	**907**
Combined	**0.23**	**1,180**	**98**	**3,804**	**428**		**10**	**291**	**977**

Table C3-20. Total fishing-related mortality of all chinook (U.S. and Canadian) by Puget Sound regional fishery: Scenario (

Alternative 2-Escapement Goal Management at the Management Unit Level

Region	All Stocks in Regional Fisheries						
	Sport				Net and Troll		
	Mortality		Salmon Angler Trips		Mortality	Landed Catch	
	Total AEQ	Landed	Marine	Freshwater	AEQ	Treaty	NonTreaty
Juan de Fuca (Area 5, 6)	0	0	0	0	0	0	0
North Sound (Area 7)	11,255	11,255	0	50,093	0	0	0
Central Sound (Area 8, 9)	414	414	0	30,389	415	415	0
South Sound (Area 10,11,13)	5,560	5,560	0	68,316	11,381	11,523	0
Hood Canal (Area 12)	1,456	1,456	0	14,777	9,371	12,745	0
TOTAL	18,685	18,685	0	163,575	21,167	24,683	0

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-21. Total fishing related mortality of Puget Sound hatchery and natural chinook stocks: Scenario C

Alternative 3--Escapement Goal Management at the Population Level

Chinook (by MU/Pop)	Objective		Regional Stocks Only: All Fisheries						SUS Sport Mortality		SUS Net &Troll Mortality		AK and BC Mortality	
				AEQ Mortality		Escapement								
	Exp. Rate	Escapement	Exp.Rate	Hatchery	Natural	Hatchery	Natural	SUS ER	Total AEQ	Landed	Total AEQ	Landed	Total AEQ	Landed
Juan de Fuca (Area 5, 6)									0	0	17	17	535	573
Dungeness Spring		**925**	0.19	--	58	--	251	0.01	0	0	2	2	57	61
Western Strait-Hoko		**850**	0.19	--	133	--	564	0.01	0	0	4	4	129	138
Elwha		**2,900**	0.19	--	360	--	1,516	0.01	0	0	11	11	349	374
North Sound (Area 7)														
Nooksack Spring	7% SUS ER	**4,000**	0.144	--	51	--	304	0.01	0	0	5	6	46	55
Nooksack/Samish summer-fall		**8,900**	0.66	18,809	--	9,571	--	0.66	11,428	11,432	1,907	2,095	5,474	6,659
Central Sound (Area 8, 9)														
Skagit														
Spring		**2,000**	0.12	114	192	865	1,460	0.02	0	0	49	53	257	298
Upper Sauk		**986**												
Suiattle		**574**												
Upper Cascade		**440**												
Summer/Fall		**14,500**	0.33	50	5,047	102	10,215	0.01	29	38	54	67	5,014	7,180
Lower Sauk		**1,926**												
Upper Skagit		**8,434**												
Lower Skagit		**4,140**												
NF Stillaguamish		**600**	0.08	--	150	--	1,738	0.02	0	0	33	35	117	161
SF Stillaguamish		**300**												
Skykomish		**3,600**	0.10	569	414	3,812	3,875	0.03	3	3	232	241	748	939
Snoqualmie		**1,000**												
Tulalip Tribal Hatchery		--	0.10	612	--	5,531	--	0.10	14	12	294	334	304	344
South Sound (Area 10,11,13)														
Lake Washington (Cedar River portion)		**1,200**	0.19	1,180	98	4,018	214	0.05	10	13	291	346	977	1,295
Green-Duwamish		**5,800**	0.36	3,879	3,255	5,950	5,800	0.23	1,597	1,606	2,607	2,797	2,930	3,886
Puyallup		**1,200**	0.57	3,160	1,618	1,100	1,200	0.44	959	962	2,670	2,741	1,149	1,524
Nisqually		**1,100**	0.61	7,873	1,712	4,914	1,100	0.51	1,274	1,294	6,788	7,030	1,522	2,019
White Spring		**1,000**	0.23	--	304	--	1,000	0.23	142	0	154	156	9	10
Gorst, Grovers, Minter, Chambers & McAllister, Deschutes		**9,600**	0.30	11,654		27,007	--	0.17	1,963	1,993	4,781	4,856	4,912	6,515
Hood Canal (Area 12)														
Mid-Canal		**750**	0.20	--	95	--	385	0.05	4	5	19	24	72	98
Skokomish		**1200**	0.43	4,528	929	6,080	1,221	0.29	1,566	1,597	1,990	2,104	1,901	2,576
Hoodsport H, Dewato, Union, Tahuya tribs.		**1,850**	0.86	14,501	107	1,857	436	0.72	146	187	11,950	12,100	2,512	3,406

LA WA components:	Exp.Rate	AEQ Hatchery	AEQ Natural	Esc. Hatchery	Esc. Natural	SUS ER	SUS Sport	SUS Net & Troll	AK and BC
all natural (cedar plus N trib)	**0.19**	**0**	**98**	**0**	**428**		**1**	**28**	**70**
cedar only natural	**0.19**	**0**	**49**	**0**	**214**		**0**	**14**	**35**
all hatchery	**0.24**	**1,180**	**0**	**3,804**	**0**		**10**	**263**	**907**
Combined	**0.23**	**1,180**	**98**	**3,804**	**428**		**10**	**291**	**977**

Table C3-22. Total fishing-related mortality of all chinook (U.S. and Canadian) by Puget Sound regional fishery: Scenario C

Alternative 3--Escapement Goal Management at the Population Level

Region	All Stocks in Regional Fisheries: Sport				Net and Troll		
	Mortality		Salmon Angler Trips		Mortality	Landed Catch	
	Total AEQ	Landed	Marine	Freshwater	AEQ	Treaty	NonTreaty
Juan de Fuca (Area 5, 6)	0	0	0	0	0	0	0
North Sound (Area 7)	11,255	11,255	0	50,093	0	0	0
Central Sound (Area 8, 9)	0	0	0	1,344	0	0	0
South Sound (Area 10,11,13)	5,560	5,560	0	68,316	11,381	11,523	0
Hood Canal (Area 12)	1,456	1,456	0	14,777	9,371	12,745	0
TOTAL	18,271	18,271	0	134,530	20,752	24,267	0

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-23. Total fishing related mortality of Puget Sound hatchery and natural chinook stocks: Scenario C

Alternative 4--No Action/No Authorized Take

Chinook (by MU/Pop)	Objective		Regional Stocks Only: All Fisheries						SUS Sport Mortality		SUS Net &Troll Mortality		AK and BC Mortality	
				AEQ Mortality		Escapement								
	Exp. Rate	Escapement	Exp.Rate	Hatchery	Natural	Hatchery	Natural	SUS ER	Total AEQ	Landed	Total AEQ	Landed	Total AEQ	Landed
Juan de Fuca (Area 5, 6)									0	0	17	17	535	573
Dungeness Spring	10% SUS ER		0.19	--	58	--	251	0.01	0	0	2	2	57	61
Western Strait-Hoko	10% SUS ER		0.19	--	133	--	564	0.01	0	0	4	4	129	138
Elwha	10% SUS ER		0.19	--	360	--	1,516	0.01	0	0	11	11	349	374
North Sound (Area 7)														
Nooksack Spring	7% SUS ER		0.14	--	51	--	304	0.01	0	0	5	6	46	55
Nooksack/Samish summer-fall			0.44	7,554	--	9,571	--	0.44	173	177	1,907	2,095	5,474	6,659
Central Sound (Area 8, 9)														
Skagit														
Spring	42% Total ER		0.12	114	192	865	1,460	0.02	0	0	49	53	257	298
Upper Sauk														
Suiattle														
Upper Cascade														
Summer/Fall	52% Total ER		0.33	50	5,047	102	10,215	0.01	29	38	54	67	5,014	7,180
Lower Sauk														
Upper Skagit														
Lower Skagit														
Stillaguamish	25% Total ER		0.08	--	150	--	1,738	0.02	0	0	33	35	117	161
Snohomish	24% Total ER		0.10	569	414	3,812	3,875	0.03	3	3	232	241	748	939
Tulalip Tribal Hatchery			0.10	612	--	5,531	--	0.10	14	12	294	334	304	344
South Sound (Area 10,11,13)														
Lake Washington (Cedar River portion)	15% pre-terminal SUS ER	1,200	0.19	1,180	98	4,018	214	0.05	10	13	291	346	977	1,295
Green-Duwamish	15% pre-terminal SUS ER	5800	0.19	2,271	1,687	7,558	7,367	0.05	30	39	999	1,189	2,930	3,886
Puyallup	50% Total ER		0.19	1,010	525	3,250	2,293	0.05	12	16	374	445	1,149	1,524
Nisqually		1100	0.17	2,378	482	10,408	2,330	0.08	64	84	1,274	1,516	1,522	2,019
White Spring	20% Total ER		0.02	--	21	--	1,283	0.01	0	0	12	14	9	10
Gorst, Grovers, Minter, Chambers & McAllister, Deschutes			0.21	7,855		29,169	--	0.08	127	166	2,818	3,696	4,912	6,515
Hood Canal (Area 12)														
Mid-Canal	15% pre-terminal SUS ER	750 spawners???	0.20	--	95	--	385	0.05	4	5	19	24	72	98
Skokomish	15% pre-terminal SUS ER	1200	0.20	2,096	430	8,513	1,730	0.05	110	141	515	628	1,901	2,576
Hoodsport H, Dewato, Union, Tahuya tribs.			0.20	3,231	107	13,126	436	0.05	146	187	681	830	2,512	3,406

LA WA components:	Exp.Rate	AEQ Hatchery	AEQ Natural	Esc. Hatchery	Esc. Natural	SUS ER	SUS Sport Total AEQ	SUS Net & Troll Total AEQ	AK and BC Total AEQ
all natural (cedar plus N trib)	**0.19**	**0**	**98**	**0**	**428**		**1**	**28**	**70**
cedar only natural	**0.19**	**0**	**49**	**0**	**214**		**0**	**14**	**35**
all hatchery	**0.24**	**1,180**	**0**	**3,804**	**0**		**10**	**263**	**907**
Combined	**0.23**	**1,180**	**98**	**3,804**	**428**		**10**	**291**	**977**

Table C3-24. Total fishing-related mortality of all chinook (U.S. and Canadian) by Puget Sound regional fishery: Scenario C

Alternative 4--No Action/No Authorized Take

Region	All Stocks in Regional Fisheries: Sport				Net and Troll		
	Mortality		Salmon Angler Trips		Mortality	Landed Catch	
	Total AEQ	Landed	Marine	Freshwater	AEQ	Treaty	NonTreaty
Juan de Fuca (Area 5, 6)	0	0	0	0	0	0	0
North Sound (Area 7)	0	0	0	840	0	0	0
Central Sound (Area 8, 9)	0	0	0	1,344	0	0	0
South Sound (Area 10,11,13)	0	0	0	2,092	0	0	0
Hood Canal (Area 12)	0	0	0	32	0	0	0
TOTAL	0	0	0	4,308	0	0	0

Sport Catch Area	Salmon Angler Trips: Marine	Freshwater
Area 5	42,841	89
Area 6	19,275	4,777
Area 7	33,132	43,741
Area 8	51,743	218,796
Area 9	54,268	0
Area 10	40,291	8,682
Area 11	75,935	21,832
Area 12	19,588	5,057
Area 13	34,875	11,569

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-25. Total fishing related mortality of Puget Sound hatchery and natural chinook stocks: Scenario D

Alternative 1--Proposed Action

Chinook (by MU/Pop)	Regional Stocks Only														
	Objective		All Fisheries						SUS Sport		SUS Net &Troll		AK and BC	
				AEQ Mortality		Escapement			Mortality		Mortality		Mortality	
	Exp. Rate	Escapement	Exp.Rate	Hatchery	Natural	Hatchery	Natural	SUS ER	Total AEQ	Landed	Total AEQ	Landed	Total AEQ	Landed
Juan de Fuca (Area 5, 6)									95	56	51	54	762	827
Dungeness Spring	10% SUS ER		0.29	--	96	--	231	0.05	10	6	5	6	81	88
Western Strait-Hoko	10% SUS ER		0.30	--	223	--	514	0.05	23	14	12	13	187	203
Elwha	10% SUS ER		0.30	--	589	--	1,395	0.05	62	36	33	35	494	537
North Sound (Area 7)														
Nooksack Spring	?		0.26	--	87	--	252	0.07	3	3	22	24	62	50
Nooksack/Samish summer-fall			0.81	39,341	--	9,370	--	0.81	5,403	5,305	23,057	23,264	10,881	13,079
Central Sound (Area 8, 9)														
Skagit														
Spring	38% Total ER		0.28	294	498	749	1,270	0.15	232	241	189	174	371	420
Upper Sauk														
Suiattle														
Upper Cascade														
Summer/Fall	50% Total ER		0.56	97	9,749	75	7,551	0.16	970	891	1,751	1,807	7,125	10,500
Lower Sauk														
Upper Skagit														
Lower Skagit														
Stillaguamish	25% Total ER		0.20	--	407	--	1,584	0.12	105	96	141	143	161	221
Snohomish	21% Total ER		0.23	1,782	1,020	3,007	3,399	0.14	956	927	730	758	1,116	1,370
Tulalip Tribal Hatchery			0.99	6,562	--	56	--	0.99	1,698	2,025	4,395	4,371	469	530
South Sound (Area 10,11,13)														
Lake Washington (Cedar River portion)	15% pre-terminal SUS ER		0.38	2,958	262	3,147	214	0.22	580	524	1,107	1,128	1,534	2,034
Green-Duwamish	15% pre-terminal SUS ER	5800	0.51	7,263	6,090	4,512	5,802	0.36	1,583	1,430	7,191	7,338	4,579	6,074
Puyallup	50% Total ER		0.50	3,445	1,862	1,588	1,834	0.35	1,332	1,270	2,176	2,194	1,799	2,386
Nisqually		1100	0.66	10,280	2,163	4,935	1,109	0.53	4,133	3,779	5,865	5,935	2,445	3,243
White Spring	20% Total ER		0.20	--	250	--	1,011	0.17	70	67	151	152	30	33
Gorst, Grovers, Minter, Chambers & McAllister, Deschutes			0.62	29,428		17,893	--	0.46	7,045	6,442	14,608	13,358	7,776	10,315
Hood Canal (Area 12)														
Mid-Canal	15% pre-terminal SUS ER		0.34	--	179	--	344	0.12	35	32	30	35	114	158
Skokomish	15% pre-terminal SUS ER	1200 nat.	0.48	5,531	1,139	6,069	1,225	0.26	1,430	1,337	2,196	2,375	3,044	4,223
Hoodsport H, Dewato, Union, Tahuya tribs.			0.76	14,062	211	4,010	384	0.55	1,443	1,302	8,806	9,043	4,024	5,583

LA WA components:									
all natural (cedar plus N trib)	**0.38**	**0**	**262**	**0**	**428**		**34**	**120**	**108**
cedar only natural	**0.38**	**0**	**131**	**0**	**214**		**17**	**60**	**54**
all hatchery	**0.50**	**2,958**	**0**	**2,933**	**0**		**546**	**986**	**1,426**
Combined	**0.49**	**2,958**	**262**	**2,933**	**428**		**580**	**1,107**	**1,534**

Table C3-26. Total fishing-related mortality of all chinook (U.S. and Canadian) by Puget Sound regional fishery: Scenario D

Alternative 1--Proposed Action

Region	All Stocks in Regional Fisheries						
	Sport				Net and Troll		
	Mortality		Salmon Angler Trips		Mortality	Landed Catch	
	Total AEQ	Landed	Marine	Freshwater	AEQ	Treaty	NonTreaty
Juan de Fuca (Area 5, 6)	10,269	5,710	266,077	20,847	2,579	2,363	0
North Sound (Area 7)	8,366	6,975	40,095	52,935	29,564	14,368	14,777
Central Sound (Area 8, 9)	14,353	6,252	162,367	335,111	6,188	5,913	226
South Sound (Area 10,11,13)	29,864	19,333	175,635	257,678	26,087	23,961	1,939
Hood Canal (Area 12)	1,421	1,001	45,438	11,732	9,371	9,340	140
TOTAL	64,273	39,271	689,612	678,303	73,788	55,944	17,082

Angler trips during "base" Sport Catch Area	**Marine**	**Freshwater**
Area 5	42,841	89
Area 6	19,275	4,777
Area 7	33,132	43,741
Area 8	51,743	218,796
Area 9	54,268	0
Area 10	40,291	188,282
Area 11	75,935	21,832
Area 12	19,588	5,057
Area 13	34,875	11,569

Angler-trips this run	
Juan de Fuca (Area 5, 6)	286,924
North Sound (Area 7)	93,031
Central Sound (Area 8, 9)	497,477
South Sound (Area 10,11,13)	433,313
Hood Canal (Area 12)	57,170
	1,367,915

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-27. Total fishing related mortality of Puget Sound hatchery and natural chinook stocks: Scenario D

Alternative 2--Escapement Goal Management at the Management Unit Level

Chinook (by MU/Pop)	Objective		Regional Stocks Only: All Fisheries						SUS Sport		SUS Net &Troll		AK and BC	
				AEQ Mortality		Escapement			Mortality		Mortality		Mortality	
	Exp. Rate	Escapement	Exp.Rate	Hatchery	Natural	Hatchery	Natural	SUS ER	Total AEQ	Landed	Total AEQ	Landed	Total AEQ	Landed
Juan de Fuca (Area 5, 6)									0	0	17	17	763	830
Dungeness Spring		**925**	0.26	--	83	--	237	0.01	0	0	2	2	81	88
Western Strait-Hoko		**850**	0.26	--	188	--	532	0.01	0	0	4	4	184	201
Elwha		**2,900**	0.26	--	509	--	1,431	0.01	0	0	11	11	498	542
North Sound (Area 7)														
Nooksack Spring	7% SUS ER	**4,000**	0.20	--	73	--	285	0.01	0	0	5	6	68	55
Nooksack/Samish summer-fall		**8,900**	0.52	22,812	--	20,673	--	0.52	10,016	10,022	1,868	2,051	10,928	13,132
Central Sound (Area 8, 9)														
Skagit														
Spring		**2,000**	0.17	163	277	825	1,395	0.02	0	0	49	54	390	436
Upper Sauk														
Suiattle														
Upper Cascade														
Summer/Fall		**14,500**	0.43	71	7,157	96	9,625	0.00	28	37	54	68	7,146	10,524
Lower Sauk														
Upper Skagit														
Lower Skagit														
Stillaguamish		**900**	0.52	--	984	--	919	0.43	391	391	425	426	167	227
Snohomish		**4,600**	0.13	847	557	3,596	3,720	0.03	7	7	231	241	1,166	1,430
Tulalip Tribal Hatchery		--	0.13	795	--	5,351	--	0.13	14	12	300	340	481	545
South Sound (Area 10,11,13)														
Lake Washington (Cedar River portion)		**1,200**	0.25	1,723	138	3,852	204	0.05	11	14	293	349	1,558	2,066
Green-Duwamish		**5,800**	0.38	4,553	3,583	5,995	5,800	0.18	1,171	1,179	2,314	2,506	4,651	6,167
Puyallup		**1,200**	0.59	3,481	1,720	1,113	1,200	0.39	961	965	2,412	2,484	1,828	2,423
Nisqually		**1,100**	0.62	8,425	1,827	4,920	1,100	0.47	1,240	1,259	6,490	6,739	2,521	3,343
White Spring		**1,000**	0.22	--	289	--	1,000	0.20	123	0	135	137	31	34
Gorst, Grovers, Minter, Chambers & McAllister, Deschutes		**9,600**	0.36	14,603		26,063	--	0.16	1,913	1,941	4,734	4,805	7,957	10,551
Hood Canal (Area 12)														
Mid-Canal		**750**	0.28	--	139	--	361	0.05	4	5	19	24	117	162
Skokomish		**1200**	0.46	5,024	1,031	6,038	1,215	0.23	1,300	1,331	1,669	1,782	3,085	4,278
Hoodsport H, Dewato, Union, Tahuya tribs.		**1,850**	0.87	15,202	158	1,854	408	0.64	144	184	11,138	11,286	4,078	5,656

LA WA components:									
all natural (cedar plus N trib)	**0.25**	**0**	**138**	**0**	**408**		**1**	**28**	**110**
cedar only natural	**0.25**	**0**	**69**	**0**	**204**		**0**	**14**	**55**
all hatchery	**0.32**	**1,723**	**0**	**3,648**	**0**		**10**	**265**	**1,448**
Combined	**0.31**	**1,723**	**138**	**3,648**	**408**		**11**	**293**	**1,558**

Table C3-28. Total fishing-related mortality of all chinook (U.S. and Canadian) by Puget Sound regional fishery: Scenario I

Alternative 2--Escapement Goal Management at the Management Unit Level

Region	All Stocks in Regional Fisheries: Sport				Net and Troll		
	Mortality		Salmon Angler Trips		Mortality	Landed Catch	
	Total AEQ	Landed	Marine	Freshwater	AEQ	Treaty	NonTreaty
Juan de Fuca (Area 5, 6)	0	0	0	0	0	0	0
North Sound (Area 7)	9,851	9,851	0	44,474	0	0	0
Central Sound (Area 8, 9)	392	392	0	30,301	391	391	0
South Sound (Area 10,11,13)	5,052	5,052	0	66,282	10,414	10,537	0
Hood Canal (Area 12)	1,191	1,191	0	13,719	9,371	11,608	0
TOTAL	16,485	16,485	0	154,776	20,176	22,537	0

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-29. Total fishing related mortality of Puget Sound hatchery and natural chinook stocks: Scenario D

Alternative 3--Escapement Goal Management at the Population Level

Chinook (by MU/Pop)	Objective		Regional Stocks Only: All Fisheries						SUS Sport Mortality		SUS Net &Troll Mortality		AK and BC Mortality	
				AEQ Mortality		Escapement								
	Exp. Rate	Escapement	Exp.Rate	Hatchery	Natural	Hatchery	Natural	SUS ER	Total AEQ	Landed	Total AEQ	Landed	Total AEQ	Landed
Juan de Fuca (Area 5, 6)									0	0	17	17	763	830
Dungeness Spring		**925**	0.26	--	83	--	237	0.01	0	0	2	2	81	88
Western Strait-Hoko		**850**	0.26	--	188	--	532	0.01	0	0	4	4	184	201
Elwha		**2,900**	0.26	--	509	--	1,431	0.01	0	0	11	11	498	542
North Sound (Area 7)														
Nooksack Spring	7% SUS ER	**4,000**	0.203	--	73	--	285	0.01	0	0	5	6	68	55
Nooksack/Samish summer-fall		**8,900**	0.52	22,812	--	20,673	--	0.52	10,016	10,022	1,868	2,051	10,928	13,132
Central Sound (Area 8, 9)														
Skagit														
Spring		**2,000**	0.17	163	277	825	1,395	0.02	0	0	49	54	390	436
Upper Sauk		**986**												
Suiattle		**574**												
Upper Cascade		**440**												
Summer/Fall		**14,500**	0.43	71	7,157	96	9,625	0.00	28	37	54	68	7,146	10,524
Lower Sauk		**1,926**												
Upper Skagit		**8,434**												
Lower Skagit		**4,140**												
NF Stillaguamish		**600**	0.11	--	201	--	1,702	0.02	0	0	34	35	167	227
SF Stillaguamish		**300**												
Skykomish		**3,600**	0.13	847	557	3,596	3,720	0.03	7	7	231	241	1,166	1,430
Snoqualmie		**1,000**												
Tulalip Tribal Hatchery		**--**	0.13	795	--	5,351	--	0.13	14	12	300	340	481	545
South Sound (Area 10,11,13)														
Lake Washington (Cedar River portion)		**1,200**	0.25	1,723	138	3,852	204	0.05	11	14	293	349	1,558	2,066
Green-Duwamish		**5,800**	0.38	4,553	3,583	5,995	5,800	0.18	1,171	1,179	2,314	2,506	4,651	6,167
Puyallup		**1,200**	0.59	3,481	1,720	1,113	1,200	0.39	961	965	2,412	2,484	1,828	2,423
Nisqually		**1,100**	0.62	8,425	1,827	4,920	1,100	0.47	1,240	1,259	6,490	6,739	2,521	3,343
White Spring		**1,000**	0.22	--	289	--	1,000	0.20	123	0	135	137	31	34
Gorst, Grovers, Minter, Chambers & McAllister, Deschutes		**9,600**	0.36	14,603		26,063	--	0.16	1,913	1,941	4,734	4,805	7,957	10,551
Hood Canal (Area 12)														
Mid-Canal		**750**	0.28	--	139	--	361	0.05	4	5	19	24	117	162
Skokomish		**1200**	0.46	5,024	1,031	6,038	1,215	0.23	1,300	1,331	1,669	1,782	3,085	4,278
Hoodsport H, Dewato, Union, Tahuya tribs.		**1,850**	0.87	15,202	158	1,854	408	0.64	144	184	11,138	11,286	4,078	5,656

LA WA components:	**Exp.Rate**	**AEQ Hatchery**	**AEQ Natural**	**Esc. Hatchery**	**Esc. Natural**	**SUS ER**	**SUS Sport Total AEQ**	**SUS Net &Troll Total AEQ**	**AK and BC Total AEQ**
all natural (cedar plus N trib)	**0.25**	**0**	**138**	**0**	**408**		**1**	**28**	**110**
cedar only natural	**0.25**	**0**	**69**	**0**	**204**		**0**	**14**	**55**
all hatchery	**0.32**	**1,723**	**0**	**3,648**	**0**		**10**	**265**	**1,448**
Combined	**0.31**	**1,723**	**138**	**3,648**	**408**		**11**	**293**	**1,558**

Table C3-30. Total fishing-related mortality of all chinook (U.S. and Canadian) by Puget Sound regional fishery: Scenario

Alternative 3--Escapement Goal Management at the Population Level

Region	All Stocks in Regional Fisheries: Sport				Net and Troll		
	Mortality		Salmon Angler Trips		Mortality	Landed Catch	
	Total AEQ	Landed	Marine	Freshwater	AEQ	Treaty	NonTreaty
Juan de Fuca (Area 5, 6)	0	0	0	0	0	0	0
North Sound (Area 7)	9,851	9,851	0	44,474	0	0	0
Central Sound (Area 8, 9)	0	0	0	1,345	0	0	0
South Sound (Area 10,11,13)	5,052	5,052	0	66,282	10,414	10,537	0
Hood Canal (Area 12)	1,191	1,191	0	13,719	9,371	11,608	0
TOTAL	16,093	16,093	0	125,820	19,784	22,145	0

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-31. Total fishing related mortality of Puget Sound hatchery and natural chinook stocks: Scenario D

Alternative 4--No Action/No Authorized Take

Chinook (by MU/Pop)	Objective		Regional Stocks Only: All Fisheries	AEQ Mortality		Escapement			SUS Sport Mortality		SUS Net &Troll Mortality		AK and BC Mortality	
	Exp. Rate	Escapement	Exp.Rate	Hatchery	Natural	Hatchery	Natural	SUS ER	Total AEQ	Landed	Total AEQ	Landed	Total AEQ	Landed
Juan de Fuca (Area 5, 6)									0	0	17	17	763	830
Dungeness Spring	10% SUS ER		0.26	--	83	--	237	0.01	0	0	2	2	81	88
Western Strait-Hoko	10% SUS ER		0.26	--	188	--	532	0.01	0	0	4	4	184	201
Elwha	10% SUS ER		0.26	--	509	--	1,431	0.01	0	0	11	11	498	542
North Sound (Area 7)														
Nooksack Spring	7% SUS ER		0.20	--	73	--	285	0.01	0	0	5	6	68	55
Nooksack/Samish summer-fall			0.58	12,961	--	9,424	--	0.58	165	171	1,868	2,051	10,928	13,132
Central Sound (Area 8, 9)														
Skagit														
Spring	42% Total ER		0.17	163	277	825	1,395	0.02	0	0	49	54	390	436
Upper Sauk														
Suiattle														
Upper Cascade														
Summer/Fall	52% Total ER		0.43	71	7,157	96	9,625	0.00	28	37	54	68	7,146	10,524
Lower Sauk														
Upper Skagit														
Lower Skagit														
Stillaguamish	25% Total ER		0.11	--	201	--	1,702	0.02	0	0	34	35	167	227
Snohomish	24% Total ER		0.13	844	556	3,600	3,720	0.03	3	3	231	241	1,166	1,430
Tulalip Tribal Hatchery			0.13	795	--	5,351	--	0.13	14	12	300	340	481	545
South Sound (Area 10,11,13)														
Lake Washington (Cedar River portion)	15% pre-terminal SUS ER	1,200	0.25	1,723	138	3,852	204	0.05	11	14	293	349	1,558	2,066
Green-Duwamish	15% pre-terminal SUS ER	5800	0.25	3,306	2,376	7,242	7,006	0.05	31	40	1,001	1,192	4,651	6,167
Puyallup	50% Total ER		0.25	1,476	739	3,118	2,180	0.05	12	16	375	447	1,828	2,423
Nisqually		1100	0.23	3,221	663	10,124	2,264	0.08	64	82	1,299	1,548	2,521	3,343
White Spring	20% Total ER		0.03	--	43	--	1,246	0.01	0	0	12	14	31	34
Gorst, Grovers, Minter, Chambers & McAllister, Deschutes			0.28	10,944		28,157	--	0.08	127	164	2,860	3,693	7,957	10,551
Hood Canal (Area 12)														
Mid-Canal	15% pre-terminal SUS ER	750 spawners???	0.28	--	139	--	361	0.05	4	5	19	24	117	162
Skokomish	15% pre-terminal SUS ER	1200	0.28	3,079	632	7,983	1,622	0.05	109	139	516	628	3,085	4,278
Hoodsport H, Dewato, Union, Tahuya tribs.			0.28	4,747	158	12,309	408	0.05	144	184	682	831	4,078	5,656

LA WA components:	Exp.Rate	AEQ Hatchery	AEQ Natural	Esc. Hatchery	Esc. Natural	SUS ER	SUS Sport	SUS Net & Troll	AK and BC
all natural (cedar plus N trib)	**0.25**	**0**	**138**	**0**	**408**		**1**	**28**	**110**
cedar only natural	**0.25**	**0**	**69**	**0**	**204**		**0**	**14**	**55**
all hatchery	**0.32**	**1,723**	**0**	**3,648**	**0**		**10**	**265**	**1,448**
Combined	**0.31**	**1,723**	**138**	**3,648**	**408**		**11**	**293**	**1,558**

Table C3-32. Total fishing-related mortality of all chinook (U.S. and Canadian) by Puget Sound regional fishery: Scenario D

Alternative 4--No Action/No Authorized Take

Region	All Stocks in Regional Fisheries: Sport Mortality		Salmon Angler Trips		Net and Troll Mortality	Landed Catch	
	Total AEQ	Landed	Marine	Freshwater	AEQ	Treaty	NonTreaty
Juan de Fuca (Area 5, 6)	0	0	0	0	0	0	0
North Sound (Area 7)	0	0	0	840	0	0	0
Central Sound (Area 8, 9)	0	0	0	1,344	0	0	0
South Sound (Area 10,11,13)	0	0	0	2,092	0	0	0
Hood Canal (Area 12)	0	0	0	32	0	0	0
TOTAL	0	0	0	4,308	0	0	0

Sport Catch Area	Salmon Angler Trips Marine	Freshwater
Area 5	42,841	89
Area 6	19,275	4,777
Area 7	33,132	43,741
Area 8	51,743	218,796
Area 9	54,268	0
Area 10	40,291	8,682
Area 11	75,935	21,832
Area 12	19,588	5,057
Area 13	34,875	11,569

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-33. Total fishing related mortality of Puget Sound hatchery and natural coho stocks: All Scenarios

Alternative 1--Proposed Action

Coho (by MU)	Regional Stocks Only											
	Wild	All Fisheries Total Mortality		All Fisheries Escapement		SUS Sport Mortality		SUS Net & Troll Mortality		AK and BC Mortality		
	Exp. Rate	Hat.	Nat.	Hat.	Nat.	Total	Landed	Total	Landed	Total	Landed	
Juan de Fuca (Area 5, 6)												
Juan de Fuca	0.14	14,570	2,739	9,516	17,323	6,659	5,319	10,432	9,686	218	185	
North Sound (Area 7)												
Nooksack/Samish	0.50	39,524	8,291	27,518	8,184	10,450	9,454	32,791	31,761	4,574	4,240	
Central Sound (Area 8, 9)												
Skagit	0.37	4,559	43,233	5,872	74,038	11,842	9,596	35,079	32,897	871	550	
Stillaguamish	0.37	65	13,988	1,174	24,096	4,678	3,620	9,216	8,449	159	89	
Snohomish	0.33	22,473	67,223	13,541	137,327	32,426	25,767	55,926	50,953	1,344	920	
So. Sound (Area 10,11,13)												
South Sound	0.55	206,910	57,064	120,196	47,446	85,517	79,452	173,914	166,931	4,543	4,173	
Hood Canal (Area 12)												
Hood Canal	0.41	37,333	13,512	11,457	19,091	21,126	18,803	28,855	24,106	864	726	

Table C3-34. Total fishing-related mortality of all coho (U.S. and Canadian) by Puget Sound regional fishery: All Scenarios

Region	All Stocks in Regional Fisheries				
	Sport Mortality		Net and Troll Total	Net and Troll Landed Catch	
	Total	Landed	Mortality	Treaty	NonTreaty
Juan de Fuca (Area 5, 6)	63,798	46,029	26,304	23,865	1,886
North Sound (Area 7)	7,549	7,104	52,633	37,374	14,234
Central Sound (Area 8, 9)	43,693	42,080	67,399	64,453	1,625
So. Sound (Area 10,11,13)	41,595	39,903	146,277	141,144	2,269
Hood Canal (Area 12)	9,161	8,746	21,692	17,051	4,379

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-35. Total fishing related mortality of Puget Sound hatchery and natural sockeye stocks: All Scenarios

Alternative 1--Proposed Action

Sockeye	Regional Stocks Only										
	Wild	All Fisheries Total Mortality		All Fisheries Escapement		SUS Sport Mortality		SUS Net & Troll Mortality		AK and BC Mortality	
	Exp. Rate	Hat.	Nat.	Hat.	Nat.	Total	Landed	Total	Landed	Total	Landed
Juan de Fuca (Area 5, 6)											
Juan de Fuca	--	--	--	--	--	--	--	--	--	--	--
North Sound (Area 7)											
Nooksack/Samish	--	--	--	--	--	--	--	--	--	--	--
Central Sound (Area 8, 9)											
Skagit	0.00	250	--	--	11,823	--	--	--	250	--	--
Stillaguamish	--	--	--	--	--	--	--	--	--	--	--
Snohomish	--	--	--	--	--	--	--	--	--	--	--
So. Sound (Area 10,11,13)											
South Sound	0.19	22,224	70,376	92,184	291,916	--	44,900	--	47,700	--	--
Hood Canal (Area 12)											
Hood Canal	--	--	--	--	--	--	--	--	--	--	--

Table C3-36. Total fishing-related mortality of all sockeye (U.S. and Canadian) by Puget Sound regional fishery: All Scenarios

Region	All Stocks in Regional Fisheries				
	Sport Mortality		Net and Troll		
			Total	Landed Catch	
	Total	Landed	Mortality	Treaty	NonTreaty
Juan de Fuca (Area 5, 6)		15		26,419	0
North Sound (Area 7)		94		255,609	246,594
Central Sound (Area 8, 9)		0		250	0
So. Sound (Area 10,11,13)		44,900		47,700	0
Hood Canal (Area 12)		0		0	0

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-37. Total fishing related mortality of Puget Sound hatchery and natural pink stocks: All Scenarios

Alternative 1--Proposed Action

Pink	Regional Stocks Only										
	Wild	All Fisheries Total Mortality		Escapement		SUS Sport Mortality		SUS Net & Troll Mortality		AK and BC Mortality	
	Exp. Rate	Hat.	Nat.	Hat.	Nat.	Total	Landed	Total	Landed	Total	Landed
Juan de Fuca (Area 5, 6)											
Juan de Fuca	0.35	--	2,574	--	4,848		116		1,374		1,084
North Sound (Area 7)											
Nooksack/Samish	0.07	--	7,184	--	91,988		734		6,450		--
Central Sound (Area 8, 9)											
Skagit	0.30	--	184,614	--	430,792		49,312		135,302		--
Stillaguamish	0.36	--	90,690	--	164,000		9,690		81,000		--
Snohomish	0.37	--	101,193	--	173,000		14,193		87,000		--
So. Sound (Area 10,11,13)											
South Sound	0.09	6	1,313	66	13,283		1,003		316		--
Hood Canal (Area 12)											
Hood Canal	0.39	27,056	12,870	4,513	20,065		424		33,043		6,459

Table C3-38. Total fishing-related mortality of all pink (U.S. and Canadian) by Puget Sound regional fishery: All Scenarios

Region	All Stocks in Regional Fisheries				
	Sport Mortality		Net and Troll		
			Total	Landed Catch	
	Total	Landed	Mortality	Treaty	NonTreaty
Juan de Fuca (Area 5, 6)		19,963		1,374	0
North Sound (Area 7)		6,357		529,707	609,422
Central Sound (Area 8, 9)		73,661		201,880	101,422
So. Sound (Area 10,11,13)		1,003		316	0
Hood Canal (Area 12)		424		28,602	4,441

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-39. Total fishing related mortality of Puget Sound hatchery and natural chum stocks: All Scenarios

Alternative 1--Proposed Action

Chum	Regional Stocks Only										
		All Fisheries				SUS Sport		SUS Net & Troll		AK and BC	
	Wild	Total Mortality		Escapement		Mortality		Mortality		Mortality	
	Exp. Rate	Hat.	Nat.	Hat.	Nat.	Total	Landed	Total	Landed	Total	Landed
Juan de Fuca (Area 5, 6)											
Juan de Fuca	0.07	--	196	--	2,585		0		137		59
North Sound (Area 7)											
Nooksack/Samish	0.56	9,976	44,763	7,936	35,610		2,686		52,052		--
Central Sound (Area 8, 9)											
Skagit	0.09	177	4,076	1,834	42,237		1,166		3,087		--
Stillaguamish	0.59	970	20,608	700	14,400		1,077		20,500		--
Snohomish	0.51	36,193	18,091	7,200	17,600		1,084		53,200		--
So. Sound (Area 10,11,13)											
South Sound	0.68	37,613	323,645	17,540	150,923		3,189		358,069		--
Hood Canal (Area 12)											
Hood Canal	0.49	169,630	49,357	37,637	50,382		4,121		214,866		--

Table C3-40. Total fishing-related mortality of all chum (U.S. and Canadian) by Puget Sound regional fishery: All Scenarios

Region	All Stocks in Regional Fisheries				
	Sport		Net and Troll		
	Mortality		Total	Landed Catch	
	Total	Landed	Mortality	Treaty	NonTreaty
Juan de Fuca (Area 5, 6)		13		10,450	0
North Sound (Area 7)		2,727		103,933	88,120
Central Sound (Area 8, 9)		2,377		48,257	28,530
So. Sound (Area 10,11,13)		3,189		196,350	161,719
Hood Canal (Area 12)		4,121		107,433	107,433

Table C3-41. Total fishing related mortality of Puget Sound hatchery and natural steelhead stocks: All Scenarios

Alternative 1--Proposed Action

Steelhead	Regional Stocks Only				
	All Fisheries			Tribal Net Mortality	
	Wild Exp. Rate	Escapement Hat.	Nat.	Total	Landed
Juan de Fuca (Area 5, 6)	na	na	na		739
Juan de Fuca					
North Sound (Area 7)	na	na	na		20
Nooksack/Samish					
Central Sound (Area 8, 9)	na	na	na		512
Skagit					
Stillaguamish					
Snohomish					
So. Sound (Area 10,11,13)	na	na	na		663
South Sound					
Hood Canal (Area 12)	na	na	na		0
Hood Canal					

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-42. Total fishing related mortality of Puget Sound hatchery and natural coho stocks: All Scenarios

Alternative 2--Escapement Goal Management at the Management Unit Level

Coho (by MU)	Regional Stocks Only											
	Wild	All Fisheries Total Mortality		All Fisheries Escapement		SUS Sport Mortality		SUS Net & Troll Mortality		AK and BC Mortality		
	Exp. Rate	Hat.	Nat.	Hat.	Nat.	Total	Landed	Total	Landed	Total	Landed	
Juan de Fuca (Area 5, 6)												
Juan de Fuca	0.06	6,345	1,212	17,622	18,819	591	413	6,747	6,079	219	186	
North Sound (Area 7)												
Nooksack/Samish	0.13	10,674	2,142	56,057	14,272	3,758	3,405	4,449	3,981	4,609	4,272	
Central Sound (Area 8, 9)												
Skagit	0.06	1,208	7,102	9,241	109,887	1,327	415	6,105	4,604	878	554	
Stillaguamish	0.17	2,840	6,532	1,296	31,413	1,491	1,031	7,721	6,993	160	91	
Snohomish	0.08	1,909	16,706	30,927	187,066	3,614	6,775	13,645	40,819	1,361	929	
So. Sound (Area 10,11,13)												
South Sound	0.33	92,656	33,957	233,962	69,945	22,184	20,084	99,739	95,161	4,690	4,321	
Hood Canal (Area 12)												
Hood Canal	0.12	11,327	3,937	37,046	28,533	4,031	3,265	10,314	4,666	919	777	

Table C3-43. Total fishing-related mortality of all coho (U.S. and Canadian) by Puget Sound regional fishery: All Scenarios

Region	All Stocks in Regional Fisheries				
	Sport Mortality		Net and Troll		
			Total	Landed Catch	
	Total	Landed	Mortality	Treaty	NonTreaty
Juan de Fuca (Area 5, 6)	0	0	4,109	1,725	2,304
North Sound (Area 7)	1,034	1,034	0	0	0
Central Sound (Area 8, 9)	1,062	1,062	2,542	2,492	0
So. Sound (Area 10,11,13)	8,897	8,897	74,347	72,889	0
Hood Canal (Area 12)	1,395	1,395	4,583	4,493	0

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-44. Total fishing related mortality of Puget Sound hatchery and natural sockeye stocks: All Scenarios

Alternative 2--Escapement Goal Management at the Management Unit Level

Sockeye	Regional Stocks Only										
	All Fisheries					SUS Sport Mortality		SUS Net & Troll Mortality		AK and BC Mortality	
	Wild	Total Mortality		Escapement							
	Exp. Rat	Hat.	Nat.	Hat.	Nat.	Total	Landed	Total	Landed	Total	Landed
Juan de Fuca (Area 5, 6)											
Juan de Fuca	--	--	--	--	--	--	--	--	--	--	--
North Sound (Area 7)											
Nooksack/Samish	--	--	--	--	--	--	--	--	--	--	--
Central Sound (Area 8, 9)											
Skagit	0.0	--	--	--	12073	--	--	--	--	--	--
Stillaguamish	--	--	--	--	--	--	--	--	--	--	--
Snohomish	--	--	--	--	--	--	--	--	--	--	--
So. Sound (Area 10,11,13)											
South Sound	0.0	--	--	114,408	362,292	--	--	--	--	--	--
Hood Canal (Area 12)											
Hood Canal	--	--	--	--	--	--	--	--	--	--	--

Table C3-45. Total fishing-related mortality of all sockeye (U.S. and Canadian) by Puget Sound regional fishery: All Scenarios

Region	All Stocks in Regional Fisheries				
	Sport Mortality		Net and Troll		
			Total	Landed Catch	
	Total	Landed	Mortality	Treaty	NonTreaty
Juan de Fuca (Area 5, 6)		0		0	0
North Sound (Area 7)		0		0	0
Central Sound (Area 8, 9)		0		0	0
So. Sound (Area 10,11,13)		0		0	0
Hood Canal (Area 12)		0		0	0

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-46. Total fishing related mortality of Puget Sound hatchery and natural pink stocks: All Scenarios

Alternative 2--Escapement Goal Management at the Management Unit Level

Pink	Regional Stocks Only										
	Wild	All Fisheries Total Mortality		Escapement		SUS Sport Mortality		SUS Net & Troll Mortality		AK and BC Mortality	
	Exp. Rate	Hat.	Nat.	Hat.	Nat.	Total	Landed	Total	Landed	Total	Landed
Juan de Fuca (Area 5, 6)											
Juan de Fuca	0.15	--	1084	--	6338	--	--	--	--	--	1084
North Sound (Area 7)											
Nooksack/Samish	0.00	--	--	--	99172	--	--	--	--	--	--
Central Sound (Area 8, 9)											
Skagit	0.00	--	--	--	615406	--	--	--	--	--	--
Stillaguamish	0.21	--	54331	--	200360	0	5731	0	48600	--	--
Snohomish	0.00	--	--	--	274193	--	--	--	34800	--	--
So. Sound (Area 10,11,13)											
South Sound	0.04	3	597	69	13999	0	284	0	316	--	--
Hood Canal (Area 12)											
Hood Canal	0.16	27080	5379	4488	27556	0	209	0	25792	--	6459

Table C3-47. Total fishing-related mortality of all pink (U.S. and Canadian) by Puget Sound regional fishery: All Scenarios

Region	All Stocks in Regional Fisheries				
	Sport Mortality		Net and Troll		
			Total	Landed Catch	
	Total	Landed	Mortality	Treaty	NonTreaty
Juan de Fuca (Area 5, 6)		0		0	0
North Sound (Area 7)		0		0	0
Central Sound (Area 8, 9)		5,731		83,400	0
So. Sound (Area 10,11,13)		284		316	0
Hood Canal (Area 12)		209		25,792	0

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-48. Total fishing related mortality of Puget Sound hatchery and natural chum stocks: All Scenarios

Alternative 2--Escapement Goal Management at the Management Unit Level

Chum	Regional Stocks Only										
	Wild	All Fisheries Total Mortality		All Fisheries Escapement		SUS Sport Mortality		SUS Net & Troll Mortality		AK and BC Mortality	
	Exp. Rate	Hat.	Nat.	Hat.	Nat.	Total	Landed	Total	Landed	Total	Landed
Juan de Fuca (Area 5, 6)											
Juan de Fuca	0.02	--	59	--	2722		0		2		59
North Sound (Area 7)											
Nooksack/Samish	0.01	199	891	17713	79482		234		856		--
Central Sound (Area 8, 9)											
Skagit	0.01	10	242	2000	46071		193		59		--
Stillaguamish	0.02	39	813	1631	34194		56		796		--
Snohomish	0.00	131	108	43262	35583		142		97		--
So. Sound (Area 10,11,13)											
South Sound	0.16	8,694	74,807	46459	399761		2338		81163		--
Hood Canal (Area 12)											
Hood Canal	0.04	62182	4266	145084	95473		635		65813		--

Table C3-49. Total fishing-related mortality of all chum (U.S. and Canadian) by Puget Sound regional fishery: All Scenarios

Region	All Stocks in Regional Fisheries				
	Sport Mortality		Net and Troll		
			Total	Landed Catch	
	Total	Landed	Mortality	Treaty	NonTreaty
Juan de Fuca (Area 5, 6)		0		2	0
North Sound (Area 7)		234		856	0
Central Sound (Area 8, 9)		391		952	0
So. Sound (Area 10,11,13)		2,338		81,163	0
Hood Canal (Area 12)		635		65,813	0

Table C3-50. Total fishing related mortality of Puget Sound hatchery and natural steelhead stocks: All Scenarios

Alternative 2--Escapement Goal Management

	Regional Stocks Only				
Steelhead	**All Fisheries**			**Tribal Net Mortality**	
	Wild	**Escapement**			
	Exp. Rate	**Hat.**	**Nat.**	**Total**	**Landed**
Juan de Fuca (Area 5, 6)	na	na	na		610
Juan de Fuca					
North Sound (Area 7)	na	na	na		14
Nooksack/Samish					
Central Sound (Area 8, 9)	na	na	na		213
Skagit					
Stillaguamish					
Snohomish					
So. Sound (Area 10,11,13)	na	na	na		653
South Sound					
Hood Canal (Area 12)	na	na	na		0
Hood Canal					

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-51. Total fishing related mortality of Puget Sound hatchery and natural coho stocks: All Scenarios

Alternative 3--Escapement Goal Management at the Population Level

Coho (by MU)	Regional Stocks Only											
	Wild	All Fisheries Total Mortality		All Fisheries Escapement		SUS Sport Mortality		SUS Net & Troll Mortality		AK and BC Mortality		
	Exp. Rate	Hat.	Nat.	Hat.	Nat.	Total	Landed	Total	Landed	Total	Landed	
Juan de Fuca (Area 5, 6)												
Juan de Fuca	0.06	6,345	1,212	17,622	18,819	591	413	6,747	6,079	219	186	
North Sound (Area 7)												
Nooksack/Samish	0.13	10,674	2,142	56,057	14,272	3,758	3,405	4,449	3,981	4,609	4,272	
Central Sound (Area 8, 9)												
Skagit	0.06	1,208	7,102	9,241	109,887	1,327	415	6,105	4,604	878	554	
Stillaguamish	0.08	19	3,105	1,317	34,840	429	42	2,535	1,866	160	91	
Snohomish	0.08	4,699	16,706	30,938	187,066	3,614	1,338	16,435	12,434	1,361	931	
So. Sound (Area 10,11,13)												
South Sound	0.33	92,656	33,957	233,962	69,945	22,184	20,084	99,739	95,161	4,690	4,321	
Hood Canal (Area 12)												
Hood Canal	0.12	11,327	3,937	37,046	28,533	4,031	3,265	10,314	4,666	919	777	

Table C3-52. Total fishing-related mortality of all coho (U.S. and Canadian) by Puget Sound regional fishery: All Scenarios

Region	All Stocks in Regional Fisheries				
	Sport Mortality		Net and Troll		
			Total	Landed Catch	
	Total	Landed	Mortality	Treaty	NonTreaty
Juan de Fuca (Area 5, 6)	0	0	4,109	1,725	2,304
North Sound (Area 7)	1,034	1,034	0	0	0
Central Sound (Area 8, 9)	0	0	146	143	0
So. Sound (Area 10,11,13)	8,897	8,897	74,347	72,889	0
Hood Canal (Area 12)	1,395	1,395	4,583	4,493	0

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-53. Total fishing related mortality of Puget Sound hatchery and natural sockeye stocks: All Scenarios

Alternative 3--Escapement Goal Management at the Population Level

Sockeye	Regional Stocks Only											
	All Fisheries					SUS Sport Mortality		SUS Net & Troll Mortality		AK and BC Mortality		
	Wild	Total Mortality		Escapement								
	Exp. Rate	Hat.	Nat.	Hat.	Nat.	Total	Landed	Total	Landed	Total	Landed	
Juan de Fuca (Area 5, 6)												
Juan de Fuca	--	--	--	--	--	--	--	--	--	--	--	
North Sound (Area 7)												
Nooksack/Samish	--	--	--	--	--	--	--	--	--	--	--	
Central Sound (Area 8, 9)												
Skagit	0.0	--	--	--	12073	--	--	--	--	--	--	
Stillaguamish	--	--	--	--	--	--	--	--	--	--	--	
Snohomish	--	--	--	--	--	--	--	--	--	--	--	
So. Sound (Area 10,11,13)												
South Sound	0.0	--	--	114,408	362,292	--	--	--	--	--	--	
Hood Canal (Area 12)												
Hood Canal	--	--	--	--	--	--	--	--	--	--	--	

Table C3-54. Total fishing-related mortality of all sockeye (U.S. and Canadian) by Puget Sound regional fishery: All Scenarios

Region	All Stocks in Regional Fisheries				
	Sport Mortality		Net and Troll		
			Total	Landed Catch	
	Total	Landed	Mortality	Treaty	NonTreaty
Juan de Fuca (Area 5, 6)		0		0	0
North Sound (Area 7)		0		0	0
Central Sound (Area 8, 9)		0		0	0
So. Sound (Area 10,11,13)		0		0	0
Hood Canal (Area 12)		0		0	0

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-55. Total fishing related mortality of Puget Sound hatchery and natural pink stocks: All Scenarios

Alternative 3--Escapement Goal Management at the Population Level

Pink	Regional Stocks Only											
	Wild	All Fisheries Total Mortality		Escapement		SUS Sport Mortality		SUS Net & Troll Mortality		AK and BC Mortality	
	Exp. Rate	Hat.	Nat.	Hat.	Nat.	Total	Landed	Total	Landed	Total	Landed
Juan de Fuca (Area 5, 6)											
Juan de Fuca	0.15	--	1084	--	6338	--	--	--	--	--	1084
North Sound (Area 7)											
Nooksack/Samish	0.00	--	--	--	99172	--	--	--	--	--	--
Central Sound (Area 8, 9)											
Skagit	0.00	--	--	--	615406	--	--	--	--	--	--
Stillaguamish	0.00	--	--	--	254690	--	--	--	--	--	--
Snohomish	0.00	--	--	--	274193	--	--	--	--	--	--
So. Sound (Area 10,11,13)											
South Sound	0.04	3	597	69	13999	0	284	0	316	--	--
Hood Canal (Area 12)											
Hood Canal	0.16	27080	5379	4488	27556	0	209	0	25792	--	6459

Table C3-56. Total fishing-related mortality of all pink (U.S. and Canadian) by Puget Sound regional fishery: All Scenarios

Region	All Stocks in Regional Fisheries				
	Sport Mortality		Net and Troll		
			Total	Landed Catch	
	Total	Landed	Mortality	Treaty	NonTreaty
Juan de Fuca (Area 5, 6)		0		0	0
North Sound (Area 7)		0		0	0
Central Sound (Area 8, 9)		--		--	0
So. Sound (Area 10,11,13)		284		316	0
Hood Canal (Area 12)		209		25,792	0

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-57. Total fishing related mortality of Puget Sound hatchery and natural chum stocks: All Scenarios

Alternative 3--Escapement Goal Management at the Population Level

	Regional Stocks Only										
Chum	**Wild**	**All Fisheries Total Mortality**		**Escapement**		**SUS Sport Mortality**		**SUS Net & Troll Mortality**		**AK and BC Mortality**	
	Exp. Rate	**Hat.**	**Nat.**	**Hat.**	**Nat.**	**Total**	**Landed**	**Total**	**Landed**	**Total**	**Landed**
Juan de Fuca (Area 5, 6)											
Juan de Fuca	0.02	--	59	--	2722		0		2		59
North Sound (Area 7)											
Nooksack/Samish	0.01	199	891	17713	79482		234		856		--
Central Sound (Area 8, 9)											
Skagit	0.01	10	242	2000	46071		193		59		--
Stillaguamish	0.00	2	44	1668	34964		1		45		--
Snohomish	0.00	131	108	43262	35583		142		97		--
So. Sound (Area 10,11,13)											
South Sound	0.16	8,694	74,807	46459	399761		2338		81163		--
Hood Canal (Area 12)											
Hood Canal	0.04	62182	4266	145084	95473		635		65813		--

Table C3-58. Total fishing-related mortality of all chum (U.S. and Canadian) by Puget Sound regional fishery: All Scenarios

All Stocks in Regional Fisheries					
Region	**Sport Mortality**		**Net and Troll**		
			Total	**Landed Catch**	
	Total	**Landed**	**Mortality**	**Treaty**	**NonTreaty**
Juan de Fuca (Area 5, 6)		0		2	0
North Sound (Area 7)		234		856	0
Central Sound (Area 8, 9)		336		201	0
So. Sound (Area 10,11,13)		2,338		81,163	0
Hood Canal (Area 12)		635		65,813	0

Table C3-59. Total fishing related mortality of Puget Sound hatchery and natural steelhead stocks: All Scenarios

Alternative 3--Escapement Goal Management at the Population Level

Steelhead	**Regional Stocks Only**				
	All Fisheries			**Tribal Net Mortality**	
	Wild Exp. Rate	**Escapement Hat.**	**Escapement Nat.**	**Total**	**Landed**
Juan de Fuca (Area 5, 6)	na	na	na		610
Juan de Fuca					
North Sound (Area 7)	na	na	na		14
Nooksack/Samish					
Central Sound (Area 8, 9)	na	na	na		213
Skagit					
Stillaguamish					
Snohomish					
So. Sound (Area 10,11,13)	na	na	na		653
South Sound					
Hood Canal (Area 12)	na	na	na		0
Hood Canal					

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-60. Total fishing related mortality of Puget Sound hatchery and natural coho stocks: All Scenarios

Alternative 4--No Action/No Authorized Take

Coho (by MU)	Regional Stocks Only											
		All Fisheries				SUS Sport		SUS Net & Troll		AK and BC		
	Wild	Total Mortality		Escapement		Mortality		Mortality		Mortality		
	Exp. Rate	Hat.	Nat.	Hat.	Nat.	Total	Landed	Total	Landed	Total	Landed	
Juan de Fuca (Area 5, 6)												
Juan de Fuca	0.06	2,236	1,212	21,732	18,819	591	413	2,638	2,050	219	186	
North Sound (Area 7)												
Nooksack/Samish	0.07	10,674	1,108	56,057	15,305	2,724	2,420	4,449	3,989	4,609	4,272	
Central Sound (Area 8, 9)												
Skagit	0.06	1,197	6,967	9,253	110,022	1,327	415	5,959	4,790	878	554	
Stillaguamish	0.08	21	3,105	1,317	34,840	429	42	2,537	1,868	160	91	
Snohomish	0.08	4,697	16,706	30,938	187,066	3,614	1,338	16,433	12,446	1,361	931	
So. Sound (Area 10,11,13)												
South Sound	0.06	37,270	6,099	293,781	97,804	13,287	11,610	25,392	22,276	4,690	4,321	
Hood Canal (Area 12)												
Hood Canal	0.07	7,160	2,126	41,214	30,345	2,636	1,936	5,731	4,667	919	777	

Table C3-61. Total fishing-related mortality of all coho (U.S. and Canadian) by Puget Sound regional fishery: All Scenarios

Region	All Stocks in Regional Fisheries				
	Sport		Net and Troll		
	Mortality		Total	Landed Catch	
	Total	Landed	Mortality	Treaty	NonTreaty
Juan de Fuca (Area 5, 6)	0	0	0	0	0
North Sound (Area 7)	0	0	0	0	0
Central Sound (Area 8, 9)	0	0	0	0	0
So. Sound (Area 10,11,13)	0	0	0	0	0
Hood Canal (Area 12)	0	0	0	0	0

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-62. Total fishing related mortality of Puget Sound hatchery and natural sockeye stocks: All Scenarios

Alternative 4--No Action/No Authorized Take

Sockeye	Regional Stocks Only: Wild Exp. Rate	All Fisheries Total Mortality: Hat.	All Fisheries Total Mortality: Nat.	Escapement: Hat.	Escapement: Nat.	SUS Sport Mortality: Total	SUS Sport Mortality: Landed	SUS Net & Troll Mortality: Total	SUS Net & Troll Mortality: Landed	AK and BC Mortality: Total	AK and BC Mortality: Landed
Juan de Fuca (Area 5, 6)											
Juan de Fuca	--	--	--	--	--	--	--	--	--	--	--
North Sound (Area 7)											
Nooksack/Samish	--	--	--	--	--	--	--	--	--	--	--
Central Sound (Area 8, 9)											
Skagit	0.00	--	--	--	12,073	--	--	--	--	--	--
Stillaguamish	--	--	--	--	--	--	--	--	--	--	--
Snohomish	--	--	--	--	--	--	--	--	--	--	--
So. Sound (Area 10,11,13)											
South Sound	0.00	--	--	114,408	362,292	--	--	--	--	--	--
Hood Canal (Area 12)											
Hood Canal	--	--	--	--	--	--	--	--	--	--	--

Table C3-63. Total fishing-related mortality of all sockeye (U.S. and Canadian) by Puget Sound regional fishery: All Scenarios

Region	All Stocks in Regional Fisheries: Sport Mortality: Total	Sport Mortality: Landed	Net and Troll: Total Mortality	Net and Troll: Landed Catch: Treaty	Net and Troll: Landed Catch: NonTreaty
Juan de Fuca (Area 5, 6)		0		0	0
North Sound (Area 7)		0		0	0
Central Sound (Area 8, 9)		0		0	0
So. Sound (Area 10,11,13)		0		0	0
Hood Canal (Area 12)		0		0	0

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-64. Total fishing related mortality of Puget Sound hatchery and natural pink stocks: All Scenarios

Alternative 4--No Action/No Authorized Take

Pink	Regional Stocks Only											
	Wild	All Fisheries Total Mortality		Escapement		SUS Sport Mortality		SUS Net & Troll Mortality		AK and BC Mortality		
	Exp. Rate	Hat.	Nat.	Hat.	Nat.	Total	Landed	Total	Landed	Total	Landed	
Juan de Fuca (Area 5, 6)												
Juan de Fuca	0.15	--	1,084	--	6,338	--	--	--	--	--	1,084	
North Sound (Area 7)												
Nooksack/Samish	0.00	--	--	--	99,172	--	--	--	--	--	--	
Central Sound (Area 8, 9)												
Skagit	0.00	--	--	--	615,406	--	--	--	--	--	--	
Stillaguamish	0.00	--	--	--	254,690	--	--	--	--	--	--	
Snohomish	0.00	--	--	--	274,193	--	--	--	--	--	--	
So. Sound (Area 10,11,13)												
South Sound	0.00	--	--	72	14,596	--	--	--	--	--	--	
Hood Canal (Area 12)												
Hood Canal	0.10	1,186	5,273	10,658	47,387	--	--	--	--	--	6,459	

Table C3-65. Total fishing-related mortality of all pink (U.S. and Canadian) by Puget Sound regional fishery: All Scenarios

Region	All Stocks in Regional Fisheries				
	Sport Mortality		Net and Troll		
			Total	Landed Catch	
	Total	Landed	Mortality	Treaty	NonTreaty
Juan de Fuca (Area 5, 6)		0		0	0
North Sound (Area 7)		0		0	0
Central Sound (Area 8, 9)		0		0	0
So. Sound (Area 10,11,13)		0		0	0
Hood Canal (Area 12)		0		0	0

Note: It is suggested that these tables be printed on larger paper to improve readability.

Table C3-66. Total fishing related mortality of Puget Sound hatchery and natural chum stocks: All Scenarios

Alternative 4--No Action/No Authorized Take

Chum	Regional Stocks Only										
	All Fisheries					SUS Sport Mortality		SUS Net & Troll Mortality		AK and BC Mortality	
	Wild Exp. Rate	Total Mortality Hat.	Total Mortality Nat.	Escapement Hat.	Escapement Nat.	Total	Landed	Total	Landed	Total	Landed
Juan de Fuca (Area 5, 6)											
Juan de Fuca	0.02	--	59	--	2,722		0		2		59
North Sound (Area 7)											
Nooksack/Samish	0.01	194	872	17,717	79,501		210		856		--
Central Sound (Area 8, 9)											
Skagit	0.01	10	242	2,000	46,071		193		59		--
Stillaguamish	0.00	2	44	1,668	34,964		1		45		--
Snohomish	0.00	131	108	43,262	35,583		142		97		--
So. Sound (Area 10,11,13)											
South Sound	0.07	3,843	33,069	51,310	441,499		523		36,389		--
Hood Canal (Area 12)											
Hood Canal	0.00	243	117	207,023	99,621		8		352		--

Table C3-67. Total fishing-related mortality of all chum (U.S. and Canadian) by Puget Sound regional fishery: All Scenarios

Region	All Stocks in Regional Fisheries				
	Sport Mortality		Net and Troll		
			Mortality	Landed Catch	
	Total	Landed	Total	Treaty	NonTreaty
Juan de Fuca (Area 5, 6)		0		2	0
North Sound (Area 7)		210		856	0
Central Sound (Area 8, 9)		336		201	0
So. Sound (Area 10,11,13)		523		36,389	0
Hood Canal (Area 12)		8		352	0

Table C3-68. Total fishing related mortality of Puget Sound hatchery and natural steelhead stocks: All Scenarios

Alternative 4--No Action/No Authorized Take

Steelhead	Regional Stocks Only				
	All Fisheries			Tribal Net Mortality	
	Wild Exp. Rate	Escapement Hat.	Nat.	Total	Landed
Juan de Fuca (Area 5, 6)	na	na	na		609
Juan de Fuca					
North Sound (Area 7)	na	na	na		14
Nooksack/Samish					
Central Sound (Area 8, 9)	na	na	na		213
Skagit					
Stillaguamish					
Snohomish					
So. Sound (Area 10,11,13)	na	na	na		512
South Sound					
Hood Canal (Area 12)	na	na	na		0
Hood Canal					

Appendix C4. Structure and Function of the FRAM

The Fishery Regulation Assessment Model (FRAM) is currently used by the Pacific Fishery Management Council (PFMC) to annually estimate impacts of proposed ocean and terminal fisheries on chinook and coho salmon stocks. The DEIS incorporates by reference a document entitled "FRAM – An overview for chinook and coho", written by the Model Evaluation Workgroup for the Salmon Technical Team of the PFMC[1]. The following was excerpted from that report.

FRAM is a single season modeling tool with separate processing code for chinook and coho salmon. The chinook version evaluates impacts on most stock groups originating from the south central Oregon coast, Columbia River, Puget Sound, and Southern British Columbia. The coho version evaluates impacts on a comprehensive set of stocks originating from Central California to Southeast Alaska and represents total West Coast production. The FRAM produces a variety of output reports that are used to examine fishery impacts for compliance with management objectives, allocation arrangements, ESA compliance, and domestic and international legal obligations. Until recently FRAM was not used for assessing compliance with chinook or coho agreements in international fisheries management forums. However, the U.S. and Canada have agreed to develop a bilateral regional coho planning tool. FRAM will be used for the development of the first version of this regional model. The intent is to have a single common tool that can support both domestic and international fishery planning processes using a common set of data and assumptions.

BACKGROUND

The need for salmon fishery assessment tools at the stock-specific level became apparent beginning in the mid-1970s with treaty fishery rights litigation and the associated legal obligation for the states of Washington and Oregon to provide treaty tribes with the opportunity to harvest specific shares of individual runs. Other legal issues such as the Magnuson Fishery Conservation Management Act and the Law of the Seas convention contributed to the need for developing better assessment tools. These legal issues in conjunction with the information available from the coast wide coded wire tag (CWT) program provided the impetus for developing the early salmon fishery assessment models.

In the late 1970s, the Washington Department of Fisheries (WDF) and U.S. National Bureau of Standards (NBS) developed a model for evaluating alternative fishery regulatory packages. The WDF/NBS Model could be configured for either chinook or coho by using different input data files. This model was coded in FORTRAN and ran on a mainframe computer at the University of Washington. Model runs were usually processed over night and results were painstakingly extracted from large volumes of printed output reports. The WDF/NBS model was not extensively used by the PFMC because it proved costly to operate and its results were difficult to obtain in a timely manner. Morishima and Henry (2000) provide a more in-depth history of Pacific Northwest salmon management and fishery modeling.

In the early 1980s, the development of personal computers permitted the WDF/NBS model to be converted into simple spreadsheet models. This transformation improved accessibility to the

[1] Yuen, H., A.Rankis,, L.LaVoy, J.Packer, C.Melcher, R. Conrad , C. D. Simmons, R. Sharma, and A.Grover. 2004 In prep. FRAM: an overview of chinook and coho. Report of the Model Evaluation Workgroup to the STT.

model during the PFMC preseason planning processes. The first spreadsheet model for chinook used by the PFMC was developed in the mid 1980s to model Columbia River "tule" fall chinook. The Coho Assessment Model (CAM) was the corresponding spreadsheet model for coho and covered stocks from the Columbia River, Puget Sound, and Washington and Oregon coastal areas. The Coho Assessment Model was revised over time, principally to improve report generation capabilities and provide more detailed information on management of terminal area fisheries through the use of Terminal Area Management Modules (TAMMs). The CAM was used as the primary model for evaluating coho impacts for PFMC fisheries until the mid 1990s.

Increasing demands for information soon outstripped the capacity of these spreadsheet models to evaluate the fishery regimes under consideration by the PFMC. In the mid 1990s, CAM was programmed in QUICK BASIC and was renamed FRAM. The recognition that common algorithms underlie both the coho and chinook spreadsheet models led to the effort to develop the QUICK BASIC version of FRAM for both species. The FRAM code could be used to evaluate fishery regimes for either chinook or coho by using different input file configurations. In 1998, FRAM was converted to VISUAL BASIC to take advantage of improved user interfaces available through the MS WINDOWS operating system. A multi-agency Model Evaluation Subgroup periodically reviewed model performance and parameter estimation methods and coordinated revisions to model capabilities during this period (1998-2000).

MODEL OVERVIEW

The FRAM is a discrete, time-oriented, age-structured, deterministic computer model intended to predict the impacts from a variety of proposed fishery regulation mechanisms for a single management year. It produces point estimates of fishery impacts by stock for specific time periods and age classes. The FRAM performs bookkeeping functions to track the progress of individual stock groups as the fisheries in each time step exploit them. Individual stock age groups are exploited as a single pool, that is, in each time step all pre-terminal fisheries operate on the entire cohort and all terminal fisheries operate on the mature run.

Currently, 33 stock groups are represented in Chinook FRAM and 128 stock groups are represented in Coho FRAM (see Appendices 1 and 2 for lists of the stocks). Each of these groups have both marked and unmarked components to permit assessment of mark-selective fishery regulations. For most wild stocks and hatchery stocks without marking or tagging programs, the cohort size of the marked component is zero and therefore the current version of FRAM has a virtual total of 66 stock groups for chinook and 256 for coho. Stocks or stock-aggregates represented in the FRAM were chosen based on the level of management interest, their contribution rate to PFMC fisheries, and the availability of representative CWT recoveries in the fisheries.

The FRAM includes pre-terminal and terminal fisheries in southeast Alaska, Canada, Puget Sound, and off the coasts of Washington, Oregon, and California. There are 73 fisheries in Chinook FRAM and 206 fisheries in Coho FRAM. The intent is to encompass all fishery impacts to modeled chinook and coho stocks in order to account for all fishing-related impacts and thereby improve model accuracy. Terminal fisheries in Chinook FRAM are aggregations of gears and management areas. Terminal fisheries in Coho FRAM are modeled with finer resolution, most notably by including individual freshwater fisheries. Fishery number and fishery name for each of the FRAM fisheries are listed in Appendix 3 for chinook and Appendix 4 for coho.

The time step structure used in FRAM represents a compromise level of resolution that corresponds to management planning fishery seasons and species-specific migration and maturation schedules.

The FRAM consists of four time periods for chinook and five periods for coho (Table 2-1). At each time step a cohort is subjected to natural mortality, pre-terminal fisheries, and also potentially to maturation (chinook only), and terminal fisheries.

Table 2-1. FRAM time steps for coho and chinook.

Coho		Chinook	
Period	Months	Period	Months
Time 1	January-June	Time 1	Preceding October-
Time 2	July	Time 2	May-June
Time 3	August	Time 3	July-September
Time 4	September	Time 4	October-April
Time 5	October -		

The recovery data available in the CWT database limit the time-step resolution of the model. Increasing the time-step resolution of the model usually decreases the number of CWT recoveries for a stock within a time period. Since estimation of fishery impacts, like exploitation rates, is dependent on CWT recovery information, decreasing the number of CWT recoveries in time/area strata increases the variance of the estimated exploitation rates in those strata. In recognition of these data limitations, efforts were made to restrict the level of time-step resolution to that necessary for fishery management purposes.

Major assumptions and limitations of the model are described briefly below.

1. <u>CWT fish accurately represent the modeled stock.</u> Many "model" stocks are aggregates of stocks that are represented by CWTs from only one component. For example, in many cases wild stocks are aggregated with hatchery stocks and both are represented by the hatchery stock's CWT data. Therefore, for each modeled stock aggregate, it is assumed that the CWT data accurately depict the exploitation and distribution of the untagged fish in the modeled stock.

2. <u>Length at age of chinook is stock specific and is constant from year to year.</u> Growth functions are used for chinook in determining the proportion of the age class that is legal size in size-limit fisheries. Parameters for the growth curves were estimated from data collected over a number of years. It is assumed that growth in the year to be modeled is similar to that in the years used to estimate the parameters.

3. <u>Stock distribution and migration is constant from year to year and estimated as the average distribution in the base period data.</u> We currently lack data on the annual variability in distribution and migration patterns of chinook and coho salmon stocks. In the absence of such estimates, fishery-specific exploitation rates are computed relative to the entire cohort. Changes in the distribution and migration of stocks from the base period will result in poor estimates of stock composition and stock-specific exploitation rates.

4. <u>There are not multiple encounters with the gear by the fish in a specific time-area fishery stratum.</u> Within each time-area fishery stratum, fish are assumed to be vulnerable to the gear only once. The catch equations used in the model are discrete and not instantaneous. Potential bias in the estimates may increase with large selective fisheries or longer time intervals, both of which increase the likelihood that fish will encounter the gear more than once.

While it is difficult to directly test the validity of these assumptions, results of validation exercises could provide one assessment of how well these assumptions are met and the sensitivity of the model to the assumptions. Currently, there is little effort directed at model validation.

BASE PERIOD DATA

The Chinook FRAM is calibrated using escapement, catch, and CWT recovery data from 1974-1979 brood year CWT releases. During the late 1970s and early 1980s, fisheries were being conducted across an extensive geographic area and over an extended period of time, thus giving the best available representation of CWT stock distribution. Not all stocks represented in the Chinook FRAM have CWT recovery data available from the 1974-1979 brood year base period (e.g., Snake River fall chinook). These stocks are categorized as "Out-of-Base" stocks. Available CWT data for these stocks are translated to equivalent base period recovery and escapement data using known fishing effort and harvest relationships between recovery years.

Model base period data for the Coho FRAM is derived from fishery and escapement recoveries of CWTs and terminal area run size estimates for the return years 1986-1991.

Chinook and coho base period data are used to estimate base period stock abundances and age-specific time-area fishery exploitation rates and maturation rates for modeled stocks. These estimates are derived through species-specific cohort analysis procedures. Cohort analysis is a series of steps and processes that uses CWT recoveries and base period catch and escapement data to "back-calculate" or reconstruct a pre-fishing cohort size for each stock and age group using assumed natural mortality and incidental mortality rates.

GENERAL INPUT TYPES

The five general types of input values used by FRAM are:

1. Cohort Abundance: For each stock or stock aggregate, an annual estimate of abundance is obtained from a source that is independent of the model. For preseason simulation modeling, these forecasts of stock abundance are used to estimate initial cohort size. For chinook, initial stock abundance estimates are segregated by age class, from age-2 to age-5 year old fish. For coho, only one age class (age 3) is assumed vulnerable to fisheries. Coho abundances are input to the model as January age-3 abundance. Chinook and coho abundance estimates are further segregated by mark status ("marked" or "unmarked").

2. Size Limits: For chinook, minimum size limits are specified by fishery where appropriate. For coho, age-3 fish are assumed fully vulnerable and age-2 fish are assumed fully invulnerable to modeled fisheries.

3. Fishery Catch Mortality: The model provides five options for estimating mortality in a fishery: a quota, an exploitation rate scalar, a ceiling, "selective", and harvest rate (for Puget Sound terminal fisheries only).
    a) <u>Quota.</u> Catch in the fishery is set equal to a value input by the user.
    b) <u>Exploitation rate scalar</u>. The exploitation rate in the fishery is scaled, relative to the base period, using a scalar input by the user.
    c) <u>Ceiling.</u> Catch is first calculated based on an exploitation rate scalar and then compared to a ceiling; if the estimated catch exceeds the ceiling, then the catch is truncated at the ceiling value.
    d) <u>Selective.</u> Identified as either a quota or exploitation rate scalar controlled fishery with additional calculations to cover catches and encounters for marked and unmarked groups.

e) Harvest rate. A terminal area harvest rate is applied to either all fish present in the terminal area or to the number of local-origin stock only.

4. Release Mortality: This is the mortality associated with the release of landed fish from hook-and-line and other gears. Release mortality rates assumed for coho are shown in Table 3-1a and for chinook in Table 3-1b. Hook-and-release mortality is assessed when coho or chinook are not allowed to be retained (so-called "chinook/coho non-retention", or CNR fisheries), when size limits apply, or in mark-selective fisheries. Release mortality has been estimated in a number of studies of hook-and-line fisheries, and release mortality rates for troll and recreational fisheries in the ocean have been formally adopted by the PFMC. Release mortality in net fisheries for chinook or coho non-retention is estimated external to FRAM and input into the model as either "landed catch" or as CNR mortality.

   Mark-selective fisheries have two additional variations of "release" mortality that are described as either the inappropriate retention of an unmarked fish or the release of a marked fish which consequently endures some release mortality. The failure to release an unmarked fish is a user input to the model called "Unmarked Recognition Error" (or Retention Error Rate) and is the proportion of the unmarked fish encountered that are retained. The release of marked fish that subsequently die due to release is a user input to the model called "Marked Recognition Error" and is the proportion of the marked fish encountered that are released. These rates are identified in Table 3-2.

5. Other Non-landed Mortality: This category includes fishing-induced mortality not associated with direct handling (or landing) of the fish (see Table 3-1a for coho and Table 3-1b for chinook). Application is for sport and troll hook-and-line "drop-off" (fish that drop off from the hook before they are brought to vessel but die from hook injuries), and net gear "drop-out" (fish which are not brought on board but die from injury as a result of being netted). In general, a 5% mortality rate is applied to the landed catch to account for "other non-landed mortality" in hook-and-line fisheries. Net drop-out mortality rates vary depending on species, net type, or terminal versus pre-terminal nature of the fishery.

Table 3-1a. FRAM/TAMM fishery-related mortality rates for coho salmon used for Southern U.S. fisheries in 2003.

Fishery: designated by area, user group, and/or gear type	Fishery Type	Comments	Release Mortality	"Other" Mortality[a]
PFMC Ocean Recreational	MSF	barbless	14.0%	5.0%
	Non-Retention	N. Pt. Arena	14.0%[b]	5.0%[b]
	Non-Retention	S. Pt. Arena	23.0%[b]	5.0%[b]
PFMC Ocean T-Troll	Retention		n.a.[c]	5.0%
PFMC Ocean NT-Troll	MSF	barbless	26.0%	5.0%
Area 5, 6C Troll	Retention		n.a.	5.0%
Puget Sound Recreational	Retention		n.a.	5.0%
	MSF	barbless	7.0%	5.0%
WA Coastal Recreational	Retention		n.a.	5.0%
Buoy 10 Recreational	MSF	barbed	16.0%	5.0%
Gillnet and Setnet			n.a.	2.0%
PS Purse Seine			26.0%[b]	0.0%
PS Reef Net, Beach Seine, Round Haul			n.a.	n.a.
Freshwater Net			n.a.	2.0%
Freshwater Recreational	Retention		n.a.	5.0%
	Non-Retention		10.0%[b]	5.0%

[a] The “other” mortality rates (which include drop-out and drop-off) are applied to landed fish (retention fisheries), thus FRAM does not assess “drop-off” in non-retention fisheries. Drop-off (and release mortality) associated with CNR fisheries are estimated outside the model and used as inputs to the model. For mark-selective fisheries (MSF), “other” mortality rates are applied to encounters of marked and unmarked fish.

[b] Rate assessed external to FRAM.

[c] None assessed.

Table 3-1b. FRAM/TAMM fishery-related mortality rates for chinook salmon used for Southern U.S. fisheries in 2003.

Fishery: designated by area, user group, and/or gear type	Fishery Type	Comments	"Shaker" Release Mortality	"Adult" Release Mortality	"Other" Mortality[a]
PFMC Ocean Recreational	Retention	N Point Arena	14.0%	n.a.[c]	5.0%
	Retention	S Point Arena	23.0%	n.a.	5.0%
PFMC Ocean Troll	Retention	barbless	25.5%	n.a.	5.0%
Area 5,6,7 T-Troll	Retention	barbed	30.0%	n.a.	5.0%
Puget Sound (PS) Recreational	Retention	barbless	20.0%	n.a.	5.0%
	MSF	barbless	20.0%	10.0%	5.0%
	Non-Retention	barbless	20.0%	10.0%	n.a.
Buoy 10 Recreational	not modeled within FRAM		n.a.	n.a.	n.a.
<u>Commercial Net</u>					
PS Areas 4B,5,6,6C	PT[d] GN, SN		n.a.	n.a.	3.0%
WA Coastal & Col R. Net	PT[d] GN, SN		n.a.	n.a.	3.0%
PS Areas 6A,7,7A	PT[d] GN, SN, Purse S		n.a.	n.a.	1.0%
NT PS Areas: 6B,9,12,12B,12C	PT[d] GN, SN, Purse S		n.a.	n.a.	1.0%
T PS Areas:7B,7C,7D	PT[d] GN, SN, Purse S		n.a.	n.a.	1.0%
All other PS marine net	Terminal GN, SN		n.a.	n.a.	2.0%
PS Purse Seine		immature	n.a.	45.0%[b]	0.0%
		mature	n.a.	33.0%[b]	0.0%
PS Reef Net, Beach Seine, Round Haul			n.a.	n.a.	n.a.
Freshwater Net			n.a.	n.a.	n.a.
Freshwater Recreational	Retention		n.a.	n.a.	n.a.
	MSF	TAMM	n.a.	10.0%[b]	n.a.
	Non-Retention	TAMM	n.a.	10.0%[b]	n.a.

[a] The "other" mortality rates (which include drop-out and drop-off) are applied to landed fish (retention fisheries), thus FRAM does not assess "drop-off" in non-retention fisheries. Drop-off (and release mortality) associated with CNR fisheries are estimated outside the model and used as inputs to the model. For mark-selective fisheries (MSF), "other" mortality rates are applied to encounters of marked and unmarked fish.

[b] Rate assessed external to FRAM.

[c] None assessed.

[d] PT = Pre-terminal.

Table 3-2. Mark-selective fishery input values for Southern U.S. fisheries.

Fishery	Unmarked Retention Rate (% of unmarked fish retained)	Mark Release Rate (% of marked fish released)
NOF troll, sport	2%	6%
SOF sport	2%	6%
Area 5,6 sport—2001 coho	2%	34%
Area 5,6 sport—2002 coho	2%	38%
Area 5,6 sport—2003 coho	2%	38%
Area 5,6 sport—2003 chinook	8%	6%
Area 7 sport—2001 coho	5%	6%
Area 7 sport—2002 coho	8%	9%
Area 7 sport—2003 coho	8%	9%
Area 13 sport—2002 coho	27%	18%
Area 13 sport—2003 coho	27%	18%
Other PS marine sport	8%	9%

OUTPUT REPORTS AND MODEL USE

Model results are available as either standard FRAM printed output reports or in Excel spreadsheets that are linked to FRAM results/reports. The TAMM spreadsheets provide comprehensive summaries of fishery mortality, exploitation rate, run size, and escapement for key stocks in the PFMC and North of Falcon annual salmon season setting processes. Early versions of these spreadsheets focused on finer resolution of stocks and fisheries for Puget Sound terminal areas. The TAMM spreadsheets have now broadened in scope and contain information for both pre-terminal and terminal fisheries as well as FRAM fishery inputs for terminal fisheries in coastal Washington (coho) and in Puget Sound (both species). Other model results not shown in the spreadsheets can be generated directly from FRAM. These reports include summaries of catch by fishery, catch by stock, catch by age, and escapement/run size reports. A new report has been created for FRAM to provide more detailed information relative to mark-selective fisheries for chinook and coho. For a full scope of FRAM report generating functions, refer to "Users Manual for the Fishery Regulation Assessment Models (FRAM) for Chinook and Coho" (MEW *in prep*.).

COMPUTATIONAL STRUCTURE

For each time step and fishery, FRAM simulates fishery regulations following the sequence of computations depicted for coho (Figure 1) and chinook (Figure 2). The first step for both coho and chinook is to scale the predicted cohort size for the current year to the base period: this is done by stock for the January age-3 cohort for coho and for the age-2 through age-5 cohorts for chinook. Each stock's cohort is then processed through a time step loop defined for the species (five time steps for coho and four for chinook). Within the time step loop: (1) natural mortality is applied to the beginning cohort size; (2) the procedures to calculate projected catches for the all fisheries in the time step are executed; and (3) all fishery mortalities for the cohort (stock) are totaled and the remaining abundance of the stock is calculated.

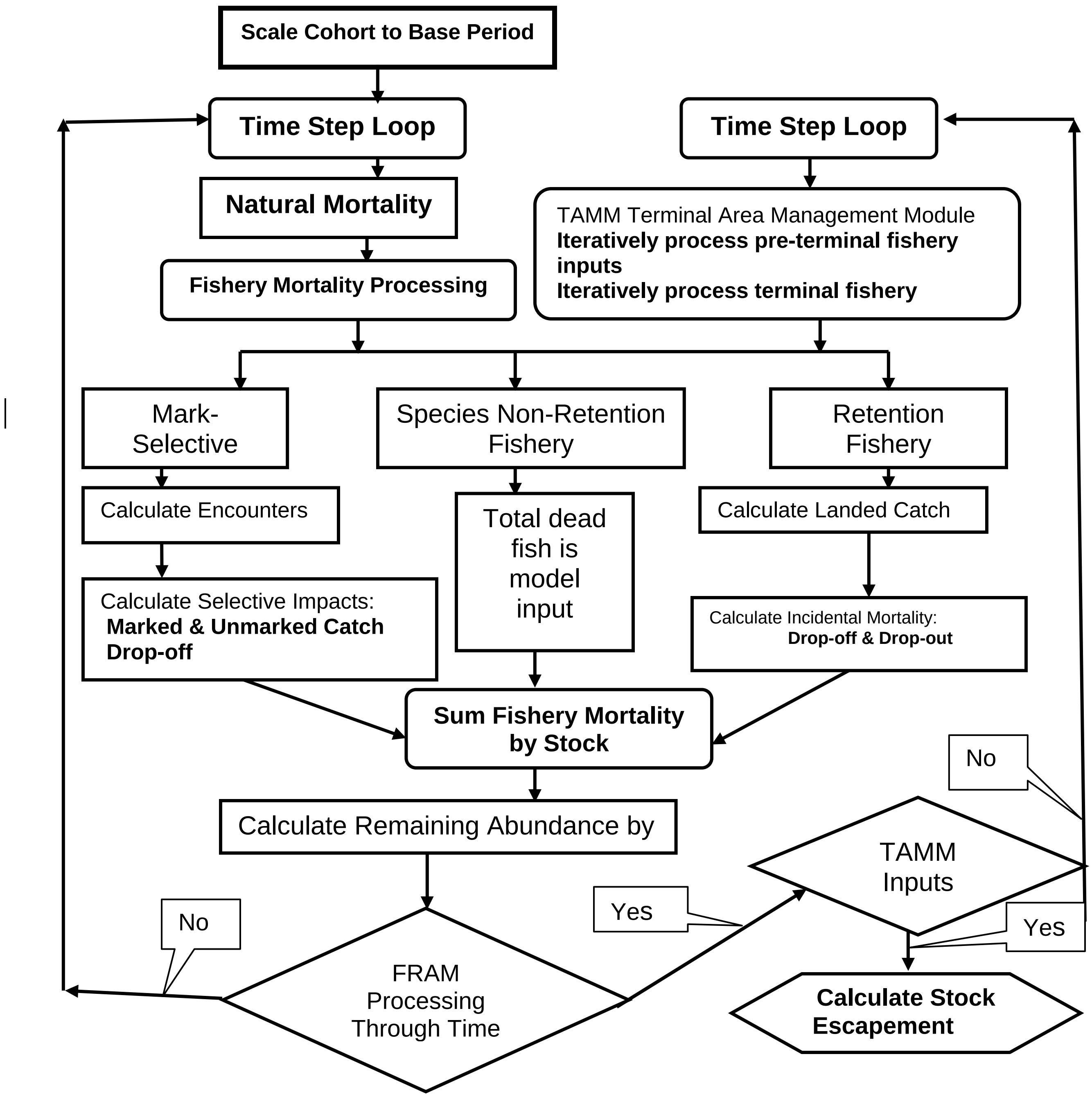


Figure 1. Flow chart for FRAM coho model.

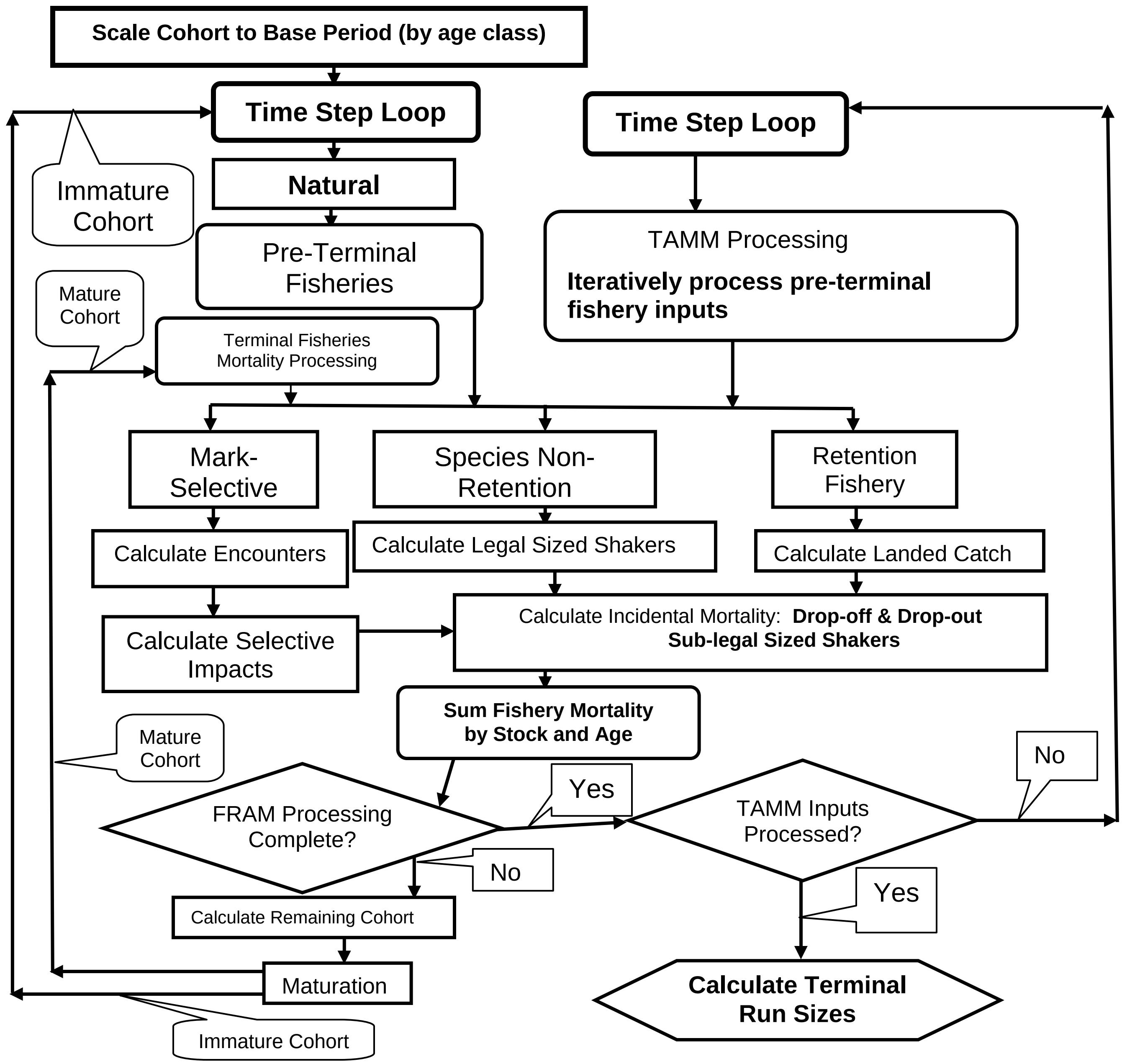


Figure 2. Flow chart for FRAM chinook model.

After FRAM has processed all steps in the time step loop, the program checks for the presence of an optional Terminal Area Management Module (TAMM). If the model user has not specified a TAMM input file for additional modeling, FRAM processing is complete and final terminal run sizes (chinook) or escapements (coho) are calculated. If a TAMM has been specified, then FRAM will repeat processing through the specified fisheries and time step loops. Although TAMMs are focused upon terminal area fisheries, some of these fisheries are in mixed-stock areas and may also impact both mature and immature chinook. Thus there exists an iterative FRAM/TAMM process to obtain the final tabulations of fishery mortalities and stock escapements (see Section 7 for further TAMM explanation).

Scale Cohort to Base Period

The equation below establishes the starting cohort size for all stocks as a product of two parameters: the average cohort size for stock *s* at age *a* ($BPCohort_{s,a}$) during the base period and a stock and age specific scalar ($StockScalar_{s,a}$). $StockScalar_{s,a}$ is estimated externally to the model and is an annual input to the model.

$$Cohort_{s,a,1} = BPCohort_{s,a} \ x \ StockScalar_{s,a}$$

Natural Mortality

At the beginning of each time step, each cohort is decreased to account for projected natural mortality using the following equation:

$$Cohort_{s,a,t} = Cohort_{s,a,t} \ \ x \ \left(1 - M_{a,t}\right)$$

where $M_{a,t}$ is the natural mortality rate for age *a* fish during time step *t* (see Appendix Table 5 for specific rates used for coho and chinook).

Catch

The FRAM simulates fisheries through the use of linear equations. Different types of computations are used depending upon whether or not a fishery operates under mark-retention restrictions. If all fish can be retained regardless of mark status, the following general formula is used (mark-selective fisheries are described in Section 6.5):

$$Catch_{s,a,f,t} = BPER_{s,a,f,t} \ x \ Cohort_{s,a,t} \ x \ PV_{s,a,t} \ x \ FishScalar_{f,t} \ x \ SHRS_{s,f,t}$$

where:

$Catch_{s,a,f,t}$	=	Catch of stock *s*, age *a*, in fishery *f*, at time step *t;*
$BPER_{s,a,f,t}$	=	Base Period Exploitation Rate (harvest rate for terminal fisheries) for stock *s*, age *a*, in fishery *f*, at time step *t* (*BPER* is derived from cohort analysis using CWT release and recovery data);
$Cohort_{s,a,t}$	=	Number of fish in cohort (chinook are expressed as both immature and mature cohorts) for stock *s* at age *a* in time step *t*;
$PV_{s,a,t}$	=	Proportion of cohort for stock *s*, age *a*, vulnerable to the gear at time step *t* (for chinook *PV* is a function of a Von Bertalanffy growth curve; for coho *PV* is always = 1.0);
$FishScalar_{f,t}$	=	Impact scalar for fishery *f* at time step *t* relative to the base period; and
$SHRS_{s,f,t}$	=	Stock-specific exploitation rate scalar for stock *s*, in fishery *f*, at time step *t* (the default value of 1.0 is rarely changed).

The parameter $FishScalar_{f,t}$ is the foundation for the model's fishery simulation algorithms. FRAM can evaluate two general types of fisheries: (1) effort-based or (2) catch-based. For effort-based fisheries, the parameter $FishScalar_{f,t}$ is specified by the modeler to reflect expected effort relative to the average effort observed during the model's base period. For catch-based fisheries, $FishScalar_{f,t}$ is computed automatically so as to attain a specified catch level. If the catch level is to be modeled as a quota, then $FishScalar_{f,t}$ is computed as:

$$FishScalar_{f,t} = \frac{QuotaLevel_{f,t}}{\sum_s \sum_a Catch_{s,a,f,t} \;\; x \;\; (1/PropModelStock_f)}$$

where $\sum_s \sum_a Catch_{s,a,f,t}$ is computed with $FishScalar_{f,t}$ = 1.0 and $PropModelStock_f$ is the proportion of model stocks in the catch to the total catch in fishery *f* for the base period ($PropModelStock_f$ is used for chinook only, it is always set to 1.0 for coho).

If the catch level is to be modeled as a ceiling, both an effort scalar and quota are specified. A catch estimate is made during a first iteration of FRAM using the effort scalar. If the effort scalar computes a catch level that is less than the catch ceiling, then the final catch estimate is this effort-based catch. If the initial effort scalar computes to a catch level that exceeds the ceiling, then the final catch estimate is the quota. In the case of a ceiling-type fishery, the final $FishScalar_{f,t}$ will be calculated based on the lower of the two types of catch estimates (effort scalar or quota).

Incidental Mortality

Several types of incidental mortality can be accounted for in FRAM either through external calculations of mortality or internal FRAM processing. Incidental mortality associated with hook-and-line drop-off and net drop-out is expressed as a fraction of retained catch or as a fraction of encounters in the case of mark-selective fisheries. Incidental mortality in mark-selective fisheries is discussed in the next section.

Mortalities in species non-retention fisheries (CNR) are derived using four different methods for chinook and one for coho. Chinook non-retention mortalities are model estimates from inputs of: the level of open versus non-retention effort within each time step (Methods 1 and 2), legal and sub-legal encounters (Method 3), or from total encounters (Method 4). The method for coho is simply an external-to-the-model estimate of coho mortalities in a fishery based on historical observations. The methods were developed to fit the observations from various fisheries. Method 1 was developed for Canadian and Alaskan fisheries that had both open and non-retention regulation periods and had changes in the gear or fishing patterns to avoid chinook encounters.

METHOD 1 – Computed Mortalities

$$CNRLegal_{s,a,f,t} = Catch_{s,a,f,t} \ x \ \frac{1 - FishScaler_{f,t}}{FishScaler_{f,t}} \ x \ RelRate_{f,t} \ x \ LegalSelRate_{f,t}$$

$$TotalLegPop_{f,t} = \sum_s \sum_a (Cohort_{s,a,t} \ x \ PV_{s,a,t}) \text{ for stocks with catch in fishery } f$$

$$TotalSubLegPop_{f,t} = \sum_s \sum_a (Cohort_{s,a,t} \ x \ (1 - PV_{s,a,t})) \text{ for stocks with catch in fishery } f$$

$$EncRate_{f,t} = TotalSubLegPop_{f,t} \big/ TotalLegPop_{f,t}$$

$$TotCatch_{f,t} = \sum_s \sum_a Catch_{s,a,f,t} \ x \ (1 / PropModelStock_f)$$

$$CNRSub_{s,a,f,t} = TotCatch_{f,t} \ x \ EncRate_{f,t} \ x \ \frac{1 - FishScaler_{f,t}}{FishScaler_{f,t}} \ x \ RelRate_{f,t} \ x \ SubSelRate_{f,t} \ x \ PropSubPop_{s,a,f,t}$$

METHOD 2 – Ratio of Non-Retention to Retention Days

$$CNRLegal_{s,a,f,t} = Catch_{s,a,f,t} \ x \ (CNRDays_{f,t} \big/ RetentDays_{f,t}) \ x \ RelRate_{f,t} \ x \ LegalSelRate_{f,t}$$

$$CNRSub_{s,a,f,t} = Shakers_{s,a,f,t} \ x \ (CNRDays_{f,t} \big/ RetentDays_{f,t}) \ x \ SubSelRate_{f,t}$$

METHOD 3 – External Estimates of Legal and Sub-Legal Sized Encounters

$$LegalPropCatch_{s,a,f,t} = Catch_{s,a,f,t} \big/ TotCatch_{f,t}$$

$$SubLegPop_{s,a,t} = Cohort_{s,a,t} \ x \ (1 - PV_{s,a,t})$$

$$SubLegNR_{s,a,f,t} = SubLegPop_{s,a,t} \ x \ SubER_{s,a,f,t} \ x \ RelRate_{f,t}$$

$$SubLegPropEnc_{s,a,f,t} = SubLegNR_{s,a,f,t} \Big/ \sum_s \sum_a SubLegNR_{s,a,f,t}$$

$$CNRLegal_{s,a,f,t} = LegalPropCatch_{s,a,f,t} \ x \ LegalEnc_{f,t} \ x \ RelRate_{f,t} \ x \ PropModelStock_f$$

$$CNRSub_{s,a,f,t} = SubLegPropEnc_{s,a,f,t} \ x \ SubLegEnc_{f,t} \ x \ RelRate_{f,t} \ x \ PropModelStock_f$$

METHOD 4 – External Estimate of Total Encounters

$$LegalPropCatch_{s,a,f,t} = Catch_{s,a,f,t} \big/ TotCatch_{f,t}$$

$$LegalEnc_{s,a,f,t} = BPER_{s,a,f,t} \ x \ Cohort_{s,a,t} \ x \ PV_{s,a,t} \ x \ SHRS_{s,f,t} \ x \ LegalPropCatch_{s,a,f,t}$$

$$SubLegEnc_{s,a,f,t} = SubER_{s,a,f,t} \ x \ SubLegPop_{s,a,t}$$

$$CNRScaler_{f,t} = \frac{TotalEstCNR_{f,t}}{\sum_s \sum_a LegalEnc_{s,a,f,t} + \sum_s \sum_a SubLegEnc_{s,a,f,t}}$$

$$CNRLegal_{s,a,f,t} = LegalEnc_{s,a,f,t} \ x \ CNRScaler_{f,t} \ x \ RelRate_{f,t}$$

$$CNRSub_{s,a,f,t} = SubLegEnc_{s,a,f,t} \ x \ CNRScaler_{f,t} \ x \ RelRate_{f,t}$$

METHOD 5 – Coho Non-Retention Mortalities from External Estimates

$$PropCatch_{s,f,t} = \frac{BPER_{s,f,t} \ x \ Cohort_{s,t} \ x \ SHRS_{s,f,t}}{\sum_s BPER_{s,f,t} \ x \ Cohort_{s,t} \ x \ SHRS_{s,f,t}}$$

$$CNR_{s,f,t} = EstCNRMorts_{f,t} \ x \ PropCatch_{s,f,t}$$

where $Cohort_{s,a,t}$, $Catch_{s,a,f,t}$, $FishScaler_{f,t}$, $PV_{s,a,t}$, $PropModelStock_f$, $BPER_{s,a,f,t}$, and $SHRS_{s,f,t}$, are previously defined and:

$CNRLegal_{s,a,f,t}$	=	Legal-sized adult non-retention mortality for stock *s*, age *a*, in fishery *f*, at time step *t*;
$RelRate_{f,t}$	=	Release mortality rate for fish in fishery *f* at time step *t*;
$LegalSelRate_{f,t}$	=	Legal-sized adult selectivity rate for fishery *f* in time step *t*, in response to changes in gear or fishing pattern (model input for Methods 1 and 2);
$TotalLegPop_{f,t}$	=	Total number of legal-sized fish from modeled stocks available to fishery *f* at time step *t*;
$TotalSubLegPop_{f,t}$	=	Total number of sub-legal sized fish from modeled stocks available to fishery *f* at time step *t*;
$EncRate_{f,t}$	=	For modeled stocks, the ratio of sub-legal sized chinook encountered for every legal-sized chinook in fishery *f* at time step *t*;
$TotCatch_{f,t}$	=	Total landed catch in fishery *f* at time step *t*;
$CNRSub_{s,a,f,t}$	=	Sub-legal sized non-retention mortality for stock *s*, age *a*, in fishery *f*, at time step *t*;
$SubSelRate_{f,t}$	=	Sub-legal sized selectivity rate for fishery *f* in time step *t*, in response to changes in gear or fishing pattern (model input for Methods 1 and 2);
$PropSubPop_{s,a,f,t}$	=	Proportion of sub-legal sized population for stock *s*, age *a*, in fishery *f*, at time step *t*;
$CNRDays_{f,t}$	=	Number of non-retention days in fishery *f*, at time step *t* (model input for Method 2);
$RetentDays_{f,t}$	=	Number of retention days in fishery *f* at time step *t* (model input for Method 2);

$Shakers_{s,a,f,t}$	=	Sub-legal shaker mortality for stock *s*, age *a*, in fishery *f*, at time step *t* (see following sub-section for method of calculation);
$LegalPropCatch_{s,a,f,t}$	=	Proportion of legal-sized catch for stock *s*, age *a*, in fishery *f*, at time step *t*;
$SubLegPop_{s,a,t}$	=	Sub-legal sized population for stock *s*, age *a*, at time step *t*;
$SubLegNR_{s,a,f,t}$	=	Sub-legal sized non-retention mortalities for stock *s*, age *a*, in fishery *f*, at time step *t*;
$SubER_{s,a,f,t}$	=	Sub-legal sized encounter rate for stock *s*, age *a*, in fishery *f*, at time step *t* calculated from base period data;
$SubLegPropEnc_{s,a,f,t}$	=	Sub-legal sized proportion of encounters for stock *s*, age *a*, in fishery *f*, at time step *t*;
$LegalEnc_{f,t}$	=	Total number of legal-sized encounters in fishery *f* at time step *t* (model input for Method 3);
$SubLegEnc_{f,t}$	=	Total number of sub-legal sized encounters in fishery *f* at time step *t* (model input for Method 3);
$LegalEnc_{s,a,f,t}$	=	Legal-sized encounters for stock *s*, age *a*, in fishery *f*, at time step *t*;
$SubLegEnc_{s,a,f,t}$	=	Sub-legal sized encounters for stock *s*, age *a*, in fishery *f*, at time step *t*;
$CNRScalar_{f,t}$	=	Non-retention scalar in fishery *f* at time step *t*;
$TotalEstCNR_{f,t}$	=	Total estimated non-retention (legal and sub-legal) in fishery *f* at time step *t* (model input for Method 4);
$PropCatch_{s,f,t}$	=	Proportion of coho catch for stock *s* in fishery *f* at time step *t*;
$EstCNRMorts_{f,t}$	=	Estimated coho non-retention mortalities in fishery *f* at time step *t* (model input for Method 5); and
$CNR_{s,f,t}$	=	Coho non-retention mortality for stock *s* in fishery *f*, at time step *t*.

<u>Sub-legal shaker mortality</u> is not estimated for coho since most minimum size limits - if they exist - apply to age 2 fish that are not represented in the model. The sub-legal and legal size encounters are stock and age specific and are calculated using Von Bertalanffy growth curves generated from CWT data. The calculations for sub-legal sized chinook (shakers) are shown below:

$$SubLegProp_{s,a,t} = 1 - PV_{s,a,t}$$

$$SubLegPop_{s,a,t} = Cohort_{s,a,t} \ x \ SubLegProp_{s,a,t}$$

$$Shakers_{s,a,f,t} = SubER_{s,a,f,t} \ x \ SubLegPop_{s,a,t} \ x \ FishScalar_{f,t} \ x \ RelRate_{f,t}$$

where all components are defined previously and (1-$PV_{s,a,t}$) is the proportion of the cohort for stock *s*, age *a*, vulnerable to the gear at time step *t* (for chinook *PV* is function of Von Bertalanffy growth curve; for coho *PV* is always = 1).

Mark-Selective Fisheries

The implementation of mark-selective fishery regulations requires the use of more complex computations. Different equations are employed for marked and unmarked fish. The time-period specific forms of the equations utilized in Coho FRAM under non-selective and mark-selective fisheries are depicted in the following table. Computations for chinook mark-selective fisheries must account for sub-legal mortality, which does not differ between marked and unmarked components. The counterpart equations for chinook would contain the elements associated with sub-legal mortality, but due to the increased complexity this introduces the analogous equations for chinook are not presented here.

	Non-Selective Fisheries	Mark-Selective Fisheries	
	Discrete Equations	Marked Fish	Unmarked Fish
Landed mortalities	$C_{s,f} = ER_{s,f}\ x\ N_{s,t}$	$C_{s,f} = ER_{s,f}\ x\ N_{s,t}\ x\,(1-mre_f)$	$C_{s,f} = ER_{s,f}\ x\ N_{s,t}\ \ x\ ure_f$
Release mortalities		$R_{s,f} = ER_{s,f}\ x\ N_{s,t}\ x\ mre_f\ \ x\ rm_f$	$R_{s,f} = ER_{s,f}\ x\ N_{s,t}\ x\,(1-ure_f)\ x\ rm_f$
Drop-off mortalities	$D_{s,f} = C_{s,f}\ \ x\ dmr_f$	$D_{s,f} = ER_{s,f}\ x\ N_{s,t}\ \ x\ dmr_f$	$D_{s,f} = ER_{s,f}\ x\ N_{s,t}\ \ x\ dmr_f$

where:

- $C_{s,f}$ = number of landed mortalities of stock *s* in fishery *f*;
- $D_{s,f}$ = drop-off mortalities for stock *s* in fishery *f*;
- dmr_f = drop-off mortality rate in fishery *f*;
- $ER_{s,f}$ = exploitation rate for stock *s* in fishery *f* (this parameter is equivalent to *BPER* x *PV* x *SHRS* in the previously described formulation);
- mre_f = marked-retention error (releasing marked fish in a selective fishery) in fishery *f*;
- $N_{s,t}$ = cohort size for stock *s* at the beginning of time period *t*;
- $R_{s,f}$ = number of release mortalities for stock *s* in fishery *f*;
- rm_f = release mortality rate in fishery *f*; and
- ure_f = unmarked recognition error (retaining and landing unmarked fish in a selective fishery) in fishery *f*.

Maturation (chinook only)

For chinook, the maturation process occurs after the pre-terminal catch has been calculated and results in a mature cohort for each stock, age, and time step. The number of fish from the age *a* cohort for stock *s* that matures at time step *t* ($TermCohort_{s,a,t}$) is calculated by:

$$TermCohort_{s,a,t} = Cohort_{s,a,t}\ \ x\ MatRate_{s,a,t}$$

where $MatRate_{s,a,t}$ is a stock, age, and time step specific maturation rate that is calculated from base period data. The mature portion of the cohort is available to those fisheries, during the same time period, that have been designated as harvesting only mature fish while the immature portion of the cohort ($Cohort_{s,at,}$ - $TermCohort_{s,a,t}$) is then used to initiate the next time step.

Escapement

All chinook fisheries in FRAM are designated as pre-terminal or terminal in the base period data. The terminal fisheries only harvest fish from the mature cohort thus simulating a migration pattern from the pre-terminal mixed stock areas. Escapement is defined as any fish from the mature cohort that does not die from fishery-related mortality. For coho, fisheries during time steps 1 through 4 are on immature fish and by default all coho fisheries in time step five are on mature fish. In the current versions of the chinook and coho base periods, all maturation and escapement of a stock occurs within a single time step. The only exceptions are Skagit stocks of spring and summer/fall chinook and Columbia River summer chinook. The equations for chinook and coho are given below:

chinook:

$$TotTermMort_{s,a,t} \sum_{f-term} (Catch_{s,a,f,t} + Shakers_{s,a,f,t} + Dropoff_{s,a,f,t} + LegalShakers_{s,a,f,t} + CNR_{s,a,f,t})$$

$$Escape_{s,a,t} = TermCohort_{s,a,t} - TotTermMort_{s,a,t}$$

coho:

$$Escape_{s,a} = Cohort_{s,a,5} - (\sum_{f} (Catch_{s,f,5} + LegalShakers_{s,f,5} + Dropoff_{s,f,5} + CNR_{s,f,5}))$$

where (age = 3 and time step = 5 for coho):

$TotTermMort_{s,a,t}$	=	Total terminal fishery mortality for stock *s*, age *a*, at time step *t*;
$Escape_{s,a,t}$	=	Escapement for stock *s*, age *a*, at time step *t*;
$Catch_{s,a,f,t}$	=	Catch for stock *s*, age *a*, in terminal fishery *f*, at time step *t*;
$Shakers_{s,a,f,t}$	=	Sub-legal mortality for stock *s*, age *a*, in terminal fishery *f*, at time step *t*;
$Dropoff_{s,a,f,t}$	=	Non-landed mortality for stock *s*, age *a*, in terminal fishery *f*, at time step *t*;
$LegalShakers_{s,a,f,t}$	=	Legal-sized mortality of fish released during mark-selective fisheries for stock *s*, age *a*, in terminal fishery *f*, at time step *t*; and
$CNR_{s,a,f,t}$	=	Non-retention mortality (legal and sub-legal sized) for stock *s*, age *a*, in terminal fishery *f*, at time step *t*.

Other Algorithms and Equations Used in the Model

Adult Equivalency (chinook only). Fishery-related mortality for chinook is expressed as a nominal value or adjusted for "Adult Equivalents" (AEQ) to account for the multiple ages that the fish mature and are vulnerable to fisheries. Fishery-related mortalities are expressed as adult equivalent mortalities so that all fishery mortalities can be expressed in a common unit of measure, which is the number of fish that would have matured (escaped to spawn) in the absence of fishing. The AEQ factors adjust for the natural mortality that would have occurred between the time/age the fish were caught and the time/age that they would have matured or escaped to spawn. The factors used in FRAM are calculated in the CWT base period calibration process and take into account fixed age-specific natural mortality rates and age and stock specific maturation rates which are calculated from CWT recoveries. Stock and age specific AEQ values are expressed in terms of the expected contribution to the age-5, time step 3 fish, which is the oldest age-class at the final time step for mature fish. The AEQ value at the maximum age and final time-step is 1.0 and all other age/time-step values are a proportion of this value. Note that all age classes have an AEQ value of 1.0 in designated "terminal fisheries" (exploitation rates for chinook are usually expressed in terms of adult equivalent mortality). The AEQ factor is calculated as:

$$AEQ_{s,a,t} = MatRate_{s,a,t} + [(1 - MatRate_{s,a,t}) \quad x \quad (1 - M_{a,t+1}) \quad x \quad AEQ_{s,a,t+1}]$$

where $AEQ_{s,a,t}$ =1 for a = 5 and t = 3 (maximum age and final time step for most chinook stocks).

Proportion Modeled Stocks (for chinook only and calculated using base period data). The "model stock proportion" is a value unique to chinook and is the proportion of the total catch in a fishery that is accounted for by the modeled stocks. These proportion modeled stocks values are calculated during the chinook FRAM calibration process. They are fishery specific and remain constant through all time periods. The coho cohort analysis used to create the model base period exploitation rates include estimates for all stock production regions, thus the proportion modeled stock is assumed to always be 1.0.

$$PropModelStock_f = \frac{\sum_s \sum_a \sum_t Catch_{s,a,f,t}}{TotalCatch_f}$$

where $TotalCatch_f$ = the average total Base Period catch in fishery f.

Total Mortality. Total mortality is used to calculate simple exploitation rates by stock, age (chinook), fishery, and time period. The equations used for chinook and coho, respectively, are:

chinook:

$$TotMort_{s,a,t} = \sum_f (Catch_{s,a,f,t} + Shakers_{s,a,f,t} + Dropoff_{s,a,f,t} + LegalShakers_{s,a,f,t} + CNR_{s,a,f,t})$$

coho:

$$TotMort_{s,t} = \sum_f (Catch_{s,f,t} + Dropoff_{s,f,t} + LegalShakers_{s,f,t} + CNR_{s,f,t})$$

and Total Exploitation Rate is then estimated as:

$$ER_s = \frac{\sum_a \sum_t TotMort_{s,a,t}}{\sum_a \sum_t TotMort_{s,a,t} + \sum_a \sum_t Escape_{s,a,t}}$$

where all components are defined previously.

TERMINAL AREA MANAGEMENT MODULE (TAMM)

The FRAM program interacts with two species-specific (chinook and coho) spreadsheet programs that allow users to specify terminal fishery impacts on a finer level of resolution. The spreadsheet program, TAMM, began with separate sections for each of the six Puget Sound terminal areas (Table 7-1) that are defined in the Puget Sound Salmon Management Plan (1985) for the State of Washington and the Treaty Tribes of Puget Sound. This structure has supported development of unique regional management goals and allows managers the flexibility to analyze and report FRAM model output according to their needs. The chinook TAMM contains the original Puget Sound sections, while the coho TAMM has been expanded to allow report generation for many non-Puget Sound stock groups.

Table 7-1. Puget Sound terminal management regions.

Nooksack-Samish	Skagit
Stillaguamish-Snohomish	South Sound
Hood Canal	Strait of Juan de Fuca

Historically, managers used TAMMs to analyze fishery impacts on individual population components of the larger FRAM stock groupings. The relatively new 1986-1991 coho base period now includes individual Puget Sound populations (61 stocks) at the management level of resolution. Similarly, the expanded Puget Sound coho fisheries are comprehensive; thus coho TAMM now serves more as a recipient of FRAM output for customized report generation. In contrast, chinook TAMM remains a critical element of pre-season Puget Sound modeling, as many populations of management focus need to be “extracted” from the aggregated FRAM stock groupings. Abundance levels of every Puget Sound chinook hatchery and natural population are entered into the TAMM, as are harvest impacts from all Puget Sound fisheries, to allow fishery-specific impact analyses on all the populations of interest.

The current chinook base period data (as in the older versions of the coho base period) aggregates terminal area fisheries for FRAM modeling at a higher level than used for management. Typically chinook FRAM has no individual area freshwater terminal sport fisheries or freshwater net fisheries. The chinook TAMM provides the ability to model the individual Puget Sound marine and freshwater net fisheries by smaller date increments associated with fisheries directed at chinook, pink, coho, chum, or steelhead. In addition, test fisheries and fisheries in sub-areas can be specified. Similarly, the ability to model individual Puget Sound freshwater sport fisheries is also provided. The appropriate chinook TAMM fishery impacts are summed into the terminal fishery definitions used by FRAM to calculate the FRAM fishery scalar inputs.

The TAMM fishery inputs, in addition to a fixed catch, allow for two fishery control mechanisms that are not used by FRAM. The control mechanisms (harvest rates) are percent of terminal area abundance (TAA) and percent of extreme terminal run size (ETRS). Each terminal area has specific rules for calculation of the TAA and ETRS values. Basically, the TAA rules include the escapement of all local area stocks and the terminal catch of all stocks. The ETRS rules include escapement and only the terminal catch of the local area stocks, but for a mixed-stock area an associated non-local stock catch is also calculated by FRAM as a base period proportion of total fishery catch. The derivation of these rules comes from the definitions used in the annual terminal run reconstruction for each of the species. Run reconstruction estimates are used in the calculation of modeling inputs for terminal area fishery impacts under the TAA and ETRS methods. The same run reconstructions may be used to develop in-season run size update models.

The TAA and ETRS methods create a problem for estimating the FRAM fishery scalars because the run size in each terminal region is dependent on the impacts from all the other regions. For example, a decrease in Skagit terminal fisheries results in higher escapement for Nooksack and higher TAA and ETRS values. The fishery impacts in Nooksack terminal fisheries would then be calculated higher which lowers the original Skagit TAA and ETRS values.

An iterative process was developed to solve the problem of simultaneous equations between the terminal areas. The FRAM program reruns the terminal fishery time steps until the difference between the TAMM specified expected fishery impacts and FRAM estimates (calculated from base period exploitation rates) are within ±0.1% of the expected value or the difference is less than one fish. On each iteration the FRAM fishery scalars are adjusted by a proportion that is calculated as the expected value divided by the FRAM estimate for each terminal fishery.

As already discussed, the current FRAM coho base period data has much finer resolution of the terminal area fisheries than does the chinook base period. This is a result of the coho run reconstruction program RRTERM fishery definitions that were used to develop this coho base period data. The coho TAMM fishery definitions are the same as the FRAM terminal fisheries and thus allow direct input for effort base fishery scalars and quota values. An iterative process is still needed for the TAA and ETRS abundance based methods.

The TAMM spreadsheets are used to create most of the output reports needed by fishery managers during the pre-season fishery negotiation processes. This functionality was preserved in the current TAMM spreadsheets to ensure continuity and familiarity with the older versions of the program and to divide the duties and responsibilities for input and error checking during the intense management sessions.

Appendix 1. Chinook FRAM Stocks.

Unmarked Stock #	Stock Name	Abbreviated Name	CWT Broods Included*
1	Nooksack-Samish summer/fall	NkSm FlFi	77,79
3	North Fork Nooksack early (spring)	NFNK Sprg	OOB - 84,88 (N. Fk.)
5	South Fork Nooksack early (spring)	SFNK Sprg	OOB - 84,88 (N. Fk.)
7	Skagit summer/fall fingerling	Skag FlFi	76,77
9	Skagit summer/fall yearling	Skag FlYr	76
11	Skagit spring yearling	Skag SpYr	OOB - 85, 86, 87,90
13	Snohomish summer/fall fingerling	Snoh FlFi	OOB - 86, 87, 88
15	Snohomish summer/fall yearling	Snoh FlYr	76
17	Stillaguamish summer/fall fingerling	Stil FlFi	OOB - 86, 87, 88,89,90
19	Tulalip summer/fall fingerling	Tula FlFi	OOB - 86, 87, 88
21	Mid S. Puget Sound fall fingerling	USPS FlFi	78,79
23	UW Accelerated fall fingerling	UW-A FlFi	77-79
25	Deep S. Puget Sound fall fingerling	DSPS FlFi	78,79
27	South Puget Sound fall yearling	SPSo FlYr	78,79
29	White River spring fingerling	Whte SpFi	OOB – 91-93
31	Hood Canal fall fingerling	HdCl FlFi	78,79
33	Hood Canal fall yearling	HdCl FlYr	78,79
35	Juan de Fuca Tribs. fall fingerling	SJDF FlFi	78,79
37	Oregon Lower Columbia River Hatchery	Oregn LRH	78,79
39	Wash. Lower Columbia River Hatchery	Washn LRH	77,79
41	Lower Columbia River Wild	Low CR Wi	77-78
43	Bonneville Pool Hatchery tule	BP H Tule	76-79
45	Columbia Upriver summer	Upp CR Su	76,77
47	Columbia Upriver bright	Col R Brt	75-77
49	Washington Lower River spring	WaLR Sprg	77
51	Willamette spring	Will Sprg	76-78
53	Snake River fall	SnakeR Fl	OOB - 84, 85, 86
55	Oregon North Migrating fall	Ore No Fl	76-78
57	West Coast Vancouver Island Total	WCVI Totl	74-77
59	Fraser Late	Fraser Lt	OOB - 81,82,83
61	Fraser Early	Fraser Er	78,79; OOB -, 86
63	Lower Georgia Strait fall	Lwr Geo St	77,78
65	White River spring yearling	Whte SpYr	OOB – 91-93

*OOB = Out-of-base stock.

Appendix 2. Coho FRAM Stocks.

Production Region	Unmarked Stock #	Abbreviated Name	Coho Stock Name
NOOKSM	1	nkskrw	Nooksack River Wild
NOOKSM	3	kendlh	Kendall Creek Hatchery
NOOKSM	5	skokmh	Skookum Creek Hatchery
NOOKSM	7	lumpdh	Lummi Ponds Hatchery
NOOKSM	9	bhambh	Bellingham Bay Net Pens
NOOKSM	11	samshw	Samish River Wild
NOOKSM	13	ar77aw	Area 7/7A Independent Wild
NOOKSM	15	whatch	Whatcom Creek Hatchery
SKAGIT	17	skagtw	Skagit River Wild
SKAGIT	19	skagth	Skagit River Hatchery
SKAGIT	21	skgbkh	Baker (Skagit) Hatchery
SKAGIT	23	skgbkw	Baker (Skagit) Wild
SKAGIT	25	swinch	Swinomish Channel Hatchery
SKAGIT	27	oakhbh	Oak Harbor Net Pens
STILSN	29	stillw	Stillaguamish River Wild
STILSN	31	stillh	Stillaguamish River Hatchery
STILSN	33	tuliph	Tulalip Hatchery
STILSN	35	snohow	Snohomish River Wild
STILSN	37	snohoh	Snohomish River Hatchery
STILSN	39	ar8anh	Area 8A Net Pens
HOODCL	41	ptgamh	Port Gamble Net Pens
HOODCL	43	ptgamw	Port Gamble Bay Wild
HOODCL	45	ar12bw	Area 12/12B Wild
HOODCL	47	qlcnbh	Quilcene Hatchery
HOODCL	49	qlcenh	Quilcene Bay Net Pens
HOODCL	51	ar12aw	Area 12A Wild
HOODCL	53	hoodsh	Hoodsport Hatchery
HOODCL	55	ar12dw	Area 12C/12D Wild
HOODCL	57	gadamh	George Adams Hatchery
HOODCL	59	skokrw	Skokomish River Wild
SPGSND	61	ar13bw	Area 13B Misc. Wild
SPGSND	63	deschw	Deschutes R. (WA) Wild
SPGSND	65	ssdnph	South Puget Sound Net Pens
SPGSND	67	nisqlh	Nisqually River Hatchery
SPGSND	69	nisqlw	Nisqually River Wild
SPGSND	71	foxish	Fox Island Net Pens
SPGSND	73	mintch	Minter Creek Hatchery
SPGSND	75	ar13mw	Area 13 Miscellaneous Wild
SPGSND	77	chambh	Chambers Creek Hatchery

Appendix 2. Coho FRAM Stocks (continued).

Production Region	Unmarked Stock #	Abbreviated Name	Coho Stock Name
SPGSND	79	ar13mh	Area 13 Misc. Hatchery
SPGSND	81	ar13aw	Area 13A Miscellaneous Wild
SPGSND	83	puyalh	Puyallup River Hatchery
SPGSND	85	puyalw	Puyallup River Wild
SPGSND	87	are11h	Area 11 Hatchery
SPGSND	89	ar11mw	Area 11 Miscellaneous Wild
SPGSND	91	ar10eh	Area 10E Hatchery
SPGSND	93	ar10ew	Area 10E Miscellaneous Wild
SPGSND	95	greenh	Green River Hatchery
SPGSND	97	greenw	Green River Wild
SPGSND	99	lakwah	Lake Washington Hatchery
SPGSND	101	lakwaw	Lake Washington Wild
SPGSND	103	are10h	Area 10 H inc. Ebay,SeaAq NP
SPGSND	105	ar10mw	Area 10 Miscellaneous Wild
SJDFCA	107	dungew	Dungeness River Wild
SJDFCA	109	dungeh	Dungeness Hatchery
SJDFCA	111	elwhaw	Elwha River Wild
SJDFCA	113	elwhah	Elwha Hatchery
SJDFCA	115	ejdfmw	East JDF Miscellaneous Wild
SJDFCA	117	wjdfmw	West JDF Miscellaneous Wild
SJDFCA	119	ptangh	Port Angeles Net Pens
SJDFCA	121	area9w	Area 9 Miscellaneous Wild
MAKAHC	123	makahw	Makah Coastal Wild
MAKAHC	125	makahh	Makah Coastal Hatchery
QUILUT	127	quilsw	Quillayute R Summer Natural
QUILUT	129	quilsh	Quillayute R Summer Hatchery
QUILUT	131	quilfw	Quillayute River Fall Natural
QUILUT	133	quilfh	Quillayute River Fall Hatchery
HOHRIV	135	hohrvw	Hoh River Wild
HOHRIV	137	hohrvh	Hoh River Hatchery
QUEETS	139	quetfw	Queets River Fall Natural
QUEETS	141	quetfh	Queets River Fall Hatchery
QUEETS	143	quetph	Queets R Supplemental Hat.
QUINLT	145	quinfw	Quinault River Fall Natural
QUINLT	147	quinfh	Quinault River Fall Hatchery
GRAYHB	149	chehlw	Chehalis River Wild
GRAYHB	151	chehlh	Chehalis River (Bingham) Hat.
GRAYHB	153	humptw	Humptulips River Wild
GRAYHB	155	humpth	Humptulips River Hatchery

Appendix 2. Coho FRAM Stocks (continued).

Production Region	Unmarked Stock #	Abbreviated Name	Coho Stock Name
GRAYHB	157	gryhmw	Grays Harbor Misc. Wild
GRAYHB	159	gryhbh	Grays Harbor Net Pens
WILLAPA	161	willaw	Willapa Bay Natural
WILLAPA	163	willah	Willapa Bay Hatchery
COLRIV	165	colreh	Columbia River Early Hatchery
COLRIV	167	youngh	Youngs Bay Hatchery
COLRIV	169	sandew	Sandy Early Wild
COLRIV	171	clakew	Clakamas Early Wild
COLRIV	173	claklw	Clakamas Late Wild
COLRIV	175	colrlh	Columbia River Late Hatchery
OREGON	177	orenoh	Oregon North Coastal Hat.
OREGON	179	orenow	Oregon North Coastal Wild
OREGON	181	orenmh	Oregon No. Mid Coastal Hat.
OREGON	183	orenmw	Oregon No. Mid Coastal Wild
OREGON	185	oresmh	Oregon So. Mid Coastal Hat.
OREGON	187	oresmw	Oregon So. Mid Coastal Wild
OREGON	189	oranah	Oregon Anadromous Hatchery
OREGON	191	oraqah	Oregon Aqua-Foods Hatchery
ORECAL	193	oresoh	Oregon South Coastal Hat.
ORECAL	195	oresow	Oregon South Coastal Wild
ORECAL	197	calnoh	California North Coastal Hat.
ORECAL	199	calnow	California North Coastal Wild
ORECAL	201	calcnh	California Central Coastal Hat.
ORECAL	203	calcnw	California Central Coastal Wild
GSMLND	205	gsmndh	Georgia Strait Mainland Hat.
GSMLND	207	gsmndw	Georgia Strait Mainland Wild
GSVNCI	209	gsvcih	Georgia Strait Vanc. Is. Hat.
GSVNCI	211	gsvciw	Georgia Strait Vanc. Is. Wild
JNSTRT	213	jnstrh	Johnstone Strait Hatchery
JNSTRT	215	jnstrw	Johnstone Strait Wild
SWVNCI	217	swvcih	SW Vancouver Island Hat.
SWVNCI	219	swvciw	SW Vancouver Island Wild
NWVNCI	221	nwvcih	NW Vancouver Island Hatchery
NWVNCI	223	nwvciw	NW Vancouver Island Wild
FRSLOW	225	frslwh	Lower Fraser River Hatchery
FRSLOW	227	frslww	Lower Fraser River Wild
FRSUPP	229	frsuph	Upper Fraser River Hatchery
FRSUPP	231	frsupw	Upper Fraser River Wild

Appendix 2. Coho FRAM Stocks (continued).

Production Region	Unmarked Stock #	Abbreviated Name	Coho Stock Name
THOMPR	233	thomph	Thompson River Hatchery
THOMPR	235	thompw	Thompson River Wild
BCCNTL	237	bccnhw	BC Central Coast Hat./Wild
BCNCST	239	bcnchw	BC North Coast Hatchery/Wild
QUEENC	241	quenhw	Queen Charlotte Is. Hat/Wild
NASSRV	243	nasshw	Nass River Hatchery/Wild
SKEENA	245	skeehw	Skeena River Hatchery/Wild
TRANAC	247	tranhw	Trans Boundary Hatchery/Wild
NIASKA	249	niakhw	Alaska No. Inside Hat./Wild
NOASKA	251	noakhw	Alaska No. Outside Hat./Wild
SIASKA	253	siakhw	Alaska So. Inside Hat./Wild
SOASKA	255	soakhw	Alaska So. Outside Hat./Wild

Appendix 3. Chinook FRAM Fisheries.

#	Fishery Name	#	Fishery Name
1	Southeast Alaska Troll	38	T San Juan Net (Area 6A,7,7A)
2	Southeast Alaska Net	39	NT Nooksack-Samish Net
3	Southeast Alaska Sport	40	T Nooksack-Samish Net
4	North/Central British Columbia Net	41	T Juan de Fuca Troll (Area 5,6,7)
5	West Coast Vancouver Island Net	42	Area 5/6 Sport
6	Strait of Georgia Net	43	NT Juan de Fuca Net (Area 4B,5,6,6C)
7	Canada Juan de Fuca Net (Area 20)	44	T Juan de Fuca Net (Area 4B,5,6,6C)
8	North/Central British Columbia Sport	45	Area 8 Sport [a]
9	North/Central British Columbia Troll	46	NT Skagit Net (Area 8)
10	West Coast Vancouver Island Troll	47	T Skagit Net (Area 8)
11	West Coast Vancouver Island Sport	48	Area 8D Sport
12	Strait of Georgia Troll	49	NT Stilly-Snohomish Net (Area 8A)
13	North Strait of Georgia Sport	50	T Stilly-Snohomish Net (Area 8A)
14	South Strait of Georgia Sport	51	NT Tulalip Bay Net (Area 8D)
15	BC Juan de Fuca Sport	52	T Tulalip Bay Net (Area 8D)
16	NT Cape Flattery-Quillayute Troll (Area 3-4)	53	Area 9 Sport
17	T Cape Flattery-Quillayute Troll (Area 3-4)	54	NT Area 6B/9 Net
18	Cape Flattery-Quillayute Sport (Area 3-4)	55	T Area 6B/9 Net
19	Cape Flattery-Quillayute Net (Area 3-4)	56	Area 10 Sport
20	NT Grays Harbor Troll (Area 2)	57	Area 11 Sport
21	T Grays Harbor Troll (Area 2)	58	NT Area 10/11 Net
22	Grays Harbor Sport (Area 2)	59	T Area 10/11 Net
23	NT Grays Harbor Net	60	NT Area 10A Net
24	T Grays Harbor Net	61	T Area 10A Net
25	Willapa Net	62	NT Area 10E Net
26	NT Columbia River Troll (Area 1)	63	T Area 10E Net
27	Columbia River Sport (Area 1)	64	Area 12 Sport
28	Columbia River Net	65	NT Hood Canal Net (Area 12,12B,12C)
29	Buoy 10 Sport	66	T Hood Canal Net (Area 12,12B,12C)
30	Orford Reef-Cape Falcon Troll (Central OR)	67	Area 13 Sport
31	Orford Reef-Cape Falcon Sport (Central OR)	68	NT Deep S. Puget Sound Net (13,13D-K)
32	Horse Mountain-Orford Reef Troll (KMZ)	69	T Deep S. Puget Sound Net (13,13D-K)
33	Horse Mountain-Orford Reef Sport (KMZ)	70	NT Area 13A Net
34	Southern California Troll	71	T Area 13A Net
35	Southern California Sport	72	Freshwater Sport
36	Area 7 Sport	73	Freshwater Net [b]
37	NT San Juan Net (Area 6A,7,7A)		

Notes: * (T = Treaty; NT = Non-treaty)
[a] Sport areas 8-1 and 8-2 were combined and input into Fishery 45.
[b] In Puget Sound, fishery 73 combines Area 11A with Puyallup River; Areas 9A, 12A, 12D with Hood Canal; Area 13C with Chambers Creek.

Appendix 4. Coho FRAM Fisheries.

Fishery Abbreviation	Fishery Number	Coho FRAM Fishery Long Name
No Cal Trm	1	North California Coast Terminal Catch
Cn Cal Trm	2	Central California Coast Terminal Catch
Ft Brg Spt	3	Fort Bragg Sport
Ft Brg Trl	4	Fort Bragg Troll
Ca KMZ Spt	5	KMZ Sport (Klamath Management Zone)
Ca KMZ Trl	6	KMZ Troll (Klamath Management Zone)
So Cal Spt	7	Southern California Sport
So Cal Trl	8	Southern California Troll
So Ore Trm	9	South Oregon Coast Terminal Catch
Or Prv Trm	10	Oregon Private Hatchery Terminal Catch
SMi Or Trm	11	South-Mid Oregon Coast Terminal Catch
NMi Or Trm	12	North-Mid Oregon Coast Terminal Catch
No Ore Trm	13	North Oregon Coast Terminal Catch
Or Cst Trm	14	Mid-North Oregon Coast Terminal Catch
Brkngs Spt	15	Brookings Sport
Brkngs Trl	16	Brookings Troll
Newprt Spt	17	Newport Sport
Newprt Trl	18	Newport Troll
Coos B Spt	19	Coos Bay Sport
Coos B Trl	20	Coos Bay Troll
Tillmk Spt	21	Tillamook Sport
Tillmk Trl	22	Tillamook Troll
Buoy10 Spt	23	Buoy 10 Sport (Columbia River Estuary)
L ColR Spt	24	Lower Columbia River Mainstem Sport
L ColR Net	25	Lower Columbia River Net (Excl Youngs Bay)
Yngs B Net	26	Youngs Bay Net
LCROrT Spt	27	Below Bonneville Oregon Tributary Sport
Clackm Spt	28	Clackamas River Sport
SandyR Spt	29	Sandy River Sport
LCRWaT Spt	30	Below Bonneville Washington Tributary Sport
UpColR Spt	31	Above Bonneville Sport
UpColR Net	32	Above Bonneville Net
A1-Ast Spt	33	Area 1 (Illwaco) & Astoria Sport
A1-Ast Trl	34	Area 1 (Illwaco) & Astoria Troll
Area2TrlNT	35	Area 2 Troll Non-treaty (Westport)
Area2TrlTR	36	Area 2 Troll Treaty (Westport)
Area 2 Spt	37	Area 2 Sport (Westport)
Area3TrlNT	38	Area 3 Troll Non-treaty (LaPush)
Area3TrlTR	39	Area 3 Troll Treaty (LaPush)

Appendix 4. Coho FRAM Fisheries (continued).

Fishery Abbreviation	Fishery Number	Coho FRAM Fishery Long Name
Area 3 Spt	40	Area 3 Sport (LaPush)
Area 4 Spt	41	Area 4 Sport (Neah Bay)
A4/4BTrlNT	42	Area 4/4B (Neah Bay PFMC Regs) Troll Non-treaty
A4/4BTrlTR	43	Area 4/4B (Neah Bay PFMC Regs) Troll Treaty
A 5-6C Trl	44	Area 5, 6, 6C Troll (Strait of Juan de Fuca)
Willpa Spt	45	Willapa Bay (Area 2.1) Sport
Wlp Tb Spt	46	Willapa Tributary Sport
WlpaBT Net	47	Willapa Bay & FW Trib Net
GryHbr Spt	48	Grays Harbor (Area 2.2) Sport
SGryHb Spt	49	South Grays Harbor Sport (Westport Boat Basin)
GryHbr Net	50	Grays Harbor Estuary Net
Hump R Spt	51	Humptulips River Sport
LwCheh Net	52	Lower Chehalis River Net
Hump R C&S	53	Humptulips River Ceremonial & Subsistence
Chehal Spt	54	Chehalis River Sport
Hump R Net	55	Humptulips River Net
UpCheh Net	56	Upper Chehalis River Net
Chehal C&S	57	Chehalis River Ceremonial & Subsistence
Wynoch Spt	58	Wynochee River Sport
Hoquam Spt	59	Hoquiam River Sport
Wishkh Spt	60	Wishkah River Sport
Satsop Spt	61	Satsop River Sport
Quin R Spt	62	Quinault River Sport
Quin R Net	63	Quinault River Net
Quin R C&S	64	Quinault River Ceremonial & Subsistence
Queets Spt	65	Queets River Sport
Clrwtr Spt	66	Clearwater River Sport
Salm R Spt	67	Salmon River (Queets) Sport
Queets Net	68	Queets River Net
Queets C&S	69	Queets River Ceremonial & Subsistence
Quilly Spt	70	Quillayute River Sport
Quilly Net	71	Quillayute River Net
Quilly C&S	72	Quillayute River Ceremonial & Subsistence
Hoh R Spt	73	Hoh River Sport
Hoh R Net	74	Hoh River Net
Hoh R C&S	75	Hoh River Ceremonial & Subsistence
Mak FW Spt	76	Makah Tributary Sport
Mak FW Net	77	Makah Freshwater Net
Makah C&S	78	Makah Ceremonial & Subsistence

Appendix 4. Coho FRAM Fisheries (continued).

Fishery Abbreviation	Fishery Number	Coho FRAM Fishery Long Name
A 4-4A Net	79	Area 4, 4A Net (Neah Bay)
A4B6CNetNT	80	Area 4B, 5, 6C Net Nontreaty (Strait of Juan de Fuca)
A4B6CNetTR	81	Area 4B, 5, 6C Net Treaty (Strait of Juan de Fuca)
Ar6D NetNT	82	Area 6D Dungeness Bay/River Net Nontreaty
Ar6D NetTR	83	Area 6D Dungeness Bay/River Net Treaty
Elwha Net	84	Elwha River Net
WJDF T Net	85	West Juan de Fuca Straits Tributary Net
EJDF T Net	86	East Juan de Fuca Straits Tributary Net
A6-7ANetNT	87	Area 7, 7A Net Nontreaty (San Juan Islands)
A6-7ANetTR	88	Area 7, 7A Net Treaty (San Juan Islands)
EJDF FWSpt	89	East Juan de Fuca Straits Tributary Sport
WJDF FWSpt	90	West Juan de Fuca Straits Tributary Sport
Area 5 Spt	91	Area 5 Marine Sport (Sekiu)
Area 6 Spt	92	Area 6 Marine Sport (Port Angeles)
Area 7 Spt	93	Area 7 Marine Sport (San Juan Islands)
Dung R Spt	94	Dungeness River Sport
ElwhaR Spt	95	Elwha River Sport
A7BCDNetNT	96	Area 7B-7C-7D Net Nontreaty (Bellingham Bay)
A7BCDNetTR	97	Area 7B-7C-7D Net Treaty (Bellingham Bay)
Nook R Net	98	Nooksack River Net
Nook R Spt	99	Nooksack River Sport
Samh R Spt	100	Samish River Sport
Ar 8 NetNT	101	Area 8 Skagit Marine Net Nontreaty
Ar 8 NetTR	102	Area 8 Skagit Marine Net Treaty
Skag R Net	103	Skagit River Net
SkgR TsNet	104	Skagit River Test Net
SwinCh Net	105	Swinomish Channel Net
Ar 8-1 Spt	106	Area 8.1 Marine Sport
Area 9 Spt	107	Area 9 Marine Sport (Admiralty Inlet)
Skag R Spt	108	Skagit River Sport
Ar8A NetNT	109	Area 8A Stillaguamish/Snohomish Net Nontreaty
Ar8A NetTR	110	Area 8A Stillaguamish/Snohomish Net Treaty
Ar8D NetNT	111	Area 8D Tulalip Bay Net Nontreaty
Ar8D NetTR	112	Area 8D Tulalip Bay Net Treaty
Stil R Net	113	Stillaguamish River Net
Snoh R Net	114	Snohomish River Net
Ar 8-2 Spt	115	Area 8.2 Marine Sport
Stil R Spt	116	Stillaguamish River Sport
Snoh R Spt	117	Snohomish River Sport

Appendix 4. Coho FRAM Fisheries (continued).

Fishery Abbreviation	Fishery Number	Coho FRAM Fishery Long Name
Ar 10 Spt	118	Area 10 Marine Sport (Seattle)
Ar10 NetNT	119	Area 10 Net Nontreaty (Seattle)
Ar10 NetTR	120	Area 10 Net Treaty (Seattle)
Ar10ANetNT	121	Area 10A Net Nontreaty (Elliott Bay)
Ar10ANetTR	122	Area 10A Net Treaty (Elliott Bay)
Ar10ENetNT	123	Area 10E Net Nontreaty (East Kitsap)
Ar10EnetTR	124	Area 10E Net Treaty (East Kitsap)
10F-G Net	125	Area 10F-G Ship Canal/Lake Washington Net Treaty
Duwm R Net	126	Green/Duwamish River Net
Duwm R Spt	127	Green/Duwamish River Sport
L WaSm Spt	128	Lake Washington-Lake Sammamish Tributary Sport
Ar 11 Spt	129	Area 11 Marine Sport (Tacoma)
Ar11 NetNT	130	Area 11 Net Nontreaty (Tacoma)
Ar11 NetTR	131	Area 11 Net Treaty (Tacoma)
Ar11ANetNT	132	Area 11A Net Nontreaty (Commencement Bay)
Ar11ANetTR	133	Area 11A Net Treaty (Commencement Bay)
Puyl R Net	134	Puyallup River Net
Puyl R Spt	135	Puyallup River Sport
Ar 13 Spt	136	Area 13 Marine Sport (South Puget Sound)
Ar13 NetNT	137	Area 13 Net Nontreaty (South Puget Sound)
Ar13 NetTR	138	Area 13 Net Treaty (South Puget Sound)
Ar13CNetNT	139	Area 13C Net Nontreaty (Chambers Bay)
Ar13CNetTR	140	Area 13C Net Treaty (Chambers Bay)
Ar13ANetNT	141	Area 13A Net Nontreaty (Carr Inlet)
Ar13ANetTR	142	Area 13A Net Treaty (Carr Inlet)
Ar13DNetNT	143	Area 13D Net Nontreaty (South Puget Sound)
Ar13DNetTR	144	Area 13D Net Treaty (South Puget Sound)
A13FKNetNT	145	Area 13F-13K Net Nontreaty (South PS Inlets)
A13FKNetTR	146	Area 13F-13K Net Treaty (South PS Inlets)
Nisq R Net	147	Nisqually River Net
McAlls Net	148	McAllister Creek Net
13D-K TSpt	149	13D-13K Tributary Sport (South PS Inlets)
Nisq R Spt	150	Nisqually River Sport
Desc R Spt	151	Deschutes River Sport (Olympia)
Ar 12 Spt	152	Area 12 Marine Sport (Hood Canal)
1212BNetNT	153	Area 12-12B Net Nontreaty (Upper Hood Canal)
1212BNetTR	154	Area 12-12B Net Treaty (Upper Hood Canal)
Ar9A NetNT	155	Area 9A Net Nontreaty (Port Gamble)
Ar9A NetTR	156	Area 9-9A Net Treaty (Port Gamble/On Reservation)

Appendix 4. Coho FRAM Fisheries (continued).

Fishery Abbreviation	Fishery Number	Coho FRAM Fishery Long Name
Ar12ANetNT	157	12A Net Nontreaty (Quilcene Bay)
Ar12ANetTR	158	12A Net Treaty (Quilcene Bay)
A12CDNetNT	159	12C-12D Net Nontreaty (Lower Hood Canal)
A12CDNetTR	160	12C-12D Net Treaty (Lower Hood Canal)
Skok R Net	161	Skokomish River Net
Quilcn Net	162	Quilcene River Net
1212B TSpt	163	12-12B Tributary FW Sport
Quilcn Spt	164	12A Tributary FW Sport (Quilcene River)
12C-D TSpt	165	12C-12D Tributary FW Sport
Skok R Spt	166	Skokomish River Sport
GSMLND Trm	167	Georgia Strait Mainland Terminal Catch
GSVNCI Trm	168	Georgia Strait Vancouver Island Terminal Catch
JNSTRT Trm	169	Johnstone Strait Terminal Catch
SWVNCI Trm	170	SW Vancouver Island Terminal Catch
NWVNCI Trm	171	NW Vancouver Island Terminal Catch
FRSLOW Trm	172	Lower Fraser River Terminal Catch
FRSUPP Trm	173	Upper Fraser River Terminal Catch
THOMPR Trm	174	Thompson River Terminal Catch
No BC Trl	175	Northern British Columbia Troll
NoC BC Trl	176	North Central British Columbia Troll
SoC BC Trl	177	South Central British Columbia Troll
NW VI Trl	178	NW Vancouver Island Troll
SW VI Trl	179	SW Vancouver Island Troll
GeoStr Trl	180	Georgia Straits Troll
BC JDF Trl	181	British Columbia Juan de Fuca Troll
No BC Net	182	Northern British Columbia Net
Cen BC Net	183	Central British Columbia Net
NW VI Net	184	NW Vancouver Island Net
SW VI Net	185	SW Vancouver Island Net
Johnst Net	186	Johnstone Straits Net
GeoStr Net	187	Georgia Straits Net
Fraser Net	188	Fraser River Gill Net
BC JDF Net	189	British Columbia Juan de Fuca Net
No BC Spt	190	Northern British Columbia Sport
Cen BC Spt	191	Central British Columbia Sport
BC JDF Spt	192	British Columbia Juan de Fuca Sport
WC VI Spt	193	West Coast Vancouver Island Sport
NGaStr Spt	194	North Georgia Straits Sport
SGaStr Spt	195	South Georgia Straits Sport

Appendix 4. Coho FRAM Fisheries (continued).

Fishery Abbreviation	Fishery Number	Coho FRAM Fishery Long Name
Albern Spt	196	Alberni Canal Sport
BCCNTL TTR	197	BCCNTL Terminal Run (Catch + Escapement)
BCNCST TTR	198	BCNCST Terminal Run (Catch + Escapement)
QUEENC TTR	199	QUEENC Terminal Run (Catch + Escapement)
NASSRV TTR	200	NASSRV Terminal Run (Catch + Escapement)
SKEENA TTR	201	SKEENA Terminal Run (Catch + Escapement)
SW AK Trl	202	Southwest Alaska Troll
SE AK Trl	203	Southeast Alaska Troll
NW AK Trl	204	Northwest Alaska Troll
NE AK Trl	205	Northeast Alaska Troll
Alaska Net	206	Alaska Net (Areas 182:183:185:192)

GLOSSARY

Adult Equivalent (AEQ) - The potential contribution of fish of a given age to the spawning escapement, in the absence of fishing. Because of natural mortality and unaccounted losses, not all unharvested fish contribute to spawning escapement. For example, a two-year-old chinook has a lower probability of surviving to spawn, in the absence of fishing, than does a five-year-old, and these two age classes have different "adult equivalents".

Base Period - A set of years used to estimate exploitation rates, maturation rates, and stock abundances from CWT data. The years used for the base period differ by species and stock, but range from 1974-1979. Brood years are chosen based on consistent coded-wire tagging, and consistent sampling and fisheries in return years. Some stocks in the model were not tagged during the 1974-1979 period; recoveries of these stocks (called "out-of-base" stocks) are adjusted to account for changes in exploitation rates relative to the base period.

Catch Ceiling - A fishery catch limitation expressed in numbers of fish. A ceiling fishery is managed so as not to exceed the ceiling; actual catch is expected to fall somewhere below the ceiling.

Catch Quota - A fishery catch allocation expressed in numbers of fish. A quota fishery is managed to catch the quota; actual catch is expected to be slightly above or below the quota.

Chinook/Coho Nonretention (CNR) - Time periods when salmon fishing is allowed, but the retention of chinook (or coho) salmon is prohibited.

Cohort Analysis - A sequential population analysis technique that is used during model calibration to reconstruct the exploited life history of coded-wire tag groups.

Cohort Size (initial) - The total number of fish of a given age and stock at the beginning of the fishing season.

Coded-Wire Tag (CWT) - Coded microtags that are implanted in juvenile salmon prior to release. A tagged fish usually has its adipose fin removed to signal tag presence. Fisheries and escapements are sampled for tagged fish. When recovered, the binary code on the tag provides specific information about the individual's tag group (e.g., location and timing of release, special hatchery treatments).

Dropoff Mortality - Mortality of salmon that "drop-off" sport or troll fishing gear before they are landed, and die from their injuries prior to harvest or spawning.

Dropout Mortality - Mortality of salmon that die in a fishing net and "drop-out" prior to harvest or salmon that disentangle from a net while it is in the water and die from their injuries prior to harvest or spawning.

Exploitation Rate (ER) - Catch or total fishing mortality in a fishery expressed as a proportion of the total cohort size in all areas (i.e., the total number of fish in the stock of interest at the beginning of the fishing year).

Exploitation Rate Scalar - A multiplier used to estimate fishery impacts by adjusting the base periods exploitation rates. Exploitation rate scalars can be either stock and fishery specific, or they can be applied to all stocks in a fishery.

FRAM - The Fishery Regulation Assessment Model is a simulation model developed for use in estimating the impacts of Pacific Coast fisheries on chinook and coho stocks of interest to fishery managers.

Harvest Rate (HR) - Catch or total fishing mortality in a fishery expressed as a proportion of the total fish abundance available in a given fishing area at the start of a time period.

Hooking Mortality - Mortality of salmon that are caught and released by sport or troll gear, and die from their injuries prior to harvest or spawning.

Management System Evaluation - An evaluation of how well the model predicts variables of interest (e.g., terminal runs, catch by stock, and stock composition) when pre-season estimates of abundance and fishery catches are used as input data. In other words, given that the model performs adequately, does our preseason decision making process, based on preseason predictions, result in the anticipated outcome?

Marked Recognition Error - the probability that a marked fish will be inadvertently released.

Model Calibration - Model process involving base period data which (1) scales the coded-wire tag recoveries to represent a stock, (2) allocates nonlanded catch mortality to stocks, and (3) reconstruct the cohort in order to compute exploitation rates, maturation rates, and stock abundance.

Model Simulation - Use of the model to vary the calibrated fish population abundance and fishing rates to portray the effects, on the stocks and fisheries, of different sets of regulations.

Nonlanded Catch - This category of fishery-related mortality includes hook-and-line drop-off, net gear drop-out, hooking mortality, and other sources of nonlanded mortality such as unreported or illegal catch.

Nontreaty Fisheries - Fisheries conducted by fishers who are not members of the twenty-four Belloni or Boldt Case Area Tribes.

Preterminal - In FRAM, a “preterminal” fishery is one that operates on both mature and immature fish.

Shaker Mortality - "Shakers": This term represents fish that are released from recreational and troll hook and line fisheries, either because they are outside of the regulatory size limits, because the species is not allowed to be kept, or because the individual fisher chooses, for personal or economic reasons, to release the fish.

Terminal - In FRAM, a “terminal” fishery is one that operates only on mature fish. These fisheries tend to be adjacent to a stock’s stream of origin and harvest returning adult fish.

Terminal Area Management Modules (TAMM) - Spreadsheets external to but integrated with FRAM that are used to: (1) provide input for FRAM simulations regarding projected Puget Sound terminal area catches or stock-specific impacts; (2) compute escapements for Puget Sound stock aggregates; and (3) create output reports that summarize simulated regulations, stock exploitation rates, allocation accounting, and escapement estimates.

Treaty Fisheries - Fisheries conducted by fishers who are members of the twenty-four Belloni or Boldt Case Area Tribes.

Unmarked Recognition Error (or Retention Error Rate) - the probability that an unmarked fish will be retained inappropriately in a selective fishery (e.g. naturally-occurring marks, fisher fails to identify mark, fisher fails to comply with release requirement).

Validation - An evaluation of how well the model predicts variables of interest (e.g., terminal runs, catch by stock, and stock composition) when post-season estimates of stock abundance and fishery catches are used as input data. Validation is intended to evaluate performance of the model. In other words, does the model yield correct stock-specific impacts using, as inputs, actual stock size and fishery catch information.

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APPENDIX D

Technical Methods – Economics

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APPENDIX D – TECHNICAL METHODS – ECONOMICS

D1 Introduction

This technical appendix describes the methods, data, and key assumptions used in the analysis of economic effects of the Proposed Action and Alternatives. The appendix is organized similar to Section 4.6 subsections, with a description of methods, data, and assumptions for commercial fishing activity and values, sport-fishing activity and values, and effects on the local and regional economy. Background data used in developing the Affected Environment (Section 3.6) is presented in Attachment A to this appendix. Information, including data and assumptions, developed by The Research Group and Meyer Resources, Inc. to produce economic factors employed in the impact assessment, is provided in Attachments B, C, D, and E to this appendix.

D2 Commercial Fishing Activity and Values

D2.1 Methods

Estimates of Puget Sound net and troll commercial salmon landings, in numbers of fish landed by species for both marine and freshwater catch areas, were developed by the fishery modeling group for each alternative and provided to the economic analysis team. For purposes of the economic analysis, these landings were assigned to one of the three economic regions in which landings are made and then converted to pounds landed, ex-vessel values, and ex-processor values. To evaluate the direct effects of the alternatives on employment and personal income (wages, profits and other income) levels in the commercial fishing industry and salmon processing industry, ex-vessel values and ex-processor values were used with direct employment and personal income multipliers and coefficients to determine changes in these economic conditions within each region. The following steps were undertaken to accomplish these tasks.

D2.1.1 Step 1: Allocate Landings to Economic Regions

Three economic regions were established based on port locations to assess the economic effects of changes in harvests of Puget Sound salmon. The ports were grouped into the following three regions: North Puget Sound, South Puget Sound/South Hood Canal, and Strait of Juan de Fuca/North Hood Canal. The geographic boundaries of these regions in relation to city and county boundaries are shown in Attachment B. The regional boundaries were chosen in consideration of fishing industry labor markets, location of ports where salmon deliveries are received and where primary processing occurs, ports where there is a likeness in fleet and vessel profiles, and other considerations. Nearly all landings from Puget Sound catch areas are accounted for in the selected regions. Some deliveries, however, occur elsewhere in Washington. For this reason, the sum of the economic impacts in the three regions does not necessarily equal statewide economic impacts.

Estimated non-tribal and tribal marine and freshwater landings were allocated to the three economic regions based on a mapping of Puget Sound catch areas to the ports where the catch is landed, using 2002 chinook salmon catch data. The landing and catch area assignments, and the data used to make the assignments, are included in Attachment B to this appendix. The landings assignments are summarized in Table D-1. To allocate the estimated landings for each alternative, the percentages shown in Table D-1 were applied to total estimated landings within each region for each species (i.e., chinook, coho, sockeye, pink, chum, and steelhead). For example, using the percentage in Table D-1, 100 percent of the catch in Marine Catch Areas 7, 8, and 9 were assumed to be landed in ports located in the North Puget Sound region.

Table D-1. Percentages used to allocate estimated harvest in marine catch areas to economic regions.

Marine Catch Area	North Puget Sound	South Puget Sound/South Hood Canal	The Straits of Juan de Fuca/North Hood Canal
Areas 5, 6	0%	0%	100%
Area 7	100%	0%	0%
Area 8, 9	100%	0%	0%
Areas 10, 11, 13	0%	100%	0%
Area 12	0%	100%	0%

D2.1.2 Step 2: Convert Landings in Each Region to Harvested Weights

Once estimated landings (in number of fish) for each species were allocated to each region (Step 1), the total harvested weight was calculated by multiplying marine and freshwater landings by average weights for each species. These averages, which are shown in Table D-2, were based on 1996–2001 averages derived from the Washington Department of Fish and Wildlife's License and Fish Ticket (LIFT) data base.

Table D-2. Average weights (in pounds) used to convert estimated landings to ex-vessel weights.

Species	Marine	Freshwater
Chinook	13.29	12.44
Chum	9.04	11.10
Coho	5.79	5.39
Pink	3.84	3.96
Sockeye	5.56	5.13
Steelhead	7.68	6.95

D2.1.3 Step 3: Convert Harvested Weights to Ex-Vessel and Ex-Processor Values

Once harvest weights were estimated (Step 2), the ex-vessel and ex-processor values of the harvests in each region were estimated by multiplying harvested poundage by average ex-vessel and ex-processor prices per pound for each species. The ex-vessel averages, shown in Table D-3, were based on 1996–2001 averages derived from the Washington Department of Fish and Wildlife's LIFT data base. The ex-processor prices, shown in Table D-4, were developed based on data analysis conducted by The Research Group (Attachment B).

Table D-3. Average prices (per pound) used to convert estimated harvested poundage to ex-vessel values.

Species	Marine	Freshwater
Chinook	$0.81	$0.63
Chum	$0.24	$0.24
Coho	$0.47	$0.41
Pink	$0.17	$0.15
Sockeye	$1.20	$0.82
Steelhead	$0.77	$0.67

Table D-4. Average prices (per landed round pound) used to convert estimated harvested poundage to ex-processor values.

Species	North Puget Sound	South Puget Sound/South Hood Canal	The Straits of Juan de Fuca/North Hood Canal
Chinook:			
Net	$1.02	$1.34	$1.20
Troll	$1.34	$1.66	$1.52
Chum	$0.79	$0.76	$1.00
Coho:			
Net	$0.94	$1.16	$1.00
Troll	$0.57	$0.61	$1.00
Pink	$0.71	$1.46	$1.31
Sockeye	$1.50	$1.50	$1.46
Steelhead	$0.71	$1.46	$1.31

D2.1.4 Step 4: Estimate Direct Employment Impacts on the Commercial Fishing Industry and Salmon Processing Industry

Employment in the commercial salmon fishing industry is highly seasonal, with jobs lasting from a few weeks to a few months. Based upon the availability and abundance of different commercial species and restrictions imposed on the harvest of protected species, fishing crews may quickly switch from fishing for salmon to other species. Vessel owners, who are often self-employed, may also increase and decrease crew sizes on a seasonal basis. Employment attributable solely to commercial salmon fishing activities is therefore difficult to estimate and assess. In an effort to accurately capture employment effects in the commercial salmon fishing industry, two measures of employment were developed using different estimation procedures. The first measure, hereafter referred to as direct jobs, reflects both full- and part-time employment in the commercial fishing industry. The second measure, hereafter referred to as direct employment, reflects full-time equivalent employment in the industry. For the processing industry, which is less sensitive to the availability of specific commercial species, only full-time equivalent employment was used to characterize employment effects.

Direct jobs in the commercial salmon fishing industry generated by harvests under each alternative were estimated using a direct employment multiplier representing the number of full- and part-time jobs generated per million dollars of ex-vessel revenue received by commercial fishermen. As discussed below, a single direct multiplier was used for all regions for non-tribal fishermen. Similarly, a single multiplier was used for all regions for tribal fishermen. Using a single multiplier for all regions incorporates the assumption that, on average, labor requirements per fish harvested would not vary across the three regions.

Direct jobs multipliers for non-tribal and tribal fishermen were estimated for all regions using non-tribal and tribal jobs data developed using the number of active license holders from the Washington Department of Fish and Wildlife's 2001 LIFT data base, and using assumptions concerning the typical crew size for commercial salmon fishing using different gear methods. Estimates of typical crew size were: one person for fishing using hook and line, dip nets, set nets, hand lines, and trolling; 1.5 crew persons for gill nets; 2 crew persons for fishing using beach seines; 3 crew persons for fishing using reef nets; and 4 crew persons for fishing using purse seines. To arrive at an estimate of the number of commercial salmon fishing jobs per million dollars of ex-vessel revenue, the estimated non-tribal and tribal commercial salmon fishing jobs were divided by the 2001 total ex-vessel values for Puget Sound salmon harvests for non-tribal and tribal fishermen. This method resulted in the following direct jobs multipliers: non-tribal – 365 jobs per $1 million in ex-vessel revenue; tribal – 507 jobs per $1 million in ex-vessel revenue. These jobs multipliers reflect the fact that commercial salmon fishing generates a large number of part-time jobs relative to full-time employment opportunities because, as discussed previously, most salmon fishermen only harvest salmon for a few months each year. Additionally, many commercial salmon license holders may fish for only a few days each year, participating in the fishery long enough to maintain their licenses. The jobs multipliers were applied to the estimated ex-vessel values for non-tribal and tribal fishermen in each region to determine the number of estimated fishing jobs generated under each alternative.

Full-time equivalent employment in the commercial fishing and salmon processing industries generated by harvests under each alternative were estimated using employment factors (i.e., coefficients) developed by The Research Group (Attachment B). Factors were provided for each salmon species specific to the three economic regions for composite product forms (i.e., averaged over all product forms, including eggs). Factors were also supplied for gear groups, when appropriate. (All salmon species other than chinook and coho are landed solely with net gear.) Factors were provided for making average calculations (i.e., total economic contributions resulting from the overall salmon fishery), and marginal calculations (i.e., economic contributions resulting from changes to the fishery). The direct employment factors for salmon harvesters and processors, shown in Tables D-5 and D-6, respectively, represent the estimated number of full-time equivalent jobs in the commercial salmon fishing and processing industries generated per million round pounds of landed salmon. The average employment factors were applied to the landed poundage estimates for each region to estimate employment levels for the Proposed Action. Similarly, the marginal employment factors were applied to the landed poundage estimates for each region to estimate employment levels for each alternative to the Proposed Action.

Table D-5. Factors (full-time equivalent jobs per million landed round pounds) used to convert estimated harvested poundage to employment in the commercial salmon fishing industry.

	North Puget Sound		South Puget Sound/South Hood Canal		The Straits of Juan de Fuca/North Hood Canal	
Species	Average	Marginal	Average	Marginal	Average	Marginal
Chinook:						
Net	16.7	18.7	15.3	17.3	16.4	18.5
Troll	23.3	26.2	21.5	24.1	23.6	26.5
Chum	2.9	3.2	2.7	3.0	2.3	2.6
Coho:						
Net	8.2	9.2	7.5	8.4	7.9	8.9
Troll	7.5	8.4	7.5	8.4	7.5	8.4
Pink	10.7	12.0	9.9	11.0	10.7	12.1
Sockeye	21.0	23.5	19.1	21.4	20.5	23.1
Steelhead	10.67	12.0	9.9	11.0	10.7	12.1

Table D-6. Factors (full-time equivalent employment per million landed round pounds) used to convert estimated harvested poundage to employment in the salmon processing industry.

	North Puget Sound		South Puget Sound/South Hood Canal		The Straits of Juan de Fuca/North Hood Canal	
Species	Average	Marginal	Average	Marginal	Average	Marginal
Chinook:						
Net	14.9	16.7	13.0	14.6	14.7	16.5
Troll	14.4	16.1	12.5	14.1	14.0	15.7
Chum	14.7	16.6	12.8	14.4	14.3	16.1
Coho:						
Net	15.1	16.9	13.1	14.7	14.7	16.5
Troll	13.6	15.3	13.6	15.3	13.6	15.3
Pink	14.7	16.6	12.8	14.4	14.5	16.3
Sockeye	14.9	16.7	13.1	14.7	14.7	16.5
Steelhead	14.7	16.6	12.8	14.4	14.5	16.3

D2.1.5 Step 5: Estimate Direct Personal Income Impacts on the Commercial Fishing Industry and Salmon Processing Industry

For the commercial fishing and processing industries, personal income generated by harvests under each alternative was estimated using a direct income coefficient representing the amount of income generated per round pound of commercial salmon landings.

Personal income for the commercial fishing and salmon processing industries generated by harvests under each alternative was estimated using income factors (i.e., coefficients) developed by The Research Group (Attachment B). Factors were provided for each salmon species specific to the three economic regions for composite product forms (i.e., averaged over all product forms, including eggs). Factors were also supplied for gear groups, when appropriate. (All salmon species other than chinook and coho are landed solely with net gear.) Factors were provided for making average calculations (i.e., total economic contributions resulting from the overall salmon fishery), and marginal calculations (i.e., economic contributions resulting from changes to the fishery). The direct personal income factors for salmon harvesters and processors, which are shown in Tables D-7 and D-8, respectively, represent the amount of personal income received by the commercial salmon fishing and processing industries per round pound of landed salmon. These factors were applied to the landed poundage estimates for each region to estimate direct personal income levels for each alternative.

Table D-7. Factors (personal income per landed round pound) used to convert estimated harvested poundage to personal income in the commercial salmon fishing industry.

	North Puget Sound		South Puget Sound/South Hood Canal		The Straits of Juan de Fuca/North Hood Canal	
Species	Average	Marginal	Average	Marginal	Average	Marginal
Chinook:						
Net	$0.43	$0.48	$0.39	$0.43	$0.42	$0.47
Troll	$0.60	$0.62	$0.54	$0.60	$0.60	$0.68
Chum	$0.07	$0.08	$0.07	$0.08	$0.06	$0.07
Coho:						
Net	$0.21	$0.24	$0.19	$0.21	$0.20	$0.23
Troll	$0.60	$0.62	$0.54	$0.60	$0.19	$0.22
Pink	$0.28	$0.28	$0.25	$0.28	$0.27	$0.31
Sockeye	$0.54	$0.55	$0.48	$0.54	$0.52	$0.59
Steelhead	$0.28	$0.28	$0.25	$0.28	$0.27	$0.31

Table D-8. Factors (personal income per landed round pound) used to convert estimated harvested poundage to personal income in the salmon processing industry.

	North Puget Sound		South Puget Sound/South Hood Canal		The Straits of Juan de Fuca/North Hood Canal	
Species	Average	Marginal	Average	Marginal	Average	Marginal
Chinook:						
Net	$0.37	$0.42	$0.34	$0.38	$0.37	$0.42
Troll	$0.36	$0.40	$0.32	$0.37	$0.35	$0.40
Chum	$0.37	$0.41	$0.33	$0.37	$0.36	$0.41
Coho:						
Net	$0.38	$0.42	$0.34	$0.38	$0.37	$0.42
Troll	$0.36	$0.40	$0.32	$0.37	$0.35	$0.39
Pink	$0.37	$0.41	$0.33	$0.37	$0.37	$0.41
Sockeye	$0.37	$0.42	$0.34	$0.38	$0.37	$0.42
Steelhead	$0.37	$0.41	$0.33	$0.37	$0.37	$0.41

D2.1.6 Step 6: Estimate Net Economic Values Associated with Commercial Salmon Fishing and Processing

The net economic value of the Puget Sound commercial salmon fishery can be measured in terms of its monetary value to producers and consumers. Producers include the commercial fishers, including operators (or permit holders) and crewmembers, and fish processors. Consumers include the public that consumes salmon.

For this analysis, only net economic value to producers is evaluated because it is assumed that changes in the supply of salmon from the alternatives would not measurably affect the price that consumers pay for salmon. Net economic value to salmon fishers is represented by the difference between the ex-vessel value of the salmon harvest and out-of-pocket and capital investment expenses for commercial salmon fishermen and the opportunity cost of labor.

Coefficients developed by Meyer Resources, Inc. for this study and reported in Attachment C were used to estimate net economic values associated with commercial fishing. As described in Attachment C, net economic values associated with commercial salmon fishing under the status-quo conditions can be considered from two different accounting perspectives. Net economic efficiency returns describe "present-day, average net economic returns evident in the salmon fishery without consideration of benefit trade-offs with family and/or community goals." Net socio-economic returns describe "net economic returns from present fishing activities plus potential economic rent foregone to achieve family, community or fishing port objectives."

Because the Proposed Action (Alternative 1) generally reflects a status quo condition, a coefficient based on average conditions was considered appropriate for estimating the net economic value of the commercial salmon harvest. A coefficient of 0.58 was used for this estimation, which reflects a measure of net economic efficiency and takes into account that the opportunity (or alternative) cost of labor for many persons involved in commercial fishing is very low, particularly tribal labor. The determination that alternative employment opportunities for commercial fishermen are limited and that wages paid to commercial fishermen should be treated as a "credit" in the calculation of net economic value was based on a review of available unemployment data for commercial fishermen in the Puget Sound area obtained from the Washington State Employment Security Department. It was concluded that the unemployment rate for both tribal and non-tribal commercial fishermen who harvest salmon in Puget Sound likely exceeds the U.S. Water Resources Council thresholds for "substantial and persistent unemployment." The 0.58 coefficient under the Proposed Action/Status Quo Condition was applied to the ex-vessel value of the commercial salmon harvest for Alternative 1.

For Alternatives 2, 3, and 4, a "marginal" coefficient of 0.94 was used that also assumes limited alternative employment opportunities for both tribal and non-tribal commercial fishermen. It should be noted that differences potentially exist in alternative employment opportunities and in the disposition of capital used for commercial fishing between tribal and non-tribal commercial fishermen, and that these differences would affect the calculation of net economic values for the two user groups. Resolution of this issue, however, was beyond the scope of this study, so the same net economic value coefficient was used for both tribal and non-tribal fishermen. The 0.94 coefficient was applied to the reduction in ex-vessel values of the commercial salmon harvest for Alternatives 2, 3, and 4 to estimate the change in net economic value associated with commercial salmon fishing.

For estimating net economic values associated with salmon processing, coefficients developed by The Research Group for this study and reported in Attachment D were used. These coefficients represent the net income to processors, and are derived as 50 percent of the economic contribution margin. The coefficients are specific to different species and gear types.

It should be noted that the reduction in net economic values associated with salmon harvest and processing under Alternatives 2, 3, and 4 would be larger than the net economic values associated with Alternative 1. This would occur because the reduction in values associated with these alternatives, estimated at 94 percent of the reductions in ex-vessel values, would exceed the net economic values associated with Alternative 1, which are estimated at 58 percent of the ex-vessel values. This result is technically feasible because of the potential negative effect of large reductions in the salmon harvest on the value of capital investment in boats and equipment used for salmon fishing, in addition to the reduction in income to operators and crew. It should be emphasized that there are many considerations that can affect the coefficients for estimating net economic values in a particular fishery, as noted in a review of coefficients in the existing literature (National Marine Fisheries Service 2002) for evaluating marginal changes in net economic values of commercial salmon fishing. Consequently, the coefficients used to estimate net economic values for this study should be interpreted with caution.

D2.2 Assumptions Used in the Analysis

The following key assumptions were incorporated into the assessment of commercial fishing activity and values.

- The allocation of landings among economic regions assumes that economic impacts generated by harvests from marine areas and rivers are primarily felt in the port and river locations where the harvests are landed.
- Average fish weights and ex-vessel prices over the period 1996–2001 were assumed in the analysis.
- For the assessment of direct job effects, labor requirements per harvested fish for non-tribal and tribal commercial fishing operations were assumed not to vary across the three regions.
- A coefficient of 0.58 was assumed in estimating the net economic value of the salmon harvest by tribal and non-tribal commercial fishermen under the Proposed Action, and a coefficient of 0.94 was assumed in estimating the loss associated with reductions in harvest under Alternatives 2, 3, or 4.

D2.3 Estimated Values

The estimated regional distributions of harvests, estimated harvest weights, harvest values, processor values, and direct employment and personal income resulting from the methodology and assumptions described above are presented in Tables D-9 through D-17 for all alternatives under Scenario B (2003 abundance and 2003 Canadian/Alaskan fisheries), which is currently considered the most likely scenario.

Table D-9. Allocation of estimated commercial landings to economic regions.
Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

	Alternative 1 - Proposed Action/Status Quo			
Specie	North Puget Sound	SPS/SHC*	SJF/ NHC*	State Total
Chinook				
Non-tribal				
Marine Net	21,548	2,079	0	23,627
Tribal				
Marine Net	26,355	13,539	1,350	41,244
Marine Troll	0	0	1,010	1,010
Freshwater Net	2,883	35,013	3	37,899
Tribal Subtotal	29,238	48,552	2,363	80,153
Total	50,786	50,631	2,363	103,780
Coho				
Non-tribal				
Marine Net	15,852	6,624	1,886	24,362
Tribal				
Marine Net	73,472	83,246	21,162	177,880
Marine Troll	0	0	910	910
Freshwater Net	28,180	74,048	1,807	104,035
Tribal Subtotal	101,652	157,294	23,879	282,825
Total	117,504	163,918	25,765	307,187
Sockeye				
Non-tribal				
Marine Net	246,594	0	0	246,594
Tribal				
Marine Net	255,609	0	26,419	282,028
Freshwater Net	250	47,700	0	47,950
Tribal Subtotal	255,859	47,700	26,419	329,978
Total	502,453	47,700	26,419	576,572
Pink				
Non-tribal				
Marine Net	710,844	4,441	0	715,285
Tribal				
Marine Net	685,155	28,748	1,374	715,277
Freshwater Net	46,432	170	0	46,602
Tribal Subtotal	731,587	28,918	1,374	761,879
Total	1,442,431	33,359	1,374	1,477,164
Chum				
Non-tribal				
Marine Net	116,650	269,152	0	385,802
Tribal				
Marine Net	98,181	226,281	10,450	334,912
Freshwater Net	54,008	77,502	0	131,510
Tribal Subtotal	152,189	303,783	10,450	466,422
Total	268,839	572,935	10,450	852,224
Steelhead				
Non-tribal				
Marine Net	0	0	0	0
Tribal				
Marine Net	282	7	119	408
Freshwater Net	250	656	620	1,526
Tribal Subtotal	532	663	739	1,934
Total	532	663	739	1,934
Total				
Non-tribal				
Marine Net	1,111,488	282,296	1,886	1,395,670
Tribal				
Marine Net	1,139,054	351,821	60,874	1,551,748
Marine Troll	0	0	1,920	1,920
Freshwater Net	132,004	235,090	2,430	369,523
Tribal Subtotal	1,271,057	586,910	65,224	1,923,191
Total	2,382,545	869,206	67,110	3,318,861

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-9. Allocation of estimated commercial landings to economic regions.
Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

	Alternative 2 - Escapement Goal Management at the Management Unit Level											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Specie	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change
Chinook												
Non-tribal												
Marine Net	2	-21,546	-100.0%	0	-2,079	-100.0%	0	0	0.0%	2	-23,625	-100.0%
Tribal												
Marine Net	7,579	-18,776	-71.2%	0	-13,539	-100.0%	0	-1,350	-100.0%	7,579	-33,665	-81.6%
Marine Troll	0	0	0.0%	0	0	0.0%	0	-1,010	-100.0%	0	-1,010	-100.0%
Freshwater Net	770	-2,114	-73.3%	42,540	7,526	21.5%	0	-3	-100.0%	43,309	5,410	14.3%
Tribal Subtotal	8,349	-20,890	-71.4%	42,540	-6,013	-12.4%	0	-2,363	-100.0%	50,888	-29,265	-36.5%
Total	8,351	-42,436	-83.6%	42,540	-8,092	-16.0%	0	-2,363	-100.0%	50,890	-52,890	-51.0%
Coho												
Non-tribal												
Marine Net	519	-15,333	-96.7%	0	-6,624	-100.0%	2,304	418	22.2%	2,823	-21,539	-88.4%
Tribal												
Marine Net	0	-73,472	-100.0%	0	-83,246	-100.0%	0	-21,162	-100.0%	0	-177,880	-100.0%
Marine Troll	0	0	0.0%	0	0	0.0%	0	-910	-100.0%	0	-910	-100.0%
Freshwater Net	33,142	4,962	17.6%	77,382	3,334	4.5%	1,725	-82	-4.5%	112,249	8,214	7.9%
Tribal Subtotal	33,142	-68,510	-67.4%	77,382	-79,912	-50.8%	1,725	-22,154	-92.8%	112,249	-170,576	-60.3%
Total	33,661	-83,843	-71.4%	77,382	-86,536	-52.8%	4,029	-21,736	-84.4%	115,072	-192,115	-62.5%
Sockeye												
Non-tribal												
Marine Net	0	-246,594	-100.0%	0	0	0.0%	0	0	0.0%	0	-246,594	-100.0%
Tribal												
Marine Net	0	-255,609	-100.0%	0	0	0.0%	0	-26,419	-100.0%	0	-282,028	-100.0%
Freshwater Net	0	-250	-100.0%	0	-47,700	-100.0%	0	0	0.0%	0	-47,950	-100.0%
Tribal Subtotal	0	-255,859	-100.0%	0	-47,700	-100.0%	0	-26,419	-100.0%	0	-329,978	-100.0%
Total	0	-502,453	-100.0%	0	-47,700	-100.0%	0	-26,419	-100.0%	0	-576,572	-100.0%
Pink												
Non-tribal												
Marine Net	0	-710,844	-100.0%	0	-4,441	-100.0%	0	0	0.0%	0	-715,285	-100.0%
Tribal												
Marine Net	0	-685,155	-100.0%	0	-28,748	-100.0%	0	-1,374	-100.0%	0	-715,277	-100.0%
Freshwater Net	83,400	36,968	79.6%	26,108	25,938	15257.6%	0	0	0.0%	109,508	62,906	135.0%
Tribal Subtotal	83,400	-648,187	-88.6%	26,108	-2,810	-9.7%	0	-1,374	-100.0%	109,508	-652,371	-85.6%
Total	83,400	-1,359,031	-94.2%	26,108	-7,251	-21.7%	0	-1,374	-100.0%	109,508	-1,367,656	-92.6%
Chum												
Non-tribal												
Marine Net	0	-116,650	-100.0%	0	-269,152	-100.0%	0	0	0.0%	0	-385,802	-100.0%
Tribal												
Marine Net	0	-98,181	-100.0%	0	-226,281	-100.0%	0	-10,450	-100.0%	0	-334,912	-100.0%
Freshwater Net	1,808	-52,200	-96.7%	146,976	69,474	89.6%	2	2	0.0%	148,786	17,276	13.1%
Tribal Subtotal	1,808	-150,381	-98.8%	146,976	-156,807	-51.6%	2	-10,448	-100.0%	148,786	-317,636	-68.1%
Total	1,808	-267,031	-99.3%	146,976	-425,959	-74.3%	2	-10,448	-100.0%	148,786	-703,438	-82.5%
Steelhead												
Non-tribal												
Marine Net	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Tribal												
Marine Net	0	-282	-100.0%	0	-7	-100.0%	0	-119	-100.0%	0	-408	-100.0%
Freshwater Net	227	-23	-9.2%	653	-3	-0.5%	610	-10	-1.6%	1,490	-36	-2.4%
Tribal Subtotal	227	-305	-57.3%	653	-10	-1.5%	610	-129	-17.5%	1,490	-444	-23.0%
Total	227	-305	-57.3%	653	-10	-1.5%	610	-129	-17.5%	1,490	-444	-23.0%
Total												
Non-tribal												
Marine Net	521	-1,110,967	-100.0%	0	-282,296	-100.0%	2,304	418	22.2%	2,825	-1,392,845	-99.8%
Tribal												
Marine Net	7,579	-1,131,475	-99.3%	0	-351,821	-100.0%	0	-60,874	-100.0%	7,579	-1,544,169	-99.5%
Marine Troll	0	0	0.0%	0	0	0.0%	0	-1,920	-100.0%	0	-1,920	-100.0%
Freshwater Net	119,347	-12,657	-9.6%	293,659	58,569	24.9%	2,337	-93	-3.8%	415,343	45,819	12.4%
Tribal Subtotal	126,926	-1,144,132	-90.0%	293,659	-293,251	-50.0%	2,337	-62,887	-96.4%	422,922	-1,500,270	-78.0%
Total	127,447	-2,255,098	-94.7%	293,659	-575,547	-66.2%	4,641	-62,469	-93.1%	425,747	-2,893,115	-87.2%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-9. Allocation of estimated commercial landings to economic regions.
Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

	Alternative 3 - Escapement Goal Management at the Population Level/Terminal Fisheries Only											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Specie	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number		Change from Baseline (%)	Number	Change from Baseline	% Change
Chinook												
Non-tribal												
Marine Net	2	-21,546	-100.0%	0	-2,079	-100.0%	0	0	0.0%	2	-23,625	-100.0%
Tribal												
Marine Net	0	-26,355	-100.0%	0	-13,539	-100.0%	0	-1,350	-100.0%	0	-41,244	-100.0%
Marine Troll	0	0	0.0%	0	0	0.0%	0	-1,010	-100.0%	0	-1,010	-100.0%
Freshwater Net	0	-2,883	-100.0%	42,540	7,526	21.5%	0	-3	-100.0%	42,540	4,641	12.2%
Tribal Subtotal	0	-29,238	-100.0%	42,540	-6,013	-12.4%	0	-2,363	-100.0%	42,540	-37,613	-46.9%
Total	2	-50,784	-100.0%	42,540	-8,092	-16.0%	0	-2,363	-100.0%	42,542	-61,238	-59.0%
Coho												
Non-tribal												
Marine Net	519	-15,333	-96.7%	0	-6,624	-100.0%	2,304	418	22.2%	2,823	-21,539	-88.4%
Tribal												
Marine Net	0	-73,472	-100.0%	0	-83,246	-100.0%	0	-21,162	-100.0%	0	-177,880	-100.0%
Marine Troll	0	0	0.0%	0	0	0.0%	0	-910	-100.0%	0	-910	-100.0%
Freshwater Net	143	-28,037	-99.5%	77,382	3,334	4.5%	1,725	-82	-4.5%	79,250	-24,785	-23.8%
Tribal Subtotal	143	-101,509	-99.9%	77,382	-79,912	-50.8%	1,725	-22,154	-92.8%	79,250	-203,575	-72.0%
Total	662	-116,842	-99.4%	77,382	-86,536	-52.8%	4,029	-21,736	-84.4%	82,073	-225,114	-73.3%
Sockeye												
Non-tribal												
Marine Net	0	-246,594	-100.0%	0	0	0.0%	0	0	0.0%	0	-246,594	-100.0%
Tribal												
Marine Net	0	-255,609	-100.0%	0	0	0.0%	0	-26,419	-100.0%	0	-282,028	-100.0%
Freshwater Net	0	-250	-100.0%	0	-47,700	-100.0%	0	0	0.0%	0	-47,950	-100.0%
Tribal Subtotal	0	-255,859	-100.0%	0	-47,700	-100.0%	0	-26,419	-100.0%	0	-329,978	-100.0%
Total	0	-502,453	-100.0%	0	-47,700	-100.0%	0	-26,419	-100.0%	0	-576,572	-100.0%
Pink												
Non-tribal												
Marine Net	0	-710,844	-100.0%	0	-4,441	-100.0%	0	0	0.0%	0	-715,285	-100.0%
Tribal												
Marine Net	0	-685,155	-100.0%	0	-28,748	-100.0%	0	-1,374	-100.0%	0	-715,277	-100.0%
Freshwater Net	0	-46,432	-100.0%	26,108	25,938	15257.6%	0	0	0.0%	26,108	-20,494	-44.0%
Tribal Subtotal	0	-731,587	-100.0%	26,108	-2,810	-9.7%	0	-1,374	-100.0%	26,108	-735,771	-96.6%
Total	0	-1,442,431	-100.0%	26,108	-7,251	-21.7%	0	-1,374	-100.0%	26,108	-1,451,056	-98.2%
Chum												
Non-tribal												
Marine Net	0	-116,650	-100.0%	0	-269,152	-100.0%	0	0	0.0%	0	-385,802	-100.0%
Tribal												
Marine Net	0	-98,181	-100.0%	0	-226,281	-100.0%	0	-10,450	-100.0%	0	-334,912	-100.0%
Freshwater Net	1,057	-52,951	-98.0%	146,976	69,474	89.6%	2	2	0.0%	148,035	16,525	12.6%
Tribal Subtotal	1,057	-151,132	-99.3%	146,976	-156,807	-51.6%	2	-10,448	-100.0%	148,035	-318,387	-68.3%
Total	1,057	-267,782	-99.6%	146,976	-425,959	-74.3%	2	-10,448	-100.0%	148,035	-704,189	-82.6%
Steelhead												
Non-tribal												
Marine Net	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Tribal												
Marine Net	0	-282	-100.0%	0	-7	-100.0%	0	-119	-100.0%	0	-408	-100.0%
Freshwater Net	227	-23	-9.2%	653	-3	-0.5%	610	-10	-1.6%	1,490	-36	-2.4%
Tribal Subtotal	227	-305	-57.3%	653	-10	-1.5%	610	-129	-17.5%	1,490	-444	-23.0%
Total	227	-305	-57.3%	653	-10	-1.5%	610	-129	-17.5%	1,490	-444	-23.0%
Total												
Non-tribal												
Marine Net	521	-1,110,967	-100.0%	0	-282,296	-100.0%	2,304	418	22.2%	2,825	-1,392,845	-99.8%
Tribal												
Marine Net	0	-1,139,054	-100.0%	0	-351,821	-100.0%	0	-60,874	-100.0%	0	-1,551,748	-100.0%
Marine Troll	0	0	0.0%	0	0	0.0%	0	-1,920	-100.0%	0	-1,920	-100.0%
Freshwater Net	1,427	-130,577	-98.9%	293,659	58,569	24.9%	2,337	-93	-3.8%	297,423	-72,100	-19.5%
Tribal Subtotal	1,427	-1,269,630	-99.9%	293,659	-293,251	-50.0%	2,337	-62,887	-96.4%	297,423	-1,625,768	-84.5%
Total	1,948	-2,380,597	-99.9%	293,659	-575,547	-66.2%	4,641	-62,469	-93.1%	300,248	-3,018,613	-91.0%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-9. Allocation of estimated commercial landings to economic regions.
Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

	Alternative 4 - No Fishing											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Specie	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number		Change from Baseline (%)	Number	Change from Baseline	% Change
Chinook												
Non-tribal												
Marine Net	0	-21,548	-100.0%	0	-2,079	-100.0%	0	0	0.0%	0	-23,627	-100.0%
Tribal												
Marine Net	0	-26,355	-100.0%	0	-13,539	-100.0%	0	-1,350	-100.0%	0	-41,244	-100.0%
Marine Troll	0	0	0.0%	0	0	0.0%	0	-1,010	-100.0%	0	-1,010	-100.0%
Freshwater Net	0	-2,883	-100.0%	0	-35,013	-100.0%	0	-3	-100.0%	0	-37,899	-100.0%
Tribal Subtotal	0	-29,238	-100.0%	0	-48,552	-100.0%	0	-2,363	-100.0%	0	-80,153	-100.0%
Total	0	-50,786	-100.0%	0	-50,631	-100.0%	0	-2,363	-100.0%	0	-103,780	-100.0%
Coho												
Non-tribal												
Marine Net	0	-15,852	-100.0%	0	-6,624	-100.0%	0	-1,886	-100.0%	0	-24,362	-100.0%
Tribal												
Marine Net	0	-73,472	-100.0%	0	-83,246	-100.0%	0	-21,162	-100.0%	0	-177,880	-100.0%
Marine Troll	0	0	0.0%	0	0	0.0%	0	-910	-100.0%	0	-910	-100.0%
Freshwater Net	0	-28,180	-100.0%	0	-74,048	-100.0%	0	-1,807	-100.0%	0	-104,035	-100.0%
Tribal Subtotal	0	-101,652	-100.0%	0	-157,294	-100.0%	0	-23,879	-100.0%	0	-282,825	-100.0%
Total	0	-117,504	-100.0%	0	-163,918	-100.0%	0	-25,765	-100.0%	0	-307,187	-100.0%
Sockeye												
Non-tribal												
Marine Net	0	-246,594	-100.0%	0	0	0.0%	0	0	0.0%	0	-246,594	-100.0%
Tribal												
Marine Net	0	-255,609	-100.0%	0	0	0.0%	0	-26,419	-100.0%	0	-282,028	-100.0%
Freshwater Net	0	-250	-100.0%	0	-47,700	-100.0%	0	0	0.0%	0	-47,950	-100.0%
Tribal Subtotal	0	-255,859	-100.0%	0	-47,700	-100.0%	0	-26,419	-100.0%	0	-329,978	-100.0%
Total	0	-502,453	-100.0%	0	-47,700	-100.0%	0	-26,419	-100.0%	0	-576,572	-100.0%
Pink												
Non-tribal												
Marine Net	0	-710,844	-100.0%	0	-4,441	-100.0%	0	0	0.0%	0	-715,285	-100.0%
Tribal												
Marine Net	0	-685,155	-100.0%	0	-28,748	-100.0%	0	-1,374	-100.0%	0	-715,277	-100.0%
Freshwater Net	0	-46,432	-100.0%	0	-170	-100.0%	0	0	0.0%	0	-46,602	-100.0%
Tribal Subtotal	0	-731,587	-100.0%	0	-28,918	-100.0%	0	-1,374	-100.0%	0	-761,879	-100.0%
Total	0	-1,442,431	-100.0%	0	-33,359	-100.0%	0	-1,374	-100.0%	0	-1,477,164	-100.0%
Chum												
Non-tribal												
Marine Net	0	-116,650	-100.0%	0	-269,152	-100.0%	0	0	0.0%	0	-385,802	-100.0%
Tribal												
Marine Net	0	-98,181	-100.0%	0	-226,281	-100.0%	0	-10,450	-100.0%	0	-334,912	-100.0%
Freshwater Net	1,057	-52,951	-98.0%	36,741	-40,761	-52.6%	2	2	0.0%	37,800	-93,710	-71.3%
Tribal Subtotal	1,057	-151,132	-99.3%	36,741	-267,042	-87.9%	2	-10,448	-100.0%	37,800	-428,622	-91.9%
Total	1,057	-267,782	-99.6%	36,741	-536,194	-93.6%	2	-10,448	-100.0%	37,800	-814,424	-95.6%
Steelhead												
Non-tribal												
Marine Net	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Tribal												
Marine Net	0	-282	-100.0%	0	-7	-100.0%	0	-119	-100.0%	0	-408	-100.0%
Freshwater Net	227	-23	-9.2%	512	-144	-22.0%	609	-11	-1.8%	1,348	-178	-11.7%
Tribal Subtotal	227	-305	-57.3%	512	-151	-22.8%	609	-130	-17.6%	1,348	-586	-30.3%
Total	227	-305	-57.3%	512	-151	-22.8%	609	-130	-17.6%	1,348	-586	-30.3%
Total												
Non-tribal												
Marine Net	0	-1,111,488	-100.0%	0	-282,296	-100.0%	0	-1,886	-100.0%	0	-1,395,670	-100.0%
Tribal												
Marine Net	0	-1,139,054	-100.0%	0	-351,821	-100.0%	0	-60,874	-100.0%	0	-1,551,748	-100.0%
Marine Troll	0	0	0.0%	0	0	0.0%	0	-1,920	-100.0%	0	-1,920	-100.0%
Freshwater Net	1,284	-130,720	-99.0%	37,253	-197,837	-84.2%	611	-1,819	-74.9%	39,148	-330,375	-89.4%
Tribal Subtotal	1,284	-1,269,773	-99.9%	37,253	-549,657	-93.7%	611	-64,613	-99.1%	39,148	-1,884,043	-98.0%
Total	1,284	-2,381,261	-99.9%	37,253	-831,953	-95.7%	611	-66,499	-99.1%	39,148	-3,279,713	-98.8%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-10. Estimated weight of commercial landings in round pounds in the economic regions with implementation of the alternatives.
Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

Specie	Average Round Pounds Per Fish Landed	Alternative 1 - Proposed Action/Status Quo			
		North Puget Sound	SPS/SHC*	SJF/ NHC*	State Total
Chinook					
Non-tribal					
Marine Net	13.29	286,373	27,630	0	314,003
Tribal					
Marine Net	13.29	350,258	179,933	17,942	548,133
Marine Troll	13.29	0	0	13,423	13,423
Freshwater Net	12.44	35,866	435,568	34	471,467
Tribal Subtotal	NA	386,124	615,501	31,398	1,033,023
Total	NA	672,497	643,131	31,398	1,347,026
Coho					
Non-tribal					
Marine Net	5.79	91,783	38,352	10,920	141,055
Tribal					
Marine Net	5.79	425,403	481,994	122,528	1,029,925
Marine Troll	5.79	0	0	5,269	5,269
Freshwater Net	5.39	151,890	399,119	9,740	560,749
Tribal Subtotal	NA	577,293	881,113	137,537	1,595,943
Total	NA	669,076	919,465	148,457	1,736,998
Sockeye					
Non-tribal					
Marine Net	5.56	1,371,063	0	0	1,371,063
Tribal					
Marine Net	5.56	1,421,186	0	146,890	1,568,076
Freshwater Net	5.13	1,283	244,701	0	245,984
Tribal Subtotal	NA	1,422,469	244,701	146,890	1,814,059
Total	NA	2,793,531	244,701	146,890	3,185,122
Pink					
Non-tribal					
Marine Net	3.84	2,729,641	17,053	0	2,746,694
Tribal					
Marine Net	3.84	2,630,994	110,392	5,276	2,746,662
Freshwater Net	3.96	183,872	673	0	184,546
Tribal Subtotal	NA	2,814,866	111,066	5,276	2,931,208
Total	NA	5,544,507	128,119	5,276	5,677,902
Chum					
Non-tribal					
Marine Net	9.04	1,054,515	2,433,134	0	3,487,649
Tribal					
Marine Net	9.04	887,556	2,045,578	94,468	3,027,602
Freshwater Net	11.10	599,490	860,276	0	1,459,766
Tribal Subtotal	NA	1,487,046	2,905,853	94,468	4,487,367
Total	NA	2,541,561	5,338,987	94,468	7,975,016
Steelhead					
Non-tribal					
Marine Net	7.68	0	0	0	0
Tribal					
Marine Net	7.68	2,166	54	914	3,133
Freshwater Net	6.95	1,738	4,559	4,309	10,606
Tribal Subtotal	NA	3,903	4,613	5,223	13,739
Total	NA	3,903	4,613	5,223	13,739
Total					
Non-tribal					
Marine Net	NA	5,533,374	2,516,170	10,920	8,060,464
Tribal					
Marine Net	NA	5,717,562	2,817,951	388,017	8,923,531
Marine Troll	NA	0	0	18,692	18,692
Freshwater Net	NA	974,138	1,944,895	14,083	2,933,116
Tribal Subtotal	NA	6,691,701	4,762,847	420,792	11,875,339
Total	NA	12,225,075	7,279,016	431,712	19,935,803

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-10. Estimated weight of commercial landings in round pounds in the economic regions with implementation of the alternatives.
Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 2 - Escapement Goal Management at the Management Unit Level											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Specie	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change
Chinook												
Non-tribal												
Marine Net	27	-286,346	-100.0%	0	-27,630	-100.0%	0	0	0.0%	27	-313,976	-100.0%
Tribal												
Marine Net	100,725	-249,533	-71.2%	0	-179,933	-100.0%	0	-17,942	-100.0%	100,725	-447,408	-81.6%
Marine Troll	0	0	0.0%	0	0	0.0%	0	-13,423	-100.0%	0	-13,423	-100.0%
Freshwater Net	9,573	-26,293	-73.3%	529,196	93,628	21.5%	0	-34	-100.0%	538,769	67,302	14.3%
Tribal Subtotal	110,298	-275,826	-71.4%	529,196	-86,305	-14.0%	0	-31,398	-100.0%	639,494	-393,529	-38.1%
Total	110,325	-562,172	-83.6%	529,196	-113,935	-17.7%	0	-31,398	-100.0%	639,521	-707,505	-52.5%
Coho												
Non-tribal												
Marine Net	3,005	-88,778	-96.7%	0	-38,352	-100.0%	13,340	2,420	22.2%	16,345	-124,710	-88.4%
Tribal												
Marine Net	0	-425,403	-100.0%	0	-481,994	-100.0%	0	-122,528	-100.0%	0	-1,029,925	-100.0%
Marine Troll	0	0	0.0%	0	0	0.0%	0	-5,269	-100.0%	0	-5,269	-100.0%
Freshwater Net	178,635	26,745	17.6%	417,089	17,970	4.5%	9,298	-442	-4.5%	605,022	44,273	7.9%
Tribal Subtotal	178,635	-398,658	-69.1%	417,089	-464,024	-52.7%	9,298	-128,239	-93.2%	605,022	-990,921	-62.1%
Total	181,640	-487,436	-72.9%	417,089	-502,376	-54.6%	22,638	-125,819	-84.8%	621,367	-1,115,631	-64.2%
Sockeye												
Non-tribal												
Marine Net	0	-1,371,063	-100.0%	0	0	0.0%	0	0	0.0%	0	-1,371,063	-100.0%
Tribal												
Marine Net	0	-1,421,186	-100.0%	0	0	0.0%	0	-146,890	-100.0%	0	-1,568,076	-100.0%
Freshwater Net	0	-1,283	-100.0%	0	-244,701	-100.0%	0	0	0.0%	0	-245,984	-100.0%
Tribal Subtotal	0	-1,422,469	-100.0%	0	-244,701	-100.0%	0	-146,890	-100.0%	0	-1,814,059	-100.0%
Total	0	-2,793,531	-100.0%	0	-244,701	-100.0%	0	-146,890	-100.0%	0	-3,185,122	-100.0%
Pink												
Non-tribal												
Marine Net	0	-2,729,641	-100.0%	0	-17,053	-100.0%	0	0	0.0%	0	-2,746,694	-100.0%
Tribal												
Marine Net	0	-2,630,994	-100.0%	0	-110,392	-100.0%	0	-5,276	-100.0%	0	-2,746,662	-100.0%
Freshwater Net	330,264	146,392	79.6%	103,388	102,714	15257.6%	0	0	0.0%	433,652	249,106	135.0%
Tribal Subtotal	330,264	-2,484,602	-88.3%	103,388	-7,678	-6.9%	0	-5,276	-100.0%	433,652	-2,497,556	-85.2%
Total	330,264	-5,214,243	-94.0%	103,388	-24,731	-19.3%	0	-5,276	-100.0%	433,652	-5,244,250	-92.4%
Chum												
Non-tribal												
Marine Net	0	-1,054,515	-100.0%	0	-2,433,134	-100.0%	0	0	0.0%	0	-3,487,649	-100.0%
Tribal												
Marine Net	0	-887,556	-100.0%	0	-2,045,578	-100.0%	0	-94,468	-100.0%	0	-3,027,602	-100.0%
Freshwater Net	20,069	-579,421	-96.7%	1,631,436	771,160	89.6%	22	22	0.0%	1,651,527	191,761	13.1%
Tribal Subtotal	20,069	-1,466,977	-98.7%	1,631,436	-1,274,418	-43.9%	22	-94,446	-100.0%	1,651,527	-2,835,841	-63.2%
Total	20,069	-2,521,492	-99.2%	1,631,436	-3,707,552	-69.4%	22	-94,446	-100.0%	1,651,527	-6,323,489	-79.3%
Steelhead												
Non-tribal												
Marine Net	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Tribal												
Marine Net	0	-2,166	-100.0%	0	-54	-100.0%	0	-914	-100.0%	0	-3,133	-100.0%
Freshwater Net	1,578	-160	-9.2%	4,538	-21	-0.5%	4,240	-70	-1.6%	10,356	-250	-2.4%
Tribal Subtotal	1,578	-2,326	-59.6%	4,538	-75	-1.6%	4,240	-983	-18.8%	10,356	-3,384	-24.6%
Total	1,578	-2,326	-59.6%	4,538	-75	-1.6%	4,240	-983	-18.8%	10,356	-3,384	-24.6%
Total												
Non-tribal												
Marine Net	3,032	-5,530,343	-99.9%	0	-2,516,170	-100.0%	13,340	2,420	22.2%	16,372	-8,044,092	-99.8%
Tribal												
Marine Net	100,725	-5,616,837	-98.2%	0	-2,817,951	-100.0%	0	-388,017	-100.0%	100,725	-8,822,806	-98.9%
Marine Troll	0	0	0.0%	0	0	0.0%	0	-18,692	-100.0%	0	-18,692	-100.0%
Freshwater Net	540,119	-434,019	-44.6%	2,685,646	740,751	38.1%	13,559	-523	-3.7%	3,239,325	306,209	10.4%
Tribal Subtotal	640,844	-6,050,857	-90.4%	2,685,646	-2,077,200	-43.6%	13,559	-407,232	-96.8%	3,340,050	-8,535,289	-71.9%
Total	643,875	-11,581,199	-94.7%	2,685,646	-4,593,370	-63.1%	26,900	-404,812	-93.8%	3,356,421	-16,579,381	-83.2%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-10. Estimated weight of commercial landings in round pounds in the economic regions with implementation of the alternatives. Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 3 - Escapement Goal Management at the Population Level/Terminal Fisheries Only											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Specie	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number		Change from Baseline (%)	Number	Change from Baseline	% Change
Chinook												
Non-tribal												
Marine Net	27	-286,346	-100.0%	0	-27,630	-100.0%	0	0	0.0%	27	-313,976	-100.0%
Tribal												
Marine Net	0	-350,258	-100.0%	0	-179,933	-100.0%	0	-17,942	-100.0%	0	-548,133	-100.0%
Marine Troll	0	0	0.0%	0	0	0.0%	0	-13,423	-100.0%	0	-13,423	-100.0%
Freshwater Net	0	-35,866	-100.0%	529,196	93,628	21.5%	0	-34	-100.0%	529,196	57,729	12.2%
Tribal Subtotal	0	-386,124	-100.0%	529,196	-86,305	-14.0%	0	-31,398	-100.0%	529,196	-503,827	-48.8%
Total	27	-672,470	-100.0%	529,196	-113,935	-17.7%	0	-31,398	-100.0%	529,222	-817,803	-60.7%
Coho												
Non-tribal												
Marine Net	3,005	-88,778	-96.7%	0	-38,352	-100.0%	13,340	2,420	22.2%	16,345	-124,710	-88.4%
Tribal												
Marine Net	0	-425,403	-100.0%	0	-481,994	-100.0%	0	-122,528	-100.0%	0	-1,029,925	-100.0%
Marine Troll	0	0	0.0%	0	0	0.0%	0	-5,269	-100.0%	0	-5,269	-100.0%
Freshwater Net	771	-151,119	-99.5%	417,089	17,970	4.5%	9,298	-442	-4.5%	427,158	-133,591	-23.8%
Tribal Subtotal	771	-576,522	-99.9%	417,089	-464,024	-52.7%	9,298	-128,239	-93.2%	427,158	-1,168,785	-73.2%
Total	3,776	-665,300	-99.4%	417,089	-502,376	-54.6%	22,638	-125,819	-84.8%	443,503	-1,293,495	-74.5%
Sockeye												
Non-tribal												
Marine Net	0	-1,371,063	-100.0%	0	0	0.0%	0	0	0.0%	0	-1,371,063	-100.0%
Tribal												
Marine Net	0	-1,421,186	-100.0%	0	0	0.0%	0	-146,890	-100.0%	0	-1,568,076	-100.0%
Freshwater Net	0	-1,283	-100.0%	0	-244,701	-100.0%	0	0	0.0%	0	-245,984	-100.0%
Tribal Subtotal	0	-1,422,469	-100.0%	0	-244,701	-100.0%	0	-146,890	-100.0%	0	-1,814,059	-100.0%
Total	0	-2,793,531	-100.0%	0	-244,701	-100.0%	0	-146,890	-100.0%	0	-3,185,122	-100.0%
Pink												
Non-tribal												
Marine Net	0	-2,729,641	-100.0%	0	-17,053	-100.0%	0	0	0.0%	0	-2,746,694	-100.0%
Tribal												
Marine Net	0	-2,630,994	-100.0%	0	-110,392	-100.0%	0	-5,276	-100.0%	0	-2,746,662	-100.0%
Freshwater Net	0	-183,872	-100.0%	103,388	102,714	15257.6%	0	0	0.0%	103,388	-81,158	-44.0%
Tribal Subtotal	0	-2,814,866	-100.0%	103,388	-7,678	-6.9%	0	-5,276	-100.0%	103,388	-2,827,820	-96.5%
Total	0	-5,544,507	-100.0%	103,388	-24,731	-19.3%	0	-5,276	-100.0%	103,388	-5,574,514	-98.2%
Chum												
Non-tribal												
Marine Net	0	-1,054,515	-100.0%	0	-2,433,134	-100.0%	0	0	0.0%	0	-3,487,649	-100.0%
Tribal												
Marine Net	0	-887,556	-100.0%	0	-2,045,578	-100.0%	0	-94,468	-100.0%	0	-3,027,602	-100.0%
Freshwater Net	11,733	-587,757	-98.0%	1,631,436	771,160	89.6%	22	22	0.0%	1,643,190	183,425	12.6%
Tribal Subtotal	11,733	-1,475,313	-99.2%	1,631,436	-1,274,418	-43.9%	22	-94,446	-100.0%	1,643,190	-2,844,177	-63.4%
Total	11,733	-2,529,828	-99.5%	1,631,436	-3,707,552	-69.4%	22	-94,446	-100.0%	1,643,190	-6,331,826	-79.4%
Steelhead												
Non-tribal												
Marine Net	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Tribal												
Marine Net	0	-2,166	-100.0%	0	-54	-100.0%	0	-914	-100.0%	0	-3,133	-100.0%
Freshwater Net	1,578	-160	-9.2%	4,538	-21	-0.5%	4,240	-70	-1.6%	10,356	-250	-2.4%
Tribal Subtotal	1,578	-2,326	-59.6%	4,538	-75	-1.6%	4,240	-983	-18.8%	10,356	-3,384	-24.6%
Total	1,578	-2,326	-59.6%	4,538	-75	-1.6%	4,240	-983	-18.8%	10,356	-3,384	-24.6%
Total												
Non-tribal												
Marine Net	3,032	-5,530,343	-99.9%	0	-2,516,170	-100.0%	13,340	2,420	22.2%	16,372	-8,044,092	-99.8%
Tribal												
Marine Net	0	-5,717,562	-100.0%	0	-2,817,951	-100.0%	0	-388,017	-100.0%	0	-8,923,531	-100.0%
Marine Troll	0	0	0.0%	0	0	0.0%	0	-18,692	-100.0%	0	-18,692	-100.0%
Freshwater Net	14,081	-960,057	-98.6%	2,685,646	740,751	38.1%	13,559	-523	-3.7%	2,713,287	-219,829	-7.5%
Tribal Subtotal	14,081	-6,677,620	-99.8%	2,685,646	-2,077,200	-43.6%	13,559	-407,232	-96.8%	2,713,287	-9,162,052	-77.2%
Total	17,113	-12,207,962	-99.9%	2,685,646	-4,593,370	-63.1%	26,900	-404,812	-93.8%	2,729,659	-17,206,144	-86.3%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-10. Estimated weight of commercial landings in round pounds in the economic regions with implementation of the alternatives.
Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 4 - No Fishing											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Specie	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number		Change from Baseline (%)	Number	Change from Baseline	% Change
Chinook												
Non-tribal												
Marine Net	0	-286,373	-100.0%	0	-27,630	-100.0%	0	0	0.0%	0	-314,003	-100.0%
Tribal												
Marine Net	0	-350,258	-100.0%	0	-179,933	-100.0%	0	-17,942	-100.0%	0	-548,133	-100.0%
Marine Troll	0	0	0.0%	0	0	0.0%	0	-13,423	-100.0%	0	-13,423	-100.0%
Freshwater Net	0	-35,866	-100.0%	0	-435,568	-100.0%	0	-34	-100.0%	0	-471,467	-100.0%
Tribal Subtotal	0	-386,124	-100.0%	0	-615,501	-100.0%	0	-31,398	-100.0%	0	-1,033,023	-100.0%
Total	0	-672,497	-100.0%	0	-643,131	-100.0%	0	-31,398	-100.0%	0	-1,347,026	-100.0%
Coho												
Non-tribal												
Marine Net	0	-91,783	-100.0%	0	-38,352	-100.0%	0	-10,920	-100.0%	0	-141,055	-100.0%
Tribal												
Marine Net	0	-425,403	-100.0%	0	-481,994	-100.0%	0	-122,528	-100.0%	0	-1,029,925	-100.0%
Marine Troll	0	0	0.0%	0	0	0.0%	0	-5,269	-100.0%	0	-5,269	-100.0%
Freshwater Net	0	-151,890	-100.0%	0	-399,119	-100.0%	0	-9,740	-100.0%	0	-560,749	-100.0%
Tribal Subtotal	0	-577,293	-100.0%	0	-881,113	-100.0%	0	-137,537	-100.0%	0	-1,595,943	-100.0%
Total	0	-669,076	-100.0%	0	-919,465	-100.0%	0	-148,457	-100.0%	0	-1,736,998	-100.0%
Sockeye												
Non-tribal												
Marine Net	0	-1,371,063	-100.0%	0	0	0.0%	0	0	0.0%	0	-1,371,063	-100.0%
Tribal												
Marine Net	0	-1,421,186	-100.0%	0	0	0.0%	0	-146,890	-100.0%	0	-1,568,076	-100.0%
Freshwater Net	0	-1,283	-100.0%	0	-244,701	-100.0%	0	0	0.0%	0	-245,984	-100.0%
Tribal Subtotal	0	-1,422,469	-100.0%	0	-244,701	-100.0%	0	-146,890	-100.0%	0	-1,814,059	-100.0%
Total	0	-2,793,531	-100.0%	0	-244,701	-100.0%	0	-146,890	-100.0%	0	-3,185,122	-100.0%
Pink												
Non-tribal												
Marine Net	0	-2,729,641	-100.0%	0	-17,053	-100.0%	0	0	0.0%	0	-2,746,694	-100.0%
Tribal												
Marine Net	0	-2,630,994	-100.0%	0	-110,392	-100.0%	0	-5,276	-100.0%	0	-2,746,662	-100.0%
Freshwater Net	0	-183,872	-100.0%	0	-673	-100.0%	0	0	0.0%	0	-184,546	-100.0%
Tribal Subtotal	0	-2,814,866	-100.0%	0	-111,066	-100.0%	0	-5,276	-100.0%	0	-2,931,208	-100.0%
Total	0	-5,544,507	-100.0%	0	-128,119	-100.0%	0	-5,276	-100.0%	0	-5,677,902	-100.0%
Chum												
Non-tribal												
Marine Net	0	-1,054,515	-100.0%	0	-2,433,134	-100.0%	0	0	0.0%	0	-3,487,649	-100.0%
Tribal												
Marine Net	0	-887,556	-100.0%	0	-2,045,578	-100.0%	0	-94,468	-100.0%	0	-3,027,602	-100.0%
Freshwater Net	11,733	-587,757	-98.0%	407,825	-452,450	-52.6%	22	22	0.0%	419,580	-1,040,186	-71.3%
Tribal Subtotal	11,733	-1,475,313	-99.2%	407,825	-2,498,028	-86.0%	22	-94,446	-100.0%	419,580	-4,067,787	-90.6%
Total	11,733	-2,529,828	-99.5%	407,825	-4,931,162	-92.4%	22	-94,446	-100.0%	419,580	-7,555,436	-94.7%
Steelhead												
Non-tribal												
Marine Net	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Tribal												
Marine Net	0	-2,166	-100.0%	0	-54	-100.0%	0	-914	-100.0%	0	-3,133	-100.0%
Freshwater Net	1,578	-160	-9.2%	3,558	-1,001	-22.0%	4,233	-76	-1.8%	9,369	-1,237	-11.7%
Tribal Subtotal	1,578	-2,326	-59.6%	3,558	-1,055	-22.9%	4,233	-990	-19.0%	9,369	-4,371	-31.8%
Total	1,578	-2,326	-59.6%	3,558	-1,055	-22.9%	4,233	-990	-19.0%	9,369	-4,371	-31.8%
Total												
Non-tribal												
Marine Net	0	-5,533,374	-100.0%	0	-2,516,170	-100.0%	0	-10,920	-100.0%	0	-8,060,464	-100.0%
Tribal												
Marine Net	0	-5,717,562	-100.0%	0	-2,817,951	-100.0%	0	-388,017	-100.0%	0	-8,923,531	-100.0%
Marine Troll	0	0	0.0%	0	0	0.0%	0	-18,692	-100.0%	0	-18,692	-100.0%
Freshwater Net	13,310	-960,828	-98.6%	411,384	-1,533,512	-78.8%	4,255	-9,828	-69.8%	428,949	-2,504,168	-85.4%
Tribal Subtotal	13,310	-6,678,390	-99.8%	411,384	-4,351,463	-91.4%	4,255	-416,537	-99.0%	428,949	-11,446,390	-96.4%
Total	13,310	-12,211,764	-99.9%	411,384	-6,867,633	-94.3%	4,255	-427,457	-99.0%	428,949	-19,506,854	-97.8%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-11. Estimated ex-vessel value of commercial landings (in 2002 dollars) in the economic regions with implementation of the alternatives.
Scenario B: 2003 abundance with Maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

Specie	Ex-Vessel Price Per Round Pound	Alternative 1 - Proposed Action/Status Quo			
		North Puget Sound	SPS/SHC*	SJF/ NHC*	State Total
Chinook					
Non-tribal					
Marine Net	$0.81	$231,962	$22,380	$0	$254,342
Tribal					
Marine Net	$0.81	$283,709	$145,746	$14,533	$443,988
Marine Troll	$0.81	$0	$0	$10,873	$10,873
Freshwater Net	$0.63	$22,595	$274,408	$21	$297,024
Tribal Subtotal	NA	$306,304	$420,154	$25,427	$751,885
Total	NA	$538,266	$442,534	$25,427	$1,006,227
Coho					
Non-tribal					
Marine Net	$0.47	$43,138	$18,026	$5,132	$66,296
Tribal					
Marine Net	$0.47	$199,939	$226,537	$57,588	$484,065
Marine Troll	$0.47	$0	$0	$2,476	$2,476
Freshwater Net	$0.41	$62,275	$163,639	$3,993	$229,907
Tribal Subtotal	NA	$262,214	$390,176	$64,058	$716,448
Total	NA	$305,352	$408,202	$69,190	$782,744
Sockeye					
Non-tribal					
Marine Net	$1.20	$1,645,275	$0	$0	$1,645,275
Tribal					
Marine Net	$1.20	$1,705,423	$0	$176,268	$1,881,691
Freshwater Net	$0.82	$1,052	$200,655	$0	$201,706
Tribal Subtotal	NA	$1,706,475	$200,655	$176,268	$2,083,397
Total	NA	$3,351,750	$200,655	$176,268	$3,728,672
Pink					
Non-tribal					
Marine Net	$0.17	$464,039	$2,899	$0	$466,938
Tribal					
Marine Net	$0.17	$447,269	$18,767	$897	$466,933
Freshwater Net	$0.15	$27,581	$101	$0	$27,682
Tribal Subtotal	NA	$474,850	$18,868	$897	$494,614
Total	NA	$938,889	$21,767	$897	$961,552
Chum					
Non-tribal					
Marine Net	$0.24	$253,084	$583,952	$0	$837,036
Tribal					
Marine Net	$0.24	$213,013	$490,939	$22,672	$726,624
Freshwater Net	$0.24	$143,878	$206,466	$0	$350,344
Tribal Subtotal	NA	$356,891	$697,405	$22,672	$1,076,968
Total	NA	$609,975	$1,281,357	$22,672	$1,914,004
Steelhead					
Non-tribal					
Marine Net	$0.77	$0	$0	$0	$0
Tribal					
Marine Net	$0.77	$1,668	$41	$704	$2,413
Freshwater Net	$0.67	$1,164	$3,055	$2,887	$7,106
Tribal Subtotal	NA	$2,832	$3,096	$3,591	$9,519
Total	NA	$2,832	$3,096	$3,591	$9,519
Total					
Non-tribal					
Marine Net	NA	2,637,498	627,257	5,132	3,269,887
Tribal					
Marine Net	NA	2,851,022	882,030	272,661	4,005,713
Marine Troll	NA	0	0	13,349	13,349
Freshwater Net	NA	258,545	848,323	6,902	1,113,769
Tribal Subtotal	NA	3,109,566	1,730,353	292,912	5,132,831
Total	NA	5,747,064	2,357,610	298,044	8,402,718

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-11. Estimated ex-vessel value of commercial landings (in 2002 dollars) in the economic regions with implementation of the alternatives. Scenario B: 2003 abundance with Maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 2 - Escapement Goal Management at the Management Unit Level											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Specie	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change
Chinook												
Non-tribal												
Marine Net	$22	-$231,941	-100.0%	$0	-$22,380	-100.0%	$0	$0	0.0%	$22	-$254,321	-100.0%
Tribal												
Marine Net	$81,587	-$202,122	-71.2%	$0	-$145,746	-100.0%	$0	-$14,533	-100.0%	$81,587	-$362,400	-81.6%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$10,873	-100.0%	$0	-$10,873	-100.0%
Freshwater Net	$6,031	-$16,564	-73.3%	$333,393	$58,986	21.5%	$0	-$21	-100.0%	$339,424	$42,400	14.3%
Tribal Subtotal	$87,618	-$218,686	-71.4%	$333,393	-$86,760	-20.6%	$0	-$25,427	-100.0%	$421,012	-$330,873	-44.0%
Total	$87,640	-$450,627	-83.7%	$333,393	-$109,140	-24.7%	$0	-$25,427	-100.0%	$421,033	-$585,194	-58.2%
Coho												
Non-tribal												
Marine Net	$1,412	-$41,726	-96.7%	$0	-$18,026	-100.0%	$6,270	$1,138	22.2%	$7,682	-$58,614	-88.4%
Tribal												
Marine Net	$0	-$199,939	-100.0%	$0	-$226,537	-100.0%	$0	-$57,588	-100.0%	$0	-$484,065	-100.0%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$2,476	-100.0%	$0	-$2,476	-100.0%
Freshwater Net	$73,241	$10,966	17.6%	$171,006	$7,368	4.5%	$3,812	-$181	-4.5%	$248,059	$18,152	7.9%
Tribal Subtotal	$73,241	-$188,974	-72.1%	$171,006	-$219,170	-56.2%	$3,812	-$60,246	-94.0%	$248,059	-$468,389	-65.4%
Total	$74,653	-$230,700	-75.6%	$171,006	-$237,195	-58.1%	$10,082	-$59,108	-85.4%	$255,741	-$527,003	-67.3%
Sockeye												
Non-tribal												
Marine Net	$0	-$1,645,275	-100.0%	$0	$0	0.0%	$0	$0	0.0%	$0	-$1,645,275	-100.0%
Tribal												
Marine Net	$0	-$1,705,423	-100.0%	$0	$0	0.0%	$0	-$176,268	-100.0%	$0	-$1,881,691	-100.0%
Freshwater Net	$0	-$1,052	-100.0%	$0	-$200,655	-100.0%	$0	$0	0.0%	$0	-$201,706	-100.0%
Tribal Subtotal	$0	-$1,706,475	-100.0%	$0	-$200,655	-100.0%	$0	-$176,268	-100.0%	$0	-$2,083,397	-100.0%
Total	$0	-$3,351,750	-100.0%	$0	-$200,655	-100.0%	$0	-$176,268	-100.0%	$0	-$3,728,672	-100.0%
Pink												
Non-tribal												
Marine Net	$0	-$464,039	-100.0%	$0	-$2,899	-100.0%	$0	$0	0.0%	$0	-$466,938	-100.0%
Tribal												
Marine Net	$0	-$447,269	-100.0%	$0	-$18,767	-100.0%	$0	-$897	-100.0%	$0	-$466,933	-100.0%
Freshwater Net	$49,540	$21,959	79.6%	$15,508	$15,407	15257.6%	$0	$0	0.0%	$65,048	$37,366	135.0%
Tribal Subtotal	$49,540	-$425,310	-89.6%	$15,508	-$3,360	-17.8%	$0	-$897	-100.0%	$65,048	-$429,567	-86.8%
Total	$49,540	-$889,349	-94.7%	$15,508	-$6,259	-28.8%	$0	-$897	-100.0%	$65,048	-$896,505	-93.2%
Chum												
Non-tribal												
Marine Net	$0	-$253,084	-100.0%	$0	-$583,952	-100.0%	$0	$0	0.0%	$0	-$837,036	-100.0%
Tribal												
Marine Net	$0	-$213,013	-100.0%	$0	-$490,939	-100.0%	$0	-$22,672	-100.0%	$0	-$726,624	-100.0%
Freshwater Net	$4,817	-$139,061	-96.7%	$391,545	$185,078	89.6%	$5	$5	0.0%	$396,366	$46,023	13.1%
Tribal Subtotal	$4,817	-$352,075	-98.7%	$391,545	-$305,860	-43.9%	$5	-$22,667	-100.0%	$396,366	-$680,602	-63.2%
Total	$4,817	-$605,158	-99.2%	$391,545	-$889,812	-69.4%	$5	-$22,667	-100.0%	$396,366	-$1,517,637	-79.3%
Steelhead												
Non-tribal												
Marine Net	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%
Tribal												
Marine Net	$0	-$1,668	-100.0%	$0	-$41	-100.0%	$0	-$704	-100.0%	$0	-$2,413	-100.0%
Freshwater Net	$1,057	-$107	-9.2%	$3,041	-$14	-0.5%	$2,840	-$47	-1.6%	$6,938	-$168	-2.4%
Tribal Subtotal	$1,057	-$1,775	-62.7%	$3,041	-$55	-1.8%	$2,840	-$750	-20.9%	$6,938	-$2,580	-27.1%
Total	$1,057	-$1,775	-62.7%	$3,041	-$55	-1.8%	$2,840	-$750	-20.9%	$6,938	-$2,580	-27.1%
Total												
Non-tribal												
Marine Net	1,434	-2,636,064	-99.9%	0	-627,257	-100.0%	6,270	1,138	22.2%	7,704	-3,262,183	-99.8%
Tribal												
Marine Net	81,587	-2,769,434	-97.1%	0	-882,030	-100.0%	0	-272,661	-100.0%	81,587	-3,924,126	-98.0%
Marine Troll	0	0	0.0%	0	0	0.0%	0	-13,349	-100.0%	0	-13,349	-100.0%
Freshwater Net	134,685	-123,860	-47.9%	914,493	66,170	7.8%	6,658	-244	-3.5%	1,055,836	-57,933	-5.2%
Tribal Subtotal	216,272	-2,893,294	-93.0%	914,493	-815,860	-47.1%	6,658	-286,254	-97.7%	1,137,423	-3,995,408	-77.8%
Total	217,706	-5,529,358	-96.2%	914,493	-1,443,117	-61.2%	12,928	-285,117	-95.7%	1,145,127	-7,257,591	-86.4%

Table D-11. Estimated ex-vessel value of commercial landings (in 2002 dollars) in the economic regions with implementation of the alternatives.
Scenario B: 2003 abundance with Maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 3 - Escapement Goal Management at the Population Level/Terminal Fisheries Only											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Specie	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number		Change from Baseline (%)	Number	Change from Baseline	% Change
Chinook												
Non-tribal												
Marine Net	$22	-$231,941	-100.0%	$0	-$22,380	-100.0%	$0	$0	0.0%	$22	-$254,321	-100.0%
Tribal												
Marine Net	$0	-$283,709	-100.0%	$0	-$145,746	-100.0%	$0	-$14,533	-100.0%	$0	-$443,988	-100.0%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$10,873	-100.0%	$0	-$10,873	-100.0%
Freshwater Net	$0	-$22,595	-100.0%	$333,393	$58,986	21.5%	$0	-$21	-100.0%	$333,393	$36,369	12.2%
Tribal Subtotal	$0	-$306,304	-100.0%	$333,393	-$86,760	-20.6%	$0	-$25,427	-100.0%	$333,393	-$418,491	-55.7%
Total	$22	-$538,245	-100.0%	$333,393	-$109,140	-24.7%	$0	-$25,427	-100.0%	$333,415	-$672,812	-66.9%
Coho												
Non-tribal												
Marine Net	$1,412	-$41,726	-96.7%	$0	-$18,026	-100.0%	$6,270	$1,138	22.2%	$7,682	-$58,614	-88.4%
Tribal												
Marine Net	$0	-$199,939	-100.0%	$0	-$226,537	-100.0%	$0	-$57,588	-100.0%	$0	-$484,065	-100.0%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$2,476	-100.0%	$0	-$2,476	-100.0%
Freshwater Net	$316	-$61,959	-99.5%	$171,006	$7,368	4.5%	$3,812	-$181	-4.5%	$175,135	-$54,772	-23.8%
Tribal Subtotal	$316	-$261,898	-99.9%	$171,006	-$219,170	-56.2%	$3,812	-$60,246	-94.0%	$175,135	-$541,314	-75.6%
Total	$1,728	-$303,624	-99.4%	$171,006	-$237,195	-58.1%	$10,082	-$59,108	-85.4%	$182,817	-$599,927	-76.6%
Sockeye												
Non-tribal												
Marine Net	$0	-$1,645,275	-100.0%	$0	$0	0.0%	$0	$0	0.0%	$0	-$1,645,275	-100.0%
Tribal												
Marine Net	$0	-$1,705,423	-100.0%	$0	$0	0.0%	$0	-$176,268	-100.0%	$0	-$1,881,691	-100.0%
Freshwater Net	$0	-$1,052	-100.0%	$0	-$200,655	-100.0%	$0	$0	0.0%	$0	-$201,706	-100.0%
Tribal Subtotal	$0	-$1,706,475	-100.0%	$0	-$200,655	-100.0%	$0	-$176,268	-100.0%	$0	-$2,083,397	-100.0%
Total	$0	-$3,351,750	-100.0%	$0	-$200,655	-100.0%	$0	-$176,268	-100.0%	$0	-$3,728,672	-100.0%
Pink												
Non-tribal												
Marine Net	$0	-$464,039	-100.0%	$0	-$2,899	-100.0%	$0	$0	0.0%	$0	-$466,938	-100.0%
Tribal												
Marine Net	$0	-$447,269	-100.0%	$0	-$18,767	-100.0%	$0	-$897	-100.0%	$0	-$466,933	-100.0%
Freshwater Net	$0	-$27,581	-100.0%	$15,508	$15,407	15257.6%	$0	$0	0.0%	$15,508	-$12,174	-44.0%
Tribal Subtotal	$0	-$474,850	-100.0%	$15,508	-$3,360	-17.8%	$0	-$897	-100.0%	$15,508	-$479,106	-96.9%
Total	$0	-$938,889	-100.0%	$15,508	-$6,259	-28.8%	$0	-$897	-100.0%	$15,508	-$946,044	-98.4%
Chum												
Non-tribal												
Marine Net	$0	-$253,084	-100.0%	$0	-$583,952	-100.0%	$0	$0	0.0%	$0	-$837,036	-100.0%
Tribal												
Marine Net	$0	-$213,013	-100.0%	$0	-$490,939	-100.0%	$0	-$22,672	-100.0%	$0	-$726,624	-100.0%
Freshwater Net	$2,816	-$141,062	-98.0%	$391,545	$185,078	89.6%	$5	$5	0.0%	$394,366	$44,022	12.6%
Tribal Subtotal	$2,816	-$354,075	-99.2%	$391,545	-$305,860	-43.9%	$5	-$22,667	-100.0%	$394,366	-$682,602	-63.4%
Total	$2,816	-$607,159	-99.5%	$391,545	-$889,812	-69.4%	$5	-$22,667	-100.0%	$394,366	-$1,519,638	-79.4%
Steelhead												
Non-tribal												
Marine Net	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%
Tribal												
Marine Net	$0	-$1,668	-100.0%	$0	-$41	-100.0%	$0	-$704	-100.0%	$0	-$2,413	-100.0%
Freshwater Net	$1,057	-$107	-9.2%	$3,041	-$14	-0.5%	$2,840	-$47	-1.6%	$6,938	-$168	-2.4%
Tribal Subtotal	$1,057	-$1,775	-62.7%	$3,041	-$55	-1.8%	$2,840	-$750	-20.9%	$6,938	-$2,580	-27.1%
Total	$1,057	-$1,775	-62.7%	$3,041	-$55	-1.8%	$2,840	-$750	-20.9%	$6,938	-$2,580	-27.1%
Total												
Non-tribal												
Marine Net	1,434	-2,636,064	-99.9%	0	-627,257	-100.0%	6,270	1,138	22.2%	7,704	-3,262,183	-99.8%
Tribal												
Marine Net	0	-2,851,022	-100.0%	0	-882,030	-100.0%	0	-272,661	-100.0%	0	-4,005,713	-100.0%
Marine Troll	0	0	0.0%	0	0	0.0%	0	-13,349	-100.0%	0	-13,349	-100.0%
Freshwater Net	4,189	-254,356	-98.4%	914,493	66,170	7.8%	6,658	-244	-3.5%	925,340	-188,429	-16.9%
Tribal Subtotal	4,189	-3,105,377	-99.9%	914,493	-815,860	-47.1%	6,658	-286,254	-97.7%	925,340	-4,207,491	-82.0%
Total	5,623	-5,741,441	-99.9%	914,493	-1,443,117	-61.2%	12,928	-285,117	-95.7%	933,044	-7,469,674	-88.9%

Table D-11. Estimated ex-vessel value of commercial landings (in 2002 dollars) in the economic regions with implementation of the alternatives. Scenario B: 2003 abundance with Maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 4 - No Fishing											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Specie	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number		Change from Baseline (%)	Number	Change from Baseline	% Change
Chinook												
Non-tribal												
Marine Net	$0	-$231,962	-100.0%	$0	-$22,380	-100.0%	$0	$0	0.0%	$0	-$254,342	-100.0%
Tribal												
Marine Net	$0	-$283,709	-100.0%	$0	-$145,746	-100.0%	$0	-$14,533	-100.0%	$0	-$443,988	-100.0%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$10,873	-100.0%	$0	-$10,873	-100.0%
Freshwater Net	$0	-$22,595	-100.0%	$0	-$274,408	-100.0%	$0	-$21	-100.0%	$0	-$297,024	-100.0%
Tribal Subtotal	$0	-$306,304	-100.0%	$0	-$420,154	-100.0%	$0	-$25,427	-100.0%	$0	-$751,885	-100.0%
Total	$0	-$538,266	-100.0%	$0	-$442,534	-100.0%	$0	-$25,427	-100.0%	$0	-$1,006,227	-100.0%
Coho												
Non-tribal												
Marine Net	$0	-$43,138	-100.0%	$0	-$18,026	-100.0%	$0	-$5,132	-100.0%	$0	-$66,296	-100.0%
Tribal												
Marine Net	$0	-$199,939	-100.0%	$0	-$226,537	-100.0%	$0	-$57,588	-100.0%	$0	-$484,065	-100.0%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$2,476	-100.0%	$0	-$2,476	-100.0%
Freshwater Net	$0	-$62,275	-100.0%	$0	-$163,639	-100.0%	$0	-$3,993	-100.0%	$0	-$229,907	-100.0%
Tribal Subtotal	$0	-$262,214	-100.0%	$0	-$390,176	-100.0%	$0	-$64,058	-100.0%	$0	-$716,448	-100.0%
Total	$0	-$305,352	-100.0%	$0	-$408,202	-100.0%	$0	-$69,190	-100.0%	$0	-$782,744	-100.0%
Sockeye												
Non-tribal												
Marine Net	$0	-$1,645,275	-100.0%	$0	$0	0.0%	$0	$0	0.0%	$0	-$1,645,275	-100.0%
Tribal												
Marine Net	$0	-$1,705,423	-100.0%	$0	$0	0.0%	$0	-$176,268	-100.0%	$0	-$1,881,691	-100.0%
Freshwater Net	$0	-$1,052	-100.0%	$0	-$200,655	-100.0%	$0	$0	0.0%	$0	-$201,706	-100.0%
Tribal Subtotal	$0	-$1,706,475	-100.0%	$0	-$200,655	-100.0%	$0	-$176,268	-100.0%	$0	-$2,083,397	-100.0%
Total	$0	-$3,351,750	-100.0%	$0	-$200,655	-100.0%	$0	-$176,268	-100.0%	$0	-$3,728,672	-100.0%
Pink												
Non-tribal												
Marine Net	$0	-$464,039	-100.0%	$0	-$2,899	-100.0%	$0	$0	0.0%	$0	-$466,938	-100.0%
Tribal												
Marine Net	$0	-$447,269	-100.0%	$0	-$18,767	-100.0%	$0	-$897	-100.0%	$0	-$466,933	-100.0%
Freshwater Net	$0	-$27,581	-100.0%	$0	-$101	-100.0%	$0	$0	0.0%	$0	-$27,682	-100.0%
Tribal Subtotal	$0	-$474,850	-100.0%	$0	-$18,868	-100.0%	$0	-$897	-100.0%	$0	-$494,614	-100.0%
Total	$0	-$938,889	-100.0%	$0	-$21,767	-100.0%	$0	-$897	-100.0%	$0	-$961,552	-100.0%
Chum												
Non-tribal												
Marine Net	$0	-$253,084	-100.0%	$0	-$583,952	-100.0%	$0	$0	0.0%	$0	-$837,036	-100.0%
Tribal												
Marine Net	$0	-$213,013	-100.0%	$0	-$490,939	-100.0%	$0	-$22,672	-100.0%	$0	-$726,624	-100.0%
Freshwater Net	$2,816	-$141,062	-98.0%	$97,878	-$108,588	-52.6%	$5	$5	0.0%	$100,699	-$249,645	-71.3%
Tribal Subtotal	$2,816	-$354,075	-99.2%	$97,878	-$599,527	-86.0%	$5	-$22,667	-100.0%	$100,699	-$976,269	-90.6%
Total	$2,816	-$607,159	-99.5%	$97,878	-$1,183,479	-92.4%	$5	-$22,667	-100.0%	$100,699	-$1,813,305	-94.7%
Steelhead												
Non-tribal												
Marine Net	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%
Tribal												
Marine Net	$0	-$1,668	-100.0%	$0	-$41	-100.0%	$0	-$704	-100.0%	$0	-$2,413	-100.0%
Freshwater Net	$1,057	-$107	-9.2%	$2,384	-$671	-22.0%	$2,836	-$51	-1.8%	$6,277	-$829	-11.7%
Tribal Subtotal	$1,057	-$1,775	-62.7%	$2,384	-$712	-23.0%	$2,836	-$755	-21.0%	$6,277	-$3,242	-34.1%
Total	$1,057	-$1,775	-62.7%	$2,384	-$712	-23.0%	$2,836	-$755	-21.0%	$6,277	-$3,242	-34.1%
Total												
Non-tribal												
Marine Net	0	-2,637,498	-100.0%	0	-627,257	-100.0%	0	-5,132	-100.0%	0	-3,269,887	-100.0%
Tribal												
Marine Net	0	-2,851,022	-100.0%	0	-882,030	-100.0%	0	-272,661	-100.0%	0	-4,005,713	-100.0%
Marine Troll	0	0	0.0%	0	0	0.0%	0	-13,349	-100.0%	0	-13,349	-100.0%
Freshwater Net	3,873	-254,672	-98.5%	100,262	-748,061	-88.2%	2,841	-4,061	-58.8%	106,976	-1,006,793	-90.4%
Tribal Subtotal	3,873	-3,105,693	-99.9%	100,262	-1,630,091	-94.2%	2,841	-290,071	-99.0%	106,976	-5,025,855	-97.9%
Total	3,873	-5,743,191	-99.9%	100,262	-2,257,348	-95.7%	2,841	-295,203	-99.0%	106,976	-8,295,742	-98.7%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-12. Estimated ex-processor value of commercial landings (in 2002 Dollars) in the economic regions with implementation of the alternatives.
Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

	Ex-Processor Price Per Round Pound			Alternative 1 - Proposed Action/Status Quo			
Specie	North Puget Sound	SPS/SHC*	SJF/ NHC*	North Puget Sound	SPS/SHC*	SJF/ NHC*	State Total
Chinook							
Non-tribal							
Marine Net	$1.02	$1.34	$1.20	$292,100	$37,024	$0	$329,124
Tribal							
Marine Net	$1.02	$1.34	$1.20	$357,263	$241,111	$21,530	$619,904
Marine Troll	$1.34	$1.66	$1.52	$0	$0	$20,403	$20,403
Freshwater Net	$1.02	$1.34	$1.20	$36,583	$583,661	$41	$620,284
Tribal Subtotal	NA	NA	NA	$393,846	$824,771	$41,973	$1,260,591
Total	NA	NA	NA	$685,946	$861,795	$41,973	$1,589,715
Coho							
Non-tribal							
Marine Net	$0.94	$1.16	$1.00	$86,276	$44,489	$10,920	$141,685
Tribal							
Marine Net	$0.94	$1.16	$1.00	$399,879	$559,113	$122,528	$1,081,520
Marine Troll	$0.61	$0.61	$1.00	$0	$0	$5,269	$5,269
Freshwater Net	$0.94	$1.16	$1.00	$142,777	$462,978	$9,740	$615,494
Tribal Subtotal	NA	NA	NA	$542,655	$1,022,091	$137,537	$1,702,283
Total	NA	NA	NA	$628,932	$1,066,580	$148,457	$1,843,968
Sockeye							
Non-tribal							
Marine Net	$1.50	$1.50	$1.46	$2,056,594	$0	$0	$2,056,594
Tribal							
Marine Net	$1.50	$1.50	$1.46	$2,131,779	$0	$214,459	$2,346,238
Freshwater Net	$1.50	$1.50	$1.46	$1,924	$367,052	$0	$368,975
Tribal Subtotal	NA	NA	NA	$2,133,703	$367,052	$214,459	$2,715,213
Total	NA	NA	NA	$4,190,297	$367,052	$214,459	$4,771,807
Pink							
Non-tribal							
Marine Net	$0.71	$1.46	$1.31	$1,938,045	$24,898	$0	$1,962,943
Tribal							
Marine Net	$0.71	$1.46	$1.31	$1,868,006	$161,173	$6,912	$2,036,090
Freshwater Net	$0.71	$1.46	$1.31	$130,549	$983	$0	$131,532
Tribal Subtotal	NA	NA	NA	$1,998,555	$162,156	$6,912	$2,167,622
Total	NA	NA	NA	$3,936,600	$187,054	$6,912	$4,130,565
Chum							
Non-tribal							
Marine Net	$0.79	$0.76	$1.00	$833,067	$1,849,182	$0	$2,682,249
Tribal							
Marine Net	$0.79	$0.76	$1.00	$701,169	$1,554,639	$94,468	$2,350,276
Freshwater Net	$0.79	$0.76	$1.00	$473,597	$653,809	$0	$1,127,407
Tribal Subtotal	NA	NA	NA	$1,174,766	$2,208,448	$94,468	$3,477,683
Total	NA	NA	NA	$2,007,833	$4,057,630	$94,468	$6,159,931
Steelhead							
Non-tribal							
Marine Net	$0.71	$1.46	$1.31	$0	$0	$0	$0
Tribal							
Marine Net	$0.71	$1.46	$1.31	$1,538	$78	$1,197	$2,813
Freshwater Net	$0.71	$1.46	$1.31	$1,234	$6,656	$5,645	$13,535
Tribal Subtotal	NA	NA	NA	$2,771	$6,735	$6,842	$16,348
Total	NA	NA	NA	$2,771	$6,735	$6,842	$16,348
Total							
Non-tribal							
Marine Net	NA	NA	NA	5,206,082	1,955,593	10,920	7,172,595
Tribal							
Marine Net	NA	NA	NA	5,459,633	2,516,114	461,094	8,436,841
Marine Troll	NA	NA	NA	0	0	25,672	25,672
Freshwater Net	NA	NA	NA	786,664	2,075,139	15,425	2,877,228
Tribal Subtotal	NA	NA	NA	6,246,297	4,591,253	502,191	11,339,741
Total	NA	NA	NA	11,452,379	6,546,846	513,111	18,512,335

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-12. Estimated ex-processor value of commercial landings (in 2002 Dollars) in the economic regions with implementation of the alterantives.
Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 2 - Escapement Goal Management at the Management Unit Level											
	North Puget Sound			**SPS/SHC***			**SJF/NHC***			**State**		
Specie	**Number**	**Change from Baseline**	**% Change**	**Number**	**Change from Baseline**	**% Change**	**Number**	**Change from Baseline**	**% Change**	**Number**	**Change from Baseline**	**% Change**
Chinook												
Non-tribal												
Marine Net	$27	-$292,073	-100.0%	$0	-$37,024	-100.0%	$0	$0	0.0%	$27	-$329,097	-100.0%
Tribal												
Marine Net	$102,739	-$254,524	-71.2%	$0	-$241,111	-100.0%	$0	-$21,530	-100.0%	$102,739	-$517,164	-83.4%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$20,403	-100.0%	$0	-$20,403	-100.0%
Freshwater Net	$9,765	-$26,818	-73.3%	$709,122	$125,462	21.5%	$0	-$41	-100.0%	$718,887	$98,603	15.9%
Tribal Subtotal	$112,504	-$281,342	-71.4%	$709,122	-$115,649	-14.0%	$0	-$41,973	-100.0%	$821,626	-$438,964	-34.8%
Total	$112,531	-$573,415	-83.6%	$709,122	-$152,673	-17.7%	$0	-$41,973	-100.0%	$821,654	-$768,062	-48.3%
Coho												
Non-tribal												
Marine Net	$2,825	-$83,451	-96.7%	$0	-$44,489	-100.0%	$13,340	$2,420	22.2%	$16,165	-$125,520	-88.6%
Tribal												
Marine Net	$0	-$399,879	-100.0%	$0	-$559,113	-100.0%	$0	-$122,528	-100.0%	$0	-$1,081,520	-100.0%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$5,269	-100.0%	$0	-$5,269	-100.0%
Freshwater Net	$167,917	$25,140	17.6%	$483,823	$20,846	4.5%	$9,298	-$442	-4.5%	$661,038	$45,544	7.4%
Tribal Subtotal	$167,917	-$374,738	-69.1%	$483,823	-$538,268	-52.7%	$9,298	-$128,239	-93.2%	$661,038	-$1,041,245	-61.2%
Total	$170,742	-$458,190	-72.9%	$483,823	-$582,757	-54.6%	$22,638	-$125,819	-84.8%	$677,203	-$1,166,765	-63.3%
Sockeye												
Non-tribal												
Marine Net	$0	-$2,056,594	-100.0%	$0	$0	0.0%	$0	$0	0.0%	$0	-$2,056,594	-100.0%
Tribal												
Marine Net	$0	-$2,131,779	-100.0%	$0	$0	0.0%	$0	-$214,459	-100.0%	$0	-$2,346,238	-100.0%
Freshwater Net	$0	-$1,924	-100.0%	$0	-$367,052	-100.0%	$0	$0	0.0%	$0	-$368,975	-100.0%
Tribal Subtotal	$0	-$2,133,703	-100.0%	$0	-$367,052	-100.0%	$0	-$214,459	-100.0%	$0	-$2,715,213	-100.0%
Total	$0	-$4,190,297	-100.0%	$0	-$367,052	-100.0%	$0	-$214,459	-100.0%	$0	-$4,771,807	-100.0%
Pink												
Non-tribal												
Marine Net	$0	-$1,938,045	-100.0%	$0	-$24,898	-100.0%	$0	$0	0.0%	$0	-$1,962,943	-100.0%
Tribal												
Marine Net	$0	-$1,868,006	-100.0%	$0	-$161,173	-100.0%	$0	-$6,912	-100.0%	$0	-$2,036,090	-100.0%
Freshwater Net	$234,487	$103,938	79.6%	$150,946	$149,963	15257.6%	$0	$0	0.0%	$385,433	$253,901	193.0%
Tribal Subtotal	$234,487	-$1,764,067	-88.3%	$150,946	-$11,210	-6.9%	$0	-$6,912	-100.0%	$385,433	-$1,782,189	-82.2%
Total	$234,487	-$3,702,112	-94.0%	$150,946	-$36,108	-19.3%	$0	-$6,912	-100.0%	$385,433	-$3,745,132	-90.7%
Chum												
Non-tribal												
Marine Net	$0	-$833,067	-100.0%	$0	-$1,849,182	-100.0%	$0	$0	0.0%	$0	-$2,682,249	-100.0%
Tribal												
Marine Net	$0	-$701,169	-100.0%	$0	-$1,554,639	-100.0%	$0	-$94,468	-100.0%	$0	-$2,350,276	-100.0%
Freshwater Net	$15,854	-$457,743	-96.7%	$1,239,891	$586,082	89.6%	$22	$22	0.0%	$1,255,768	$128,361	11.4%
Tribal Subtotal	$15,854	-$1,158,912	-98.7%	$1,239,891	-$968,557	-43.9%	$22	-$94,446	-100.0%	$1,255,768	-$2,221,915	-63.9%
Total	$15,854	-$1,991,979	-99.2%	$1,239,891	-$2,817,739	-69.4%	$22	-$94,446	-100.0%	$1,255,768	-$4,904,164	-79.6%
Steelhead												
Non-tribal												
Marine Net	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%
Tribal												
Marine Net	$0	-$1,538	-100.0%	$0	-$78	-100.0%	$0	-$1,197	-100.0%	$0	-$2,813	-100.0%
Freshwater Net	$1,120	-$113	-9.2%	$6,626	-$30	-0.5%	$5,554	-$91	-1.6%	$13,300	-$235	-1.7%
Tribal Subtotal	$1,120	-$1,651	-59.6%	$6,626	-$109	-1.6%	$5,554	-$1,288	-18.8%	$13,300	-$3,048	-18.6%
Total	$1,120	-$1,651	-59.6%	$6,626	-$109	-1.6%	$5,554	-$1,288	-18.8%	$13,300	-$3,048	-18.6%
Total												
Non-tribal												
Marine Net	2,852	-5,203,230	-99.9%	0	-1,955,593	-100.0%	13,340	2,420	22.2%	16,192	-7,156,403	-99.8%
Tribal												
Marine Net	102,739	-5,356,894	-98.1%	0	-2,516,114	-100.0%	0	-461,094	-100.0%	102,739	-8,334,102	-98.8%
Marine Troll	0	0	0.0%	0	0	0.0%	0	-25,672	-100.0%	0	-25,672	-100.0%
Freshwater Net	429,144	-357,520	-45.4%	2,590,409	515,270	24.8%	14,874	-552	-3.6%	3,034,426	157,199	5.5%
Tribal Subtotal	531,883	-5,714,414	-91.5%	2,590,409	-2,000,844	-43.6%	14,874	-487,317	-97.0%	3,137,166	-8,202,575	-72.3%
Total	534,735	-10,917,644	-95.3%	2,590,409	-3,956,437	-60.4%	28,214	-484,897	-94.5%	3,153,358	-15,358,978	-83.0%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-12. Estimated ex-processor value of commercial landings (in 2002 Dollars) in the economic regions with implementation of the alterantives.
Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 3 - Escapement Goal Management at the Population Level/Terminal Fisheries Only											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Specie	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number		Change from Baseline (%)	Number	Change from Baseline	% Change
Chinook												
Non-tribal												
Marine Net	$27	-$292,073	-100.0%	$0	-$37,024	-100.0%	$0	$0	0.0%	$27	-$329,097	-100.0%
Tribal												
Marine Net	$0	-$357,263	-100.0%	$0	-$241,111	-100.0%	$0	-$21,530	-100.0%	$0	-$619,904	-100.0%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$20,403	-100.0%	$0	-$20,403	-100.0%
Freshwater Net	$0	-$36,583	-100.0%	$709,122	$125,462	21.5%	$0	-$41	-100.0%	$709,122	$88,838	14.3%
Tribal Subtotal	$0	-$393,846	-100.0%	$709,122	-$115,649	-14.0%	$0	-$41,973	-100.0%	$709,122	-$551,468	-43.7%
Total	$27	-$685,919	-100.0%	$709,122	-$152,673	-17.7%	$0	-$41,973	-100.0%	$709,150	-$880,566	-55.4%
Coho												
Non-tribal												
Marine Net	$2,825	-$83,451	-96.7%	$0	-$44,489	-100.0%	$13,340	$2,420	22.2%	$16,165	-$125,520	-88.6%
Tribal												
Marine Net	$0	-$399,879	-100.0%	$0	-$559,113	-100.0%	$0	-$122,528	-100.0%	$0	-$1,081,520	-100.0%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$5,269	-100.0%	$0	-$5,269	-100.0%
Freshwater Net	$725	-$142,052	-99.5%	$483,823	$20,846	4.5%	$9,298	-$442	-4.5%	$493,845	-$121,649	-19.8%
Tribal Subtotal	$725	-$541,931	-99.9%	$483,823	-$538,268	-52.7%	$9,298	-$128,239	-93.2%	$493,845	-$1,208,438	-71.0%
Total	$3,549	-$625,382	-99.4%	$483,823	-$582,757	-54.6%	$22,638	-$125,819	-84.8%	$510,010	-$1,333,958	-72.3%
Sockeye												
Non-tribal												
Marine Net	$0	-$2,056,594	-100.0%	$0	$0	0.0%	$0	$0	0.0%	$0	-$2,056,594	-100.0%
Tribal												
Marine Net	$0	-$2,131,779	-100.0%	$0	$0	0.0%	$0	-$214,459	-100.0%	$0	-$2,346,238	-100.0%
Freshwater Net	$0	-$1,924	-100.0%	$0	-$367,052	-100.0%	$0	$0	0.0%	$0	-$368,975	-100.0%
Tribal Subtotal	$0	-$2,133,703	-100.0%	$0	-$367,052	-100.0%	$0	-$214,459	-100.0%	$0	-$2,715,213	-100.0%
Total	$0	-$4,190,297	-100.0%	$0	-$367,052	-100.0%	$0	-$214,459	-100.0%	$0	-$4,771,807	-100.0%
Pink												
Non-tribal												
Marine Net	$0	-$1,938,045	-100.0%	$0	-$24,898	-100.0%	$0	$0	0.0%	$0	-$1,962,943	-100.0%
Tribal												
Marine Net	$0	-$1,868,006	-100.0%	$0	-$161,173	-100.0%	$0	-$6,912	-100.0%	$0	-$2,036,090	-100.0%
Freshwater Net	$0	-$130,549	-100.0%	$150,946	$149,963	15257.6%	$0	$0	0.0%	$150,946	$19,414	14.8%
Tribal Subtotal	$0	-$1,998,555	-100.0%	$150,946	-$11,210	-6.9%	$0	-$6,912	-100.0%	$150,946	-$2,016,676	-93.0%
Total	$0	-$3,936,600	-100.0%	$150,946	-$36,108	-19.3%	$0	-$6,912	-100.0%	$150,946	-$3,979,619	-96.3%
Chum												
Non-tribal												
Marine Net	$0	-$833,067	-100.0%	$0	-$1,849,182	-100.0%	$0	$0	0.0%	$0	-$2,682,249	-100.0%
Tribal												
Marine Net	$0	-$701,169	-100.0%	$0	-$1,554,639	-100.0%	$0	-$94,468	-100.0%	$0	-$2,350,276	-100.0%
Freshwater Net	$9,269	-$464,328	-98.0%	$1,239,891	$586,082	89.6%	$22	$22	0.0%	$1,249,182	$121,775	10.8%
Tribal Subtotal	$9,269	-$1,165,498	-99.2%	$1,239,891	-$968,557	-43.9%	$22	-$94,446	-100.0%	$1,249,182	-$2,228,501	-64.1%
Total	$9,269	-$1,998,564	-99.5%	$1,239,891	-$2,817,739	-69.4%	$22	-$94,446	-100.0%	$1,249,182	-$4,910,749	-79.7%
Steelhead												
Non-tribal												
Marine Net	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%
Tribal												
Marine Net	$0	-$1,538	-100.0%	$0	-$78	-100.0%	$0	-$1,197	-100.0%	$0	-$2,813	-100.0%
Freshwater Net	$1,120	-$113	-9.2%	$6,626	-$30	-0.5%	$5,554	-$91	-1.6%	$13,300	-$235	-1.7%
Tribal Subtotal	$1,120	-$1,651	-59.6%	$6,626	-$109	-1.6%	$5,554	-$1,288	-18.8%	$13,300	-$3,048	-18.6%
Total	$1,120	-$1,651	-59.6%	$6,626	-$109	-1.6%	$5,554	-$1,288	-18.8%	$13,300	-$3,048	-18.6%
Total												
Non-tribal												
Marine Net	2,852	-5,203,230	-99.9%	0	-1,955,593	-100.0%	13,340	2,420	22.2%	16,192	-7,156,403	-99.8%
Tribal												
Marine Net	0	-5,459,633	-100.0%	0	-2,516,114	-100.0%	0	-461,094	-100.0%	0	-8,436,841	-100.0%
Marine Troll	0	0	0.0%	0	0	0.0%	0	-25,672	-100.0%	0	-25,672	-100.0%
Freshwater Net	11,113	-775,550	-98.6%	2,590,409	515,270	24.8%	14,874	-552	-3.6%	2,616,396	-260,832	-9.1%
Tribal Subtotal	11,113	-6,235,184	-99.8%	2,590,409	-2,000,844	-43.6%	14,874	-487,317	-97.0%	2,616,396	-8,723,345	-76.9%
Total	13,965	-11,438,414	-99.9%	2,590,409	-3,956,437	-60.4%	28,214	-484,897	-94.5%	2,632,588	-15,879,747	-85.8%

Table D-12. Estimated ex-processor value of commercial landings (in 2002 Dollars) in the economic regions with implementation of the alterantives.
Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 4 - No Fishing											
	North Puget Sound			**SPS/SHC***			**SJF/NHC***			**State**		
Specie	**Number**	**Change from Baseline**	**% Change**	**Number**	**Change from Baseline**	**% Change**	**Number**		**Change from Baseline (%)**	**Number**	**Change from Baseline**	**% Change**
Chinook												
Non-tribal												
Marine Net	$0	-$292,100	-100.0%	$0	-$37,024	-100.0%	$0	$0	0.0%	$0	-$329,124	-100.0%
Tribal												
Marine Net	$0	-$357,263	-100.0%	$0	-$241,111	-100.0%	$0	-$21,530	-100.0%	$0	-$619,904	-100.0%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$20,403	-100.0%	$0	-$20,403	-100.0%
Freshwater Net	$0	-$36,583	-100.0%	$0	-$583,661	-100.0%	$0	-$41	-100.0%	$0	-$620,284	-100.0%
Tribal Subtotal	$0	-$393,846	-100.0%	$0	-$824,771	-100.0%	$0	-$41,973	-100.0%	$0	-$1,260,591	-100.0%
Total	$0	-$685,946	-100.0%	$0	-$861,795	-100.0%	$0	-$41,973	-100.0%	$0	-$1,589,715	-100.0%
Coho												
Non-tribal												
Marine Net	$0	-$86,276	-100.0%	$0	-$44,489	-100.0%	$0	-$10,920	-100.0%	$0	-$141,685	-100.0%
Tribal												
Marine Net	$0	-$399,879	-100.0%	$0	-$559,113	-100.0%	$0	-$122,528	-100.0%	$0	-$1,081,520	-100.0%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$5,269	-100.0%	$0	-$5,269	-100.0%
Freshwater Net	$0	-$142,777	-100.0%	$0	-$462,978	-100.0%	$0	-$9,740	-100.0%	$0	-$615,494	-100.0%
Tribal Subtotal	$0	-$542,655	-100.0%	$0	-$1,022,091	-100.0%	$0	-$137,537	-100.0%	$0	-$1,702,283	-100.0%
Total	$0	-$628,932	-100.0%	$0	-$1,066,580	-100.0%	$0	-$148,457	-100.0%	$0	-$1,843,968	-100.0%
Sockeye												
Non-tribal												
Marine Net	$0	-$2,056,594	-100.0%	$0	$0	0.0%	$0	$0	0.0%	$0	-$2,056,594	-100.0%
Tribal												
Marine Net	$0	-$2,131,779	-100.0%	$0	$0	0.0%	$0	-$214,459	-100.0%	$0	-$2,346,238	-100.0%
Freshwater Net	$0	-$1,924	-100.0%	$0	-$367,052	-100.0%	$0	$0	0.0%	$0	-$368,975	-100.0%
Tribal Subtotal	$0	-$2,133,703	-100.0%	$0	-$367,052	-100.0%	$0	-$214,459	-100.0%	$0	-$2,715,213	-100.0%
Total	$0	-$4,190,297	-100.0%	$0	-$367,052	-100.0%	$0	-$214,459	-100.0%	$0	-$4,771,807	-100.0%
Pink												
Non-tribal												
Marine Net	$0	-$1,938,045	-100.0%	$0	-$24,898	-100.0%	$0	$0	0.0%	$0	-$1,962,943	-100.0%
Tribal												
Marine Net	$0	-$1,868,006	-100.0%	$0	-$161,173	-100.0%	$0	-$6,912	-100.0%	$0	-$2,036,090	-100.0%
Freshwater Net	$0	-$130,549	-100.0%	$0	-$983	-100.0%	$0	$0	0.0%	$0	-$131,532	-100.0%
Tribal Subtotal	$0	-$1,998,555	-100.0%	$0	-$162,156	-100.0%	$0	-$6,912	-100.0%	$0	-$2,167,622	-100.0%
Total	$0	-$3,936,600	-100.0%	$0	-$187,054	-100.0%	$0	-$6,912	-100.0%	$0	-$4,130,565	-100.0%
Chum												
Non-tribal												
Marine Net	$0	-$833,067	-100.0%	$0	-$1,849,182	-100.0%	$0	$0	0.0%	$0	-$2,682,249	-100.0%
Tribal												
Marine Net	$0	-$701,169	-100.0%	$0	-$1,554,639	-100.0%	$0	-$94,468	-100.0%	$0	-$2,350,276	-100.0%
Freshwater Net	$9,269	-$464,328	-98.0%	$309,947	-$343,862	-52.6%	$22	$22	0.0%	$319,238	-$808,168	-71.7%
Tribal Subtotal	$9,269	-$1,165,498	-99.2%	$309,947	-$1,898,501	-86.0%	$22	-$94,446	-100.0%	$319,238	-$3,158,445	-90.8%
Total	$9,269	-$1,998,564	-99.5%	$309,947	-$3,747,683	-92.4%	$22	-$94,446	-100.0%	$319,238	-$5,840,693	-94.8%
Steelhead												
Non-tribal												
Marine Net	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%
Tribal												
Marine Net	$0	-$1,538	-100.0%	$0	-$78	-100.0%	$0	-$1,197	-100.0%	$0	-$2,813	-100.0%
Freshwater Net	$1,120	-$113	-9.2%	$5,195	-$1,461	-22.0%	$5,545	-$100	-1.8%	$11,860	-$1,675	-12.4%
Tribal Subtotal	$1,120	-$1,651	-59.6%	$5,195	-$1,540	-22.9%	$5,545	-$1,297	-19.0%	$11,860	-$4,488	-27.5%
Total	$1,120	-$1,651	-59.6%	$5,195	-$1,540	-22.9%	$5,545	-$1,297	-19.0%	$11,860	-$4,488	-27.5%
Total												
Non-tribal												
Marine Net	0	-5,206,082	-100.0%	0	-1,955,593	-100.0%	0	-10,920	-100.0%	0	-7,172,595	-100.0%
Tribal												
Marine Net	0	-5,459,633	-100.0%	0	-2,516,114	-100.0%	0	-461,094	-100.0%	0	-8,436,841	-100.0%
Marine Troll	0	0	0.0%	0	0	0.0%	0	-25,672	-100.0%	0	-25,672	-100.0%
Freshwater Net	10,389	-776,275	-98.7%	315,142	-1,759,996	-84.8%	5,567	-9,858	-63.9%	331,098	-2,546,129	-88.5%
Tribal Subtotal	10,389	-6,235,908	-99.8%	315,142	-4,276,111	-93.1%	5,567	-496,624	-98.9%	331,098	-11,008,642	-97.1%
Total	10,389	-11,441,990	-99.9%	315,142	-6,231,703	-95.2%	5,567	-507,544	-98.9%	331,098	-18,181,237	-98.2%

Table D-13. Direct changes in harvesting sector jobs (in full- and part-time jobs) caused by changes in commercial landings under the project alternatives.

Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

	Alternative 1 - Proposed Action/Status Quo			
Specie	North Puget Sound	SPS/SHC*	SJF/ NHC*	State Total
Chinook				
Non-tribal				
Marine Net	84.7	8.2	0.0	92.8
Tribal				
Marine Net	143.8	73.9	7.4	225.1
Marine Troll	0.0	0.0	5.5	5.5
Freshwater Net	11.5	139.1	0.0	150.6
Tribal Subtotal	155.3	213.0	12.9	381.2
Total	240.0	221.2	12.9	474.0
Coho				
Non-tribal				
Marine Net	15.7	6.6	1.9	24.2
Tribal				
Marine Net	101.4	114.9	29.2	245.4
Marine Troll	0.0	0.0	1.3	1.3
Freshwater Net	31.6	83.0	2.0	116.6
Tribal Subtotal	132.9	197.8	32.5	363.2
Total	148.7	204.4	34.4	387.4
Sockeye				
Non-tribal				
Marine Net	600.5	0.0	0.0	600.5
Tribal				
Marine Net	864.6	0.0	89.4	954.0
Freshwater Net	0.5	101.7	0.0	102.3
Tribal Subtotal	865.2	101.7	89.4	1,056.3
Total	1,465.7	101.7	89.4	1,656.8
Pink				
Non-tribal				
Marine Net	169.4	1.1	0.0	170.4
Tribal				
Marine Net	226.8	9.5	0.5	236.7
Freshwater Net	14.0	0.1	0.0	14.0
Tribal Subtotal	240.7	9.6	0.5	250.8
Total	410.1	10.6	0.5	421.2
Chum				
Non-tribal				
Marine Net	92.4	213.1	0.0	305.5
Tribal				
Marine Net	108.0	248.9	11.5	368.4
Freshwater Net	72.9	104.7	0.0	177.6
Tribal Subtotal	180.9	353.6	11.5	546.0
Total	273.3	566.7	11.5	851.5
Steelhead				
Non-tribal				
Marine Net	0.0	0.0	0.0	0.0
Tribal				
Marine Net	0.8	0.0	0.4	1.2
Freshwater Net	0.6	1.5	1.5	3.6
Tribal Subtotal	1.4	1.6	1.8	4.8
Total	1.4	1.6	1.8	4.8
Total				
Non-tribal				
Marine Net	962.7	228.9	1.9	1,193.5
Tribal				
Marine Net	1,445.5	447.2	138.2	2,030.9
Marine Troll	0.0	0.0	6.8	6.8
Freshwater Net	131.1	430.1	3.5	564.7
Tribal Subtotal	1,576.6	877.3	148.5	2,602.3
Total	2,539.2	1,106.2	150.4	3,795.9

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-13. Direct changes in harvesting sector jobs (in full- and part-time jobs) caused by changes in commercial landings under the project alternatives.
Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 2 - Escapement Goal Management at the Management Unit Level											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Specie	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change
Chinook												
Non-tribal												
Marine Net	0.0	-84.7	-100.0%	0.0	-8.2	-100.0%	0.0	0.0	0.0%	0.0	-92.8	-100.0%
Tribal												
Marine Net	41.4	-102.5	-71.2%	0.0	-73.9	-100.0%	0.0	-7.4	-100.0%	41.4	-183.7	-81.6%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-5.5	-100.0%	0.0	-5.5	-100.0%
Freshwater Net	3.1	-8.4	-73.3%	169.0	29.9	21.5%	0.0	0.0	-100.0%	172.1	21.5	14.3%
Tribal Subtotal	44.4	-110.9	-71.4%	169.0	-44.0	-20.6%	0.0	-12.9	-100.0%	213.5	-167.8	-44.0%
Total	44.4	-195.5	-81.5%	169.0	-52.2	-23.6%	0.0	-12.9	-100.0%	213.5	-260.6	-55.0%
Coho												
Non-tribal												
Marine Net	0.5	-15.2	-96.7%	0.0	-6.6	-100.0%	2.3	0.4	22.2%	2.8	-21.4	-88.4%
Tribal												
Marine Net	0.0	-101.4	-100.0%	0.0	-114.9	-100.0%	0.0	-29.2	-100.0%	0.0	-245.4	-100.0%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-1.3	-100.0%	0.0	-1.3	-100.0%
Freshwater Net	37.1	5.6	17.6%	86.7	3.7	4.5%	1.9	-0.1	-4.5%	125.8	9.2	7.9%
Tribal Subtotal	37.1	-95.8	-72.1%	86.7	-111.1	-56.2%	1.9	-30.5	-94.0%	125.8	-237.5	-65.4%
Total	37.6	-111.0	-74.7%	86.7	-117.7	-57.6%	4.2	-30.1	-87.7%	128.6	-258.9	-66.8%
Sockeye												
Non-tribal												
Marine Net	0.0	-600.5	-100.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-600.5	-100.0%
Tribal												
Marine Net	0.0	-864.6	-100.0%	0.0	0.0	0.0%	0.0	-89.4	-100.0%	0.0	-954.0	-100.0%
Freshwater Net	0.0	-0.5	-100.0%	0.0	-101.7	-100.0%	0.0	0.0	0.0%	0.0	-102.3	-100.0%
Tribal Subtotal	0.0	-865.2	-100.0%	0.0	-101.7	-100.0%	0.0	-89.4	-100.0%	0.0	-1,056.3	-100.0%
Total	0.0	-1,465.7	-100.0%	0.0	-101.7	-100.0%	0.0	-89.4	-100.0%	0.0	-1,656.8	-100.0%
Pink												
Non-tribal												
Marine Net	0.0	-169.4	-100.0%	0.0	-1.1	-100.0%	0.0	0.0	0.0%	0.0	-170.4	-100.0%
Tribal												
Marine Net	0.0	-226.8	-100.0%	0.0	-9.5	-100.0%	0.0	-0.5	-100.0%	0.0	-236.7	-100.0%
Freshwater Net	25.1	11.1	79.6%	7.9	7.8	15257.6%	0.0	0.0	0.0%	33.0	18.9	135.0%
Tribal Subtotal	25.1	-215.6	-89.6%	7.9	-1.7	-17.8%	0.0	-0.5	-100.0%	33.0	-217.8	-86.8%
Total	25.1	-385.0	-93.9%	7.9	-2.8	-26.0%	0.0	-0.5	-100.0%	33.0	-388.2	-92.2%
Chum												
Non-tribal												
Marine Net	0.0	-92.4	-100.0%	0.0	-213.1	-100.0%	0.0	0.0	0.0%	0.0	-305.5	-100.0%
Tribal												
Marine Net	0.0	-108.0	-100.0%	0.0	-248.9	-100.0%	0.0	-11.5	-100.0%	0.0	-368.4	-100.0%
Freshwater Net	2.4	-70.5	-96.7%	198.5	93.8	89.6%	0.0	0.0	0.0%	201.0	23.3	13.1%
Tribal Subtotal	2.4	-178.5	-98.7%	198.5	-155.1	-43.9%	0.0	-11.5	-100.0%	201.0	-345.1	-63.2%
Total	2.4	-270.9	-99.1%	198.5	-368.2	-65.0%	0.0	-11.5	-100.0%	201.0	-650.6	-76.4%
Steelhead												
Non-tribal												
Marine Net	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%
Tribal												
Marine Net	0.0	-0.8	-100.0%	0.0	0.0	-100.0%	0.0	-0.4	-100.0%	0.0	-1.2	-100.0%
Freshwater Net	0.5	-0.1	-9.2%	1.5	0.0	-0.5%	1.4	0.0	-1.6%	3.5	-0.1	-2.4%
Tribal Subtotal	0.5	-0.9	-62.7%	1.5	0.0	-1.8%	1.4	-0.4	-20.9%	3.5	-1.3	-27.1%
Total	0.5	-0.9	-62.7%	1.5	0.0	-1.8%	1.4	-0.4	-20.9%	3.5	-1.3	-27.1%
Total												
Non-tribal												
Marine Net	0.5	-962.2	-99.9%	0.0	-228.9	-100.0%	2.3	0.4	22.2%	2.8	-1,190.7	-99.8%
Tribal												
Marine Net	41.4	-1,404.1	-97.1%	0.0	-447.2	-100.0%	0.0	-138.2	-100.0%	41.4	-1,989.5	-98.0%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-6.8	-100.0%	0.0	-6.8	-100.0%
Freshwater Net	68.3	-62.8	-47.9%	463.6	33.5	7.8%	3.4	-0.1	-3.5%	535.3	-29.4	-5.2%
Tribal Subtotal	109.6	-1,466.9	-93.0%	463.6	-413.6	-47.1%	3.4	-145.1	-97.7%	576.7	-2,025.7	-77.8%
Total	110.2	-2,429.1	-95.7%	463.6	-642.6	-58.1%	5.7	-144.7	-96.2%	579.5	-3,216.4	-84.7%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-13. Direct changes in harvesting sector jobs (in full- and part-time jobs) caused by changes in commercial landings under the project alternatives. Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 3 - Escapement Goal Management at the Population Level/Terminal Fisheries Onl											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Specie	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number		Change from Baseline (%)	Number	Change from Baseline	% Change
Chinook												
Non-tribal												
Marine Net	0.0	-84.7	-100.0%	0.0	-8.2	-100.0%	0.0	0.0	0.0%	0.0	-92.8	-100.0%
Tribal												
Marine Net	0.0	-143.8	-100.0%	0.0	-73.9	-100.0%	0.0	-7.4	-100.0%	0.0	-225.1	-100.0%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-5.5	-100.0%	0.0	-5.5	-100.0%
Freshwater Net	0.0	-11.5	-100.0%	169.0	29.9	21.5%	0.0	0.0	-100.0%	169.0	18.4	12.2%
Tribal Subtotal	0.0	-155.3	-100.0%	169.0	-44.0	-20.6%	0.0	-12.9	-100.0%	169.0	-212.2	-55.7%
Total	0.0	-240.0	-100.0%	169.0	-52.2	-23.6%	0.0	-12.9	-100.0%	169.0	-305.0	-64.3%
Coho												
Non-tribal												
Marine Net	0.5	-15.2	-96.7%	0.0	-6.6	-100.0%	2.3	0.4	22.2%	2.8	-21.4	-88.4%
Tribal												
Marine Net	0.0	-101.4	-100.0%	0.0	-114.9	-100.0%	0.0	-29.2	-100.0%	0.0	-245.4	-100.0%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-1.3	-100.0%	0.0	-1.3	-100.0%
Freshwater Net	0.2	-31.4	-99.5%	86.7	3.7	4.5%	1.9	-0.1	-4.5%	88.8	-27.8	-23.8%
Tribal Subtotal	0.2	-132.8	-99.9%	86.7	-111.1	-56.2%	1.9	-30.5	-94.0%	88.8	-274.4	-75.6%
Total	0.7	-148.0	-99.5%	86.7	-117.7	-57.6%	4.2	-30.1	-87.7%	91.6	-295.8	-76.4%
Sockeye												
Non-tribal												
Marine Net	0.0	-600.5	-100.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-600.5	-100.0%
Tribal												
Marine Net	0.0	-864.6	-100.0%	0.0	0.0	0.0%	0.0	-89.4	-100.0%	0.0	-954.0	-100.0%
Freshwater Net	0.0	-0.5	-100.0%	0.0	-101.7	-100.0%	0.0	0.0	0.0%	0.0	-102.3	-100.0%
Tribal Subtotal	0.0	-865.2	-100.0%	0.0	-101.7	-100.0%	0.0	-89.4	-100.0%	0.0	-1,056.3	-100.0%
Total	0.0	-1,465.7	-100.0%	0.0	-101.7	-100.0%	0.0	-89.4	-100.0%	0.0	-1,656.8	-100.0%
Pink												
Non-tribal												
Marine Net	0.0	-169.4	-100.0%	0.0	-1.1	-100.0%	0.0	0.0	0.0%	0.0	-170.4	-100.0%
Tribal												
Marine Net	0.0	-226.8	-100.0%	0.0	-9.5	-100.0%	0.0	-0.5	-100.0%	0.0	-236.7	-100.0%
Freshwater Net	0.0	-14.0	-100.0%	7.9	7.8	15257.6%	0.0	0.0	0.0%	7.9	-6.2	-44.0%
Tribal Subtotal	0.0	-240.7	-100.0%	7.9	-1.7	-17.8%	0.0	-0.5	-100.0%	7.9	-242.9	-96.9%
Total	0.0	-410.1	-100.0%	7.9	-2.8	-26.0%	0.0	-0.5	-100.0%	7.9	-413.3	-98.1%
Chum												
Non-tribal												
Marine Net	0.0	-92.4	-100.0%	0.0	-213.1	-100.0%	0.0	0.0	0.0%	0.0	-305.5	-100.0%
Tribal												
Marine Net	0.0	-108.0	-100.0%	0.0	-248.9	-100.0%	0.0	-11.5	-100.0%	0.0	-368.4	-100.0%
Freshwater Net	1.4	-71.5	-98.0%	198.5	93.8	89.6%	0.0	0.0	0.0%	199.9	22.3	12.6%
Tribal Subtotal	1.4	-179.5	-99.2%	198.5	-155.1	-43.9%	0.0	-11.5	-100.0%	199.9	-346.1	-63.4%
Total	1.4	-271.9	-99.5%	198.5	-368.2	-65.0%	0.0	-11.5	-100.0%	199.9	-651.6	-76.5%
Steelhead												
Non-tribal												
Marine Net	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%
Tribal												
Marine Net	0.0	-0.8	-100.0%	0.0	0.0	-100.0%	0.0	-0.4	-100.0%	0.0	-1.2	-100.0%
Freshwater Net	0.5	-0.1	-9.2%	1.5	0.0	-0.5%	1.4	0.0	-1.6%	3.5	-0.1	-2.4%
Tribal Subtotal	0.5	-0.9	-62.7%	1.5	0.0	-1.8%	1.4	-0.4	-20.9%	3.5	-1.3	-27.1%
Total	0.5	-0.9	-62.7%	1.5	0.0	-1.8%	1.4	-0.4	-20.9%	3.5	-1.3	-27.1%
Total												
Non-tribal												
Marine Net	0.5	-962.2	-99.9%	0.0	-228.9	-100.0%	2.3	0.4	22.2%	2.8	-1,190.7	-99.8%
Tribal												
Marine Net	0.0	-1,445.5	-100.0%	0.0	-447.2	-100.0%	0.0	-138.2	-100.0%	0.0	-2,030.9	-100.0%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-6.8	-100.0%	0.0	-6.8	-100.0%
Freshwater Net	2.1	-129.0	-98.4%	463.6	33.5	7.8%	3.4	-0.1	-3.5%	469.1	-95.5	-16.9%
Tribal Subtotal	2.1	-1,574.4	-99.9%	463.6	-413.6	-47.1%	3.4	-145.1	-97.7%	469.1	-2,133.2	-82.0%
Total	2.6	-2,536.6	-99.9%	463.6	-642.6	-58.1%	5.7	-144.7	-96.2%	472.0	-3,323.9	-87.6%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-13. Direct changes in harvesting sector jobs (in full- and part-time jobs) caused by changes in commercial landings under the project alternatives. Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 4 - No Fishing											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Specie	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number		Change from Baseline (%)	Number	Change from Baseline	% Change
Chinook												
Non-tribal												
Marine Net	0.0	-84.7	-100.0%	0.0	-8.2	-100.0%	0.0	0.0	0.0%	0.0	-92.8	-100.0%
Tribal												
Marine Net	0.0	-143.8	-100.0%	0.0	-73.9	-100.0%	0.0	-7.4	-100.0%	0.0	-225.1	-100.0%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-5.5	-100.0%	0.0	-5.5	-100.0%
Freshwater Net	0.0	-11.5	-100.0%	0.0	-139.1	-100.0%	0.0	0.0	-100.0%	0.0	-150.6	-100.0%
Tribal Subtotal	0.0	-155.3	-100.0%	0.0	-213.0	-100.0%	0.0	-12.9	-100.0%	0.0	-381.2	-100.0%
Total	0.0	-240.0	-100.0%	0.0	-221.2	-100.0%	0.0	-12.9	-100.0%	0.0	-474.0	-100.0%
Coho												
Non-tribal												
Marine Net	0.0	-15.7	-100.0%	0.0	-6.6	-100.0%	0.0	-1.9	-100.0%	0.0	-24.2	-100.0%
Tribal												
Marine Net	0.0	-101.4	-100.0%	0.0	-114.9	-100.0%	0.0	-29.2	-100.0%	0.0	-245.4	-100.0%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-1.3	-100.0%	0.0	-1.3	-100.0%
Freshwater Net	0.0	-31.6	-100.0%	0.0	-83.0	-100.0%	0.0	-2.0	-100.0%	0.0	-116.6	-100.0%
Tribal Subtotal	0.0	-132.9	-100.0%	0.0	-197.8	-100.0%	0.0	-32.5	-100.0%	0.0	-363.2	-100.0%
Total	0.0	-148.7	-100.0%	0.0	-204.4	-100.0%	0.0	-34.4	-100.0%	0.0	-387.4	-100.0%
Sockeye												
Non-tribal												
Marine Net	0.0	-600.5	-100.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-600.5	-100.0%
Tribal												
Marine Net	0.0	-864.6	-100.0%	0.0	0.0	0.0%	0.0	-89.4	-100.0%	0.0	-954.0	-100.0%
Freshwater Net	0.0	-0.5	-100.0%	0.0	-101.7	-100.0%	0.0	0.0	0.0%	0.0	-102.3	-100.0%
Tribal Subtotal	0.0	-865.2	-100.0%	0.0	-101.7	-100.0%	0.0	-89.4	-100.0%	0.0	-1,056.3	-100.0%
Total	0.0	-1,465.7	-100.0%	0.0	-101.7	-100.0%	0.0	-89.4	-100.0%	0.0	-1,656.8	-100.0%
Pink												
Non-tribal												
Marine Net	0.0	-169.4	-100.0%	0.0	-1.1	-100.0%	0.0	0.0	0.0%	0.0	-170.4	-100.0%
Tribal												
Marine Net	0.0	-226.8	-100.0%	0.0	-9.5	-100.0%	0.0	-0.5	-100.0%	0.0	-236.7	-100.0%
Freshwater Net	0.0	-14.0	-100.0%	0.0	-0.1	-100.0%	0.0	0.0	0.0%	0.0	-14.0	-100.0%
Tribal Subtotal	0.0	-240.7	-100.0%	0.0	-9.6	-100.0%	0.0	-0.5	-100.0%	0.0	-250.8	-100.0%
Total	0.0	-410.1	-100.0%	0.0	-10.6	-100.0%	0.0	-0.5	-100.0%	0.0	-421.2	-100.0%
Chum												
Non-tribal												
Marine Net	0.0	-92.4	-100.0%	0.0	-213.1	-100.0%	0.0	0.0	0.0%	0.0	-305.5	-100.0%
Tribal												
Marine Net	0.0	-108.0	-100.0%	0.0	-248.9	-100.0%	0.0	-11.5	-100.0%	0.0	-368.4	-100.0%
Freshwater Net	1.4	-71.5	-98.0%	49.6	-55.1	-52.6%	0.0	0.0	0.0%	51.1	-126.6	-71.3%
Tribal Subtotal	1.4	-179.5	-99.2%	49.6	-304.0	-86.0%	0.0	-11.5	-100.0%	51.1	-495.0	-90.6%
Total	1.4	-271.9	-99.5%	49.6	-517.1	-91.2%	0.0	-11.5	-100.0%	51.1	-800.5	-94.0%
Steelhead												
Non-tribal												
Marine Net	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%
Tribal												
Marine Net	0.0	-0.8	-100.0%	0.0	0.0	-100.0%	0.0	-0.4	-100.0%	0.0	-1.2	-100.0%
Freshwater Net	0.5	-0.1	-9.2%	1.2	-0.3	-22.0%	1.4	0.0	-1.8%	3.2	-0.4	-11.7%
Tribal Subtotal	0.5	-0.9	-62.7%	1.2	-0.4	-23.0%	1.4	-0.4	-21.0%	3.2	-1.6	-34.1%
Total	0.5	-0.9	-62.7%	1.2	-0.4	-23.0%	1.4	-0.4	-21.0%	3.2	-1.6	-34.1%
Total												
Non-tribal												
Marine Net	0.0	-962.7	-100.0%	0.0	-228.9	-100.0%	0.0	-1.9	-100.0%	0.0	-1,193.5	-100.0%
Tribal												
Marine Net	0.0	-1,445.5	-100.0%	0.0	-447.2	-100.0%	0.0	-138.2	-100.0%	0.0	-2,030.9	-100.0%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-6.8	-100.0%	0.0	-6.8	-100.0%
Freshwater Net	2.0	-129.1	-98.5%	50.8	-379.3	-88.2%	1.4	-2.1	-58.8%	54.2	-510.4	-90.4%
Tribal Subtotal	2.0	-1,574.6	-99.9%	50.8	-826.5	-94.2%	1.4	-147.1	-99.0%	54.2	-2,548.1	-97.9%
Total	2.0	-2,537.3	-99.9%	50.8	-1,055.4	-95.4%	1.4	-148.9	-99.0%	54.2	-3,741.6	-98.6%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-14. Direct changes in harvesting sector employment (in full-time equivalent jobs) caused by changes in commercial landings under the project alternatives.

Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

	Alternative 1 - Proposed Action/Status Quo			
Specie	North Puget Sound	SPS/SHC*	SJF/ NHC*	State Total
Chinook				
Non-tribal				
Marine Net	4.8	0.4	0.0	5.0
Tribal				
Marine Net	5.8	2.8	0.3	8.7
Marine Troll	0.0	0.0	0.3	0.3
Freshwater Net	0.6	6.7	0.0	7.5
Tribal Subtotal	6.4	9.4	0.6	16.5
Total	11.2	9.9	0.6	21.5
Coho				
Non-tribal				
Marine Net	0.8	0.3	0.1	1.1
Tribal				
Marine Net	3.5	3.6	1.0	7.9
Marine Troll	0.0	0.0	0.0	0.0
Freshwater Net	1.2	3.0	0.1	4.3
Tribal Subtotal	4.7	6.6	1.1	12.2
Total	5.5	6.9	1.2	13.3
Sockeye				
Non-tribal				
Marine Net	28.7	0.0	0.0	27.1
Tribal				
Marine Net	29.8	0.0	3.0	31.0
Freshwater Net	0.0	4.7	0.0	4.9
Tribal Subtotal	29.8	4.7	3.0	35.9
Total	58.5	4.7	3.0	63.0
Pink				
Non-tribal				
Marine Net	29.3	0.2	0.0	28.3
Tribal				
Marine Net	28.2	1.1	0.1	28.3
Freshwater Net	2.0	0.0	0.0	1.9
Tribal Subtotal	30.2	1.1	0.1	30.2
Total	59.5	1.3	0.1	58.6
Chum				
Non-tribal				
Marine Net	3.1	6.5	0.0	9.0
Tribal				
Marine Net	2.6	5.5	0.2	7.8
Freshwater Net	1.7	2.3	0.0	3.8
Tribal Subtotal	4.3	7.8	0.2	11.6
Total	7.4	14.3	0.2	20.6
Steelhead				
Non-tribal				
Marine Net	0.0	0.0	0.0	0.0
Tribal				
Marine Net	0.0	0.0	0.0	0.0
Freshwater Net	0.0	0.0	0.0	0.1
Tribal Subtotal	0.0	0.0	0.1	0.1
Total	0.0	0.0	0.1	0.1
Total				
Non-tribal				
Marine Net	66.6	7.4	0.1	70.5
Tribal				
Marine Net	69.9	12.9	4.6	83.8
Marine Troll	0.0	0.0	0.4	0.3
Freshwater Net	5.6	16.7	0.1	22.4
Tribal Subtotal	75.5	29.6	5.0	106.6
Total	142.2	37.1	5.1	177.1

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-14. Direct changes in harvesting sector employment (in full-time equivalent jobs) caused by changes in commercial landings under the project alternatives. Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries., continued

	Alternative 2 - Escapement Goal Management at the Management Unit Level											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Specie	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change
Chinook												
Non-tribal												
Marine Net	0.0	-4.8	-100.0%	0.0	-0.4	-100.0%	0.0	0.0	0.0%	0.0	-5.0	-100.0%
Tribal												
Marine Net	1.9	-4.0	-67.7%	0.0	-2.8	-100.0%	0.0	-0.3	-100.0%	1.8	-6.9	-79.4%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-0.3	-100.0%	0.0	-0.3	-100.0%
Freshwater Net	0.2	-0.4	-70.0%	9.1	2.4	36.6%	0.0	0.0	-100.0%	9.6	2.1	28.4%
Tribal Subtotal	2.1	-4.4	-67.9%	9.1	-0.3	-3.3%	0.0	-0.6	-100.0%	11.4	-5.1	-30.8%
Total	2.1	-9.2	-81.6%	9.1	-0.7	-7.5%	0.0	-0.6	-100.0%	11.4	-10.1	-46.9%
Coho												
Non-tribal												
Marine Net	0.0	-0.7	-96.3%	0.0	-0.3	-100.0%	0.1	0.0	37.9%	0.1	-0.9	-87.0%
Tribal												
Marine Net	0.0	-3.5	-100.0%	0.0	-3.6	-100.0%	0.0	-1.0	-100.0%	0.0	-7.9	-100.0%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	-100.0%	0.0	0.0	-100.0%
Freshwater Net	1.6	0.4	31.9%	3.5	0.5	17.0%	0.1	0.0	7.8%	5.2	0.9	20.8%
Tribal Subtotal	1.6	-3.1	-65.3%	3.5	-3.1	-47.0%	0.1	-1.0	-92.4%	5.2	-7.0	-57.5%
Total	1.7	-3.8	-69.6%	3.5	-3.4	-49.2%	0.2	-1.0	-82.8%	5.3	-8.0	-59.9%
Sockeye												
Non-tribal												
Marine Net	0.0	-28.7	-100.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-27.1	-100.0%
Tribal												
Marine Net	0.0	-29.8	-100.0%	0.0	0.0	0.0%	0.0	-3.0	-100.0%	0.0	-31.0	-100.0%
Freshwater Net	0.0	0.0	-100.0%	0.0	-4.7	-100.0%	0.0	0.0	0.0%	0.0	-4.9	-100.0%
Tribal Subtotal	0.0	-29.8	-100.0%	0.0	-4.7	-100.0%	0.0	-3.0	-100.0%	0.0	-35.9	-100.0%
Total	0.0	-58.5	-100.0%	0.0	-4.7	-100.0%	0.0	-3.0	-100.0%	0.0	-63.0	-100.0%
Pink												
Non-tribal												
Marine Net	0.0	-29.3	-100.0%	0.0	-0.2	-100.0%	0.0	0.0	0.0%	0.0	-28.3	-100.0%
Tribal												
Marine Net	0.0	-28.2	-100.0%	0.0	-1.1	-100.0%	0.0	-0.1	-100.0%	0.0	-28.3	-100.0%
Freshwater Net	4.0	2.0	101.4%	1.1	1.1	17119.2%	0.0	0.0	0.0%	5.0	3.1	164.4%
Tribal Subtotal	4.0	-26.2	-86.8%	1.1	0.0	4.4%	0.0	-0.1	-100.0%	5.0	-25.2	-83.4%
Total	4.0	-55.5	-93.3%	1.1	-0.1	-9.5%	0.0	-0.1	-100.0%	5.0	-53.5	-91.4%
Chum												
Non-tribal												
Marine Net	0.0	-3.1	-100.0%	0.0	-6.5	-100.0%	0.0	0.0	0.0%	0.0	-9.0	-100.0%
Tribal												
Marine Net	0.0	-2.6	-100.0%	0.0	-5.5	-100.0%	0.0	-0.2	-100.0%	0.0	-7.8	-100.0%
Freshwater Net	0.1	-1.7	-96.3%	5.0	2.7	114.9%	0.0	0.0	0.0%	4.8	1.0	26.6%
Tribal Subtotal	0.1	-4.3	-98.5%	5.0	-2.8	-36.4%	0.0	-0.2	-100.0%	4.8	-6.8	-58.8%
Total	0.1	-7.3	-99.1%	5.0	-9.4	-65.4%	0.0	-0.2	-100.0%	4.8	-15.8	-76.8%
Steelhead												
Non-tribal												
Marine Net	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%
Tribal												
Marine Net	0.0	0.0	-100.0%	0.0	0.0	-100.0%	0.0	0.0	-100.0%	0.0	0.0	-100.0%
Freshwater Net	0.0	0.0	1.8%	0.1	0.0	11.6%	0.1	0.0	11.0%	0.1	0.0	9.8%
Tribal Subtotal	0.0	0.0	-54.7%	0.1	0.0	10.3%	0.1	0.0	-8.5%	0.1	0.0	-15.2%
Total	0.0	0.0	-54.7%	0.1	0.0	10.3%	0.1	0.0	-8.5%	0.1	0.0	-15.2%
Total												
Non-tribal												
Marine Net	0.0	-66.6	-100.0%	0.0	-7.4	-100.0%	0.1	0.0	37.9%	0.1	-70.4	-99.8%
Tribal												
Marine Net	1.9	-68.0	-97.3%	0.0	-12.9	-100.0%	0.0	-4.6	-100.0%	1.8	-82.0	-97.9%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-0.4	-100.0%	0.0	-0.3	-100.0%
Freshwater Net	5.9	0.3	4.8%	18.8	2.1	12.4%	0.1	0.0	8.5%	24.7	2.3	10.3%
Tribal Subtotal	7.8	-67.8	-89.7%	18.8	-10.9	-36.7%	0.1	-4.9	-97.3%	26.5	-80.0	-75.1%
Total	7.8	-134.4	-94.5%	18.8	-18.3	-49.3%	0.3	-4.9	-95.1%	26.7	-150.4	-84.9%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-14. Direct changes in harvesting sector employment (in full-time equivalent jobs) caused by changes in commercial landings under the project alternatives. Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries., continued

	Alternative 3 - Escapement Goal Management at the Population Level/Terminal Fisheries Only											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Specie	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number		Change from Baseline (%)	Number	Change from Baseline	% Change
Chinook												
Non-tribal												
Marine Net	0.0	-4.8	-100.0%	0.0	-0.4	-100.0%	0.0	0.0	0.0%	0.0	-5.0	-100.0%
Tribal												
Marine Net	0.0	-5.8	-100.0%	0.0	-2.8	-100.0%	0.0	-0.3	-100.0%	0.0	-8.7	-100.0%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-0.3	-100.0%	0.0	-0.3	-100.0%
Freshwater Net	0.0	-0.6	-100.0%	9.1	2.4	36.6%	0.0	0.0	-100.0%	9.5	2.0	26.1%
Tribal Subtotal	0.0	-6.4	-100.0%	9.1	-0.3	-3.3%	0.0	-0.6	-100.0%	9.5	-7.1	-42.8%
Total	0.0	-11.2	-100.0%	9.1	-0.7	-7.5%	0.0	-0.6	-100.0%	9.5	-12.1	-56.0%
Coho												
Non-tribal												
Marine Net	0.0	-0.7	-96.3%	0.0	-0.3	-100.0%	0.1	0.0	37.9%	0.1	-0.9	-87.0%
Tribal												
Marine Net	0.0	-3.5	-100.0%	0.0	-3.6	-100.0%	0.0	-1.0	-100.0%	0.0	-7.9	-100.0%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	-100.0%	0.0	0.0	-100.0%
Freshwater Net	0.0	-1.2	-99.4%	3.5	0.5	17.0%	0.1	0.0	7.8%	3.7	-0.6	-14.7%
Tribal Subtotal	0.0	-4.7	-99.9%	3.5	-3.1	-47.0%	0.1	-1.0	-92.4%	3.7	-8.6	-70.0%
Total	0.0	-5.4	-99.4%	3.5	-3.4	-49.2%	0.2	-1.0	-82.8%	3.8	-9.5	-71.4%
Sockeye												
Non-tribal												
Marine Net	0.0	-28.7	-100.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-27.1	-100.0%
Tribal												
Marine Net	0.0	-29.8	-100.0%	0.0	0.0	0.0%	0.0	-3.0	-100.0%	0.0	-31.0	-100.0%
Freshwater Net	0.0	0.0	-100.0%	0.0	-4.7	-100.0%	0.0	0.0	0.0%	0.0	-4.9	-100.0%
Tribal Subtotal	0.0	-29.8	-100.0%	0.0	-4.7	-100.0%	0.0	-3.0	-100.0%	0.0	-35.9	-100.0%
Total	0.0	-58.5	-100.0%	0.0	-4.7	-100.0%	0.0	-3.0	-100.0%	0.0	-63.0	-100.0%
Pink												
Non-tribal												
Marine Net	0.0	-29.3	-100.0%	0.0	-0.2	-100.0%	0.0	0.0	0.0%	0.0	-28.3	-100.0%
Tribal												
Marine Net	0.0	-28.2	-100.0%	0.0	-1.1	-100.0%	0.0	-0.1	-100.0%	0.0	-28.3	-100.0%
Freshwater Net	0.0	-2.0	-100.0%	1.1	1.1	17119.2%	0.0	0.0	0.0%	1.2	-0.7	-37.0%
Tribal Subtotal	0.0	-30.2	-100.0%	1.1	0.0	4.4%	0.0	-0.1	-100.0%	1.2	-29.0	-96.0%
Total	0.0	-59.5	-100.0%	1.1	-0.1	-9.5%	0.0	-0.1	-100.0%	1.2	-57.4	-98.0%
Chum												
Non-tribal												
Marine Net	0.0	-3.1	-100.0%	0.0	-6.5	-100.0%	0.0	0.0	0.0%	0.0	-9.0	-100.0%
Tribal												
Marine Net	0.0	-2.6	-100.0%	0.0	-5.5	-100.0%	0.0	-0.2	-100.0%	0.0	-7.8	-100.0%
Freshwater Net	0.0	-1.7	-97.8%	5.0	2.7	114.9%	0.0	0.0	0.0%	4.7	1.0	26.0%
Tribal Subtotal	0.0	-4.3	-99.1%	5.0	-2.8	-36.4%	0.0	-0.2	-100.0%	4.7	-6.8	-59.0%
Total	0.0	-7.4	-99.5%	5.0	-9.4	-65.4%	0.0	-0.2	-100.0%	4.7	-15.8	-76.9%
Steelhead												
Non-tribal												
Marine Net	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%
Tribal												
Marine Net	0.0	0.0	-100.0%	0.0	0.0	-100.0%	0.0	0.0	-100.0%	0.0	0.0	-100.0%
Freshwater Net	0.0	0.0	1.8%	0.1	0.0	11.6%	0.1	0.0	11.0%	0.1	0.0	9.8%
Tribal Subtotal	0.0	0.0	-54.7%	0.1	0.0	10.3%	0.1	0.0	-8.5%	0.1	0.0	-15.2%
Total	0.0	0.0	-54.7%	0.1	0.0	10.3%	0.1	0.0	-8.5%	0.1	0.0	-15.2%
Total												
Non-tribal												
Marine Net	0.0	-66.6	-100.0%	0.0	-7.4	-100.0%	0.1	0.0	37.9%	0.1	-70.4	-99.8%
Tribal												
Marine Net	0.0	-69.9	-100.0%	0.0	-12.9	-100.0%	0.0	-4.6	-100.0%	0.0	-83.8	-100.0%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-0.4	-100.0%	0.0	-0.3	-100.0%
Freshwater Net	0.1	-5.5	-98.9%	18.8	2.1	12.4%	0.1	0.0	8.5%	19.2	-3.3	-14.5%
Tribal Subtotal	0.1	-75.5	-99.9%	18.8	-10.9	-36.7%	0.1	-4.9	-97.3%	19.2	-87.4	-82.0%
Total	0.1	-142.1	-99.9%	18.8	-18.3	-49.3%	0.3	-4.9	-95.1%	19.3	-157.8	-89.1%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-14. Direct changes in harvesting sector employment (in full-time equivalent jobs) caused by changes in c Table D-23. Direct changes in harvesting sector employment (in full-time equivalent jobs) caused by changes in commercial landings under the project alternatives
Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries., continued Scenario B: 2003 abundance with maximum AK and Canadian PST fisheries, *continued* .

	Alternative 4 - No Fishing											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Specie	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number		Change from Baseline (%)	Number	Change from Baseline	% Change
Chinook												
Non-tribal												
Marine Net	0.0	-4.8	-100.0%	0.0	-0.4	-100.0%	0.0	0.0	0.0%	0.0	-5.0	-100.0%
Tribal												
Marine Net	0.0	-5.8	-100.0%	0.0	-2.8	-100.0%	0.0	-0.3	-100.0%	0.0	-8.7	-100.0%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-0.3	-100.0%	0.0	-0.3	-100.0%
Freshwater Net	0.0	-0.6	-100.0%	0.0	-6.7	-100.0%	0.0	0.0	-100.0%	0.0	-7.5	-100.0%
Tribal Subtotal	0.0	-6.4	-100.0%	0.0	-9.4	-100.0%	0.0	-0.6	-100.0%	0.0	-16.5	-100.0%
Total	0.0	-11.2	-100.0%	0.0	-9.9	-100.0%	0.0	-0.6	-100.0%	0.0	-21.5	-100.0%
Coho												
Non-tribal												
Marine Net	0.0	-0.8	-100.0%	0.0	-0.3	-100.0%	0.0	-0.1	-100.0%	0.0	-1.1	-100.0%
Tribal												
Marine Net	0.0	-3.5	-100.0%	0.0	-3.6	-100.0%	0.0	-1.0	-100.0%	0.0	-7.9	-100.0%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	-100.0%	0.0	0.0	-100.0%
Freshwater Net	0.0	-1.2	-100.0%	0.0	-3.0	-100.0%	0.0	-0.1	-100.0%	0.0	-4.3	-100.0%
Tribal Subtotal	0.0	-4.7	-100.0%	0.0	-6.6	-100.0%	0.0	-1.1	-100.0%	0.0	-12.2	-100.0%
Total	0.0	-5.5	-100.0%	0.0	-6.9	-100.0%	0.0	-1.2	-100.0%	0.0	-13.3	-100.0%
Sockeye												
Non-tribal												
Marine Net	0.0	-28.7	-100.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-27.1	-100.0%
Tribal												
Marine Net	0.0	-29.8	-100.0%	0.0	0.0	0.0%	0.0	-3.0	-100.0%	0.0	-31.0	-100.0%
Freshwater Net	0.0	0.0	-100.0%	0.0	-4.7	-100.0%	0.0	0.0	0.0%	0.0	-4.9	-100.0%
Tribal Subtotal	0.0	-29.8	-100.0%	0.0	-4.7	-100.0%	0.0	-3.0	-100.0%	0.0	-35.9	-100.0%
Total	0.0	-58.5	-100.0%	0.0	-4.7	-100.0%	0.0	-3.0	-100.0%	0.0	-63.0	-100.0%
Pink												
Non-tribal												
Marine Net	0.0	-29.3	-100.0%	0.0	-0.2	-100.0%	0.0	0.0	0.0%	0.0	-28.3	-100.0%
Tribal												
Marine Net	0.0	-28.2	-100.0%	0.0	-1.1	-100.0%	0.0	-0.1	-100.0%	0.0	-28.3	-100.0%
Freshwater Net	0.0	-2.0	-100.0%	0.0	0.0	-100.0%	0.0	0.0	0.0%	0.0	-1.9	-100.0%
Tribal Subtotal	0.0	-30.2	-100.0%	0.0	-1.1	-100.0%	0.0	-0.1	-100.0%	0.0	-30.2	-100.0%
Total	0.0	-59.5	-100.0%	0.0	-1.3	-100.0%	0.0	-0.1	-100.0%	0.0	-58.6	-100.0%
Chum												
Non-tribal												
Marine Net	0.0	-3.1	-100.0%	0.0	-6.5	-100.0%	0.0	0.0	0.0%	0.0	-9.0	-100.0%
Tribal												
Marine Net	0.0	-2.6	-100.0%	0.0	-5.5	-100.0%	0.0	-0.2	-100.0%	0.0	-7.8	-100.0%
Freshwater Net	0.0	-1.7	-97.8%	1.2	-1.1	-46.3%	0.0	0.0	0.0%	1.2	-2.6	-67.8%
Tribal Subtotal	0.0	-4.3	-99.1%	1.2	-6.6	-84.1%	0.0	-0.2	-100.0%	1.2	-10.4	-89.5%
Total	0.0	-7.4	-99.5%	1.2	-13.1	-91.3%	0.0	-0.2	-100.0%	1.2	-19.4	-94.1%
Steelhead												
Non-tribal												
Marine Net	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%
Tribal												
Marine Net	0.0	0.0	-100.0%	0.0	0.0	-100.0%	0.0	0.0	-100.0%	0.0	0.0	-100.0%
Freshwater Net	0.0	0.0	1.8%	0.0	0.0	-12.5%	0.1	0.0	10.8%	0.1	0.0	-0.6%
Tribal Subtotal	0.0	0.0	-54.7%	0.0	0.0	-13.5%	0.1	0.0	-8.6%	0.1	0.0	-23.3%
Total	0.0	0.0	-54.7%	0.0	0.0	-13.5%	0.1	0.0	-8.6%	0.1	0.0	-23.3%
Total												
Non-tribal												
Marine Net	0.0	-66.6	-100.0%	0.0	-7.4	-100.0%	0.0	-0.1	-100.0%	0.0	-70.5	-100.0%
Tribal												
Marine Net	0.0	-69.9	-100.0%	0.0	-12.9	-100.0%	0.0	-4.6	-100.0%	0.0	-83.8	-100.0%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-0.4	-100.0%	0.0	-0.3	-100.0%
Freshwater Net	0.1	-5.5	-99.0%	1.3	-15.4	-92.3%	0.1	-0.1	-58.5%	1.3	-21.1	-94.1%
Tribal Subtotal	0.1	-75.5	-99.9%	1.3	-28.4	-95.7%	0.1	-5.0	-99.0%	1.3	-105.3	-98.8%
Total	0.1	-142.1	-100.0%	1.3	-35.8	-96.5%	0.1	-5.1	-99.0%	1.3	-175.8	-99.3%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-15. Direct changes in processing sector employment (in full-time equivalent jobs) caused by changes in commercial landings under the project alternatives.
Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

	Alternative 1 - Proposed Action/Status Quo			
Specie	North Puget Sound	SPS/SHC*	SJF/ NHC*	State Total
Chinook				
Non-tribal				
Marine Net	4.3	0.4	0.0	4.4
Tribal				
Marine Net	5.2	2.3	0.3	7.7
Marine Troll	0.0	0.0	0.2	0.2
Freshwater Net	0.5	5.6	0.0	6.7
Tribal Subtotal	5.7	8.0	0.5	14.6
Total	10.0	8.3	0.5	19.0
Coho				
Non-tribal				
Marine Net	1.4	0.5	0.2	2.0
Tribal				
Marine Net	6.4	6.3	1.8	14.7
Marine Troll	0.0	0.0	0.1	0.1
Freshwater Net	2.3	5.2	0.1	8.0
Tribal Subtotal	8.7	11.6	2.0	22.7
Total	10.1	12.1	2.2	24.7
Sockeye				
Non-tribal				
Marine Net	20.4	0.0	0.0	19.4
Tribal				
Marine Net	21.1	0.0	2.2	22.1
Freshwater Net	0.0	3.2	0.0	3.5
Tribal Subtotal	21.2	3.2	2.2	25.6
Total	41.6	3.2	2.2	45.0
Pink				
Non-tribal				
Marine Net	40.1	0.2	0.0	38.8
Tribal				
Marine Net	38.7	1.4	0.1	38.8
Freshwater Net	2.7	0.0	0.0	2.6
Tribal Subtotal	41.4	1.4	0.1	41.4
Total	81.5	1.6	0.1	80.2
Chum				
Non-tribal				
Marine Net	15.5	31.2	0.0	48.2
Tribal				
Marine Net	13.0	26.3	1.4	41.8
Freshwater Net	8.8	11.0	0.0	20.2
Tribal Subtotal	21.9	37.3	1.4	62.0
Total	37.3	68.5	1.4	110.2
Steelhead				
Non-tribal				
Marine Net	0.0	0.0	0.0	0.0
Tribal				
Marine Net	0.0	0.0	0.0	0.0
Freshwater Net	0.0	0.1	0.1	0.1
Tribal Subtotal	0.1	0.1	0.1	0.2
Total	0.1	0.1	0.1	0.2
Total				
Non-tribal				
Marine Net	81.6	32.3	0.2	112.8
Tribal				
Marine Net	84.5	36.3	5.7	125.2
Marine Troll	0.0	0.0	0.3	0.3
Freshwater Net	14.4	25.2	0.2	41.0
Tribal Subtotal	98.9	61.5	6.1	166.5
Total	180.5	93.9	6.3	279.3

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-15. Direct changes in processing sector employment (in full-time equivalent jobs) caused by changes in commercial landings under the project alternatives.
Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 2 - Escapement Goal Management at the Management Unit Level											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Specie	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change
Chinook												
Non-tribal												
Marine Net	0.0	-4.3	-100.0%	0.0	-0.4	-100.0%	0.0	0.0	0.0%	0.0	-4.4	-100.0%
Tribal												
Marine Net	1.5	-3.7	-71.2%	0.0	-2.3	-100.0%	0.0	-0.3	-100.0%	1.4	-6.3	-81.6%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-0.2	-100.0%	0.0	-0.2	-100.0%
Freshwater Net	0.1	-0.4	-73.3%	6.9	1.2	21.5%	0.0	0.0	-100.0%	7.6	1.0	14.3%
Tribal Subtotal	1.6	-4.1	-71.4%	6.9	-1.1	-14.0%	0.0	-0.5	-100.0%	9.0	-5.6	-38.1%
Total	1.6	-8.4	-83.6%	6.9	-1.5	-17.7%	0.0	-0.5	-100.0%	9.0	-10.0	-52.5%
Coho												
Non-tribal												
Marine Net	0.0	-1.3	-96.7%	0.0	-0.5	-100.0%	0.2	0.0	22.2%	0.2	-1.8	-88.4%
Tribal												
Marine Net	0.0	-6.4	-100.0%	0.0	-6.3	-100.0%	0.0	-1.8	-100.0%	0.0	-14.7	-100.0%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-0.1	-100.0%	0.0	-0.1	-100.0%
Freshwater Net	2.7	0.4	17.6%	5.5	0.2	4.5%	0.1	0.0	-4.5%	8.6	0.6	7.9%
Tribal Subtotal	2.7	-6.0	-69.1%	5.5	-6.1	-52.7%	0.1	-1.9	-93.2%	8.6	-14.1	-62.1%
Total	2.7	-7.3	-72.9%	5.5	-6.6	-54.6%	0.3	-1.8	-84.7%	8.9	-15.9	-64.2%
Sockeye												
Non-tribal												
Marine Net	0.0	-20.4	-100.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-19.4	-100.0%
Tribal												
Marine Net	0.0	-21.1	-100.0%	0.0	0.0	0.0%	0.0	-2.2	-100.0%	0.0	-22.1	-100.0%
Freshwater Net	0.0	0.0	-100.0%	0.0	-3.2	-100.0%	0.0	0.0	0.0%	0.0	-3.5	-100.0%
Tribal Subtotal	0.0	-21.2	-100.0%	0.0	-3.2	-100.0%	0.0	-2.2	-100.0%	0.0	-25.6	-100.0%
Total	0.0	-41.6	-100.0%	0.0	-3.2	-100.0%	0.0	-2.2	-100.0%	0.0	-45.0	-100.0%
Pink												
Non-tribal												
Marine Net	0.0	-40.1	-100.0%	0.0	-0.2	-100.0%	0.0	0.0	0.0%	0.0	-38.8	-100.0%
Tribal												
Marine Net	0.0	-38.7	-100.0%	0.0	-1.4	-100.0%	0.0	-0.1	-100.0%	0.0	-38.8	-100.0%
Freshwater Net	4.9	2.2	79.6%	1.3	1.3	15257.6%	0.0	0.0	0.0%	6.1	3.5	135.0%
Tribal Subtotal	4.9	-36.5	-88.3%	1.3	-0.1	-6.9%	0.0	-0.1	-100.0%	6.1	-35.3	-85.2%
Total	4.9	-76.6	-94.0%	1.3	-0.3	-19.3%	0.0	-0.1	-100.0%	6.1	-74.1	-92.4%
Chum												
Non-tribal												
Marine Net	0.0	-15.5	-100.0%	0.0	-31.2	-100.0%	0.0	0.0	0.0%	0.0	-48.2	-100.0%
Tribal												
Marine Net	0.0	-13.0	-100.0%	0.0	-26.3	-100.0%	0.0	-1.4	-100.0%	0.0	-41.8	-100.0%
Freshwater Net	0.3	-8.5	-96.7%	20.9	9.9	89.6%	0.0	0.0	0.0%	22.8	2.6	13.1%
Tribal Subtotal	0.3	-21.6	-98.7%	20.9	-16.4	-43.9%	0.0	-1.4	-100.0%	22.8	-39.2	-63.2%
Total	0.3	-37.1	-99.2%	20.9	-47.6	-69.4%	0.0	-1.4	-100.0%	22.8	-87.4	-79.3%
Steelhead												
Non-tribal												
Marine Net	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%
Tribal												
Marine Net	0.0	0.0	-100.0%	0.0	0.0	-100.0%	0.0	0.0	-100.0%	0.0	0.0	-100.0%
Freshwater Net	0.0	0.0	-9.2%	0.1	0.0	-0.5%	0.1	0.0	-1.6%	0.1	0.0	-2.4%
Tribal Subtotal	0.0	0.0	-59.6%	0.1	0.0	-1.6%	0.1	0.0	-18.8%	0.1	0.0	-24.6%
Total	0.0	0.0	-59.6%	0.1	0.0	-1.6%	0.1	0.0	-18.8%	0.1	0.0	-24.6%
Total												
Non-tribal												
Marine Net	0.0	-81.6	-99.9%	0.0	-32.3	-100.0%	0.2	0.0	22.2%	0.2	-112.5	-99.8%
Tribal												
Marine Net	1.5	-83.0	-98.2%	0.0	-36.3	-100.0%	0.0	-5.7	-100.0%	1.4	-123.8	-98.9%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-0.3	-100.0%	0.0	-0.3	-100.0%
Freshwater Net	8.0	-6.4	-44.3%	34.7	9.5	37.5%	0.2	0.0	-3.7%	45.3	4.3	10.4%
Tribal Subtotal	9.5	-89.4	-90.4%	34.7	-26.9	-43.7%	0.2	-5.9	-96.8%	46.7	-119.8	-71.9%
Total	9.5	-171.0	-94.7%	34.7	-59.2	-63.1%	0.4	-5.9	-93.7%	47.0	-232.3	-83.2%

Table D-15. Direct changes in processing sector employment (in full-time equivalent jobs) caused by changes in commercial landings under the project alternatives. Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 3 - Escapement Goal Management at the Population Level/Terminal Fisheries Only											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Specie	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number		Change from Baseline (%)	Number	Change from Baseline	% Change
Chinook												
Non-tribal												
Marine Net	0.0	-4.3	-100.0%	0.0	-0.4	-100.0%	0.0	0.0	0.0%	0.0	-4.4	-100.0%
Tribal												
Marine Net	0.0	-5.2	-100.0%	0.0	-2.3	-100.0%	0.0	-0.3	-100.0%	0.0	-7.7	-100.0%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-0.2	-100.0%	0.0	-0.2	-100.0%
Freshwater Net	0.0	-0.5	-100.0%	6.9	1.2	21.5%	0.0	0.0	-100.0%	7.5	0.8	12.2%
Tribal Subtotal	0.0	-5.7	-100.0%	6.9	-1.1	-14.0%	0.0	-0.5	-100.0%	7.5	-7.1	-48.7%
Total	0.0	-10.0	-100.0%	6.9	-1.5	-17.7%	0.0	-0.5	-100.0%	7.5	-11.5	-60.7%
Coho												
Non-tribal												
Marine Net	0.0	-1.3	-96.7%	0.0	-0.5	-100.0%	0.2	0.0	22.2%	0.2	-1.8	-88.4%
Tribal												
Marine Net	0.0	-6.4	-100.0%	0.0	-6.3	-100.0%	0.0	-1.8	-100.0%	0.0	-14.7	-100.0%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-0.1	-100.0%	0.0	-0.1	-100.0%
Freshwater Net	0.0	-2.3	-99.5%	5.5	0.2	4.5%	0.1	0.0	-4.5%	6.1	-1.9	-23.8%
Tribal Subtotal	0.0	-8.7	-99.9%	5.5	-6.1	-52.7%	0.1	-1.9	-93.2%	6.1	-16.6	-73.2%
Total	0.1	-10.0	-99.4%	5.5	-6.6	-54.6%	0.3	-1.8	-84.7%	6.3	-18.4	-74.5%
Sockeye												
Non-tribal												
Marine Net	0.0	-20.4	-100.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-19.4	-100.0%
Tribal												
Marine Net	0.0	-21.1	-100.0%	0.0	0.0	0.0%	0.0	-2.2	-100.0%	0.0	-22.1	-100.0%
Freshwater Net	0.0	0.0	-100.0%	0.0	-3.2	-100.0%	0.0	0.0	0.0%	0.0	-3.5	-100.0%
Tribal Subtotal	0.0	-21.2	-100.0%	0.0	-3.2	-100.0%	0.0	-2.2	-100.0%	0.0	-25.6	-100.0%
Total	0.0	-41.6	-100.0%	0.0	-3.2	-100.0%	0.0	-2.2	-100.0%	0.0	-45.0	-100.0%
Pink												
Non-tribal												
Marine Net	0.0	-40.1	-100.0%	0.0	-0.2	-100.0%	0.0	0.0	0.0%	0.0	-38.8	-100.0%
Tribal												
Marine Net	0.0	-38.7	-100.0%	0.0	-1.4	-100.0%	0.0	-0.1	-100.0%	0.0	-38.8	-100.0%
Freshwater Net	0.0	-2.7	-100.0%	1.3	1.3	15257.6%	0.0	0.0	0.0%	1.5	-1.1	-44.0%
Tribal Subtotal	0.0	-41.4	-100.0%	1.3	-0.1	-6.9%	0.0	-0.1	-100.0%	1.5	-39.9	-96.5%
Total	0.0	-81.5	-100.0%	1.3	-0.3	-19.3%	0.0	-0.1	-100.0%	1.5	-78.7	-98.2%
Chum												
Non-tribal												
Marine Net	0.0	-15.5	-100.0%	0.0	-31.2	-100.0%	0.0	0.0	0.0%	0.0	-48.2	-100.0%
Tribal												
Marine Net	0.0	-13.0	-100.0%	0.0	-26.3	-100.0%	0.0	-1.4	-100.0%	0.0	-41.8	-100.0%
Freshwater Net	0.2	-8.6	-98.0%	20.9	9.9	89.6%	0.0	0.0	0.0%	22.7	2.5	12.6%
Tribal Subtotal	0.2	-21.7	-99.2%	20.9	-16.4	-43.9%	0.0	-1.4	-100.0%	22.7	-39.3	-63.4%
Total	0.2	-37.2	-99.5%	20.9	-47.6	-69.4%	0.0	-1.4	-100.0%	22.7	-87.5	-79.4%
Steelhead												
Non-tribal												
Marine Net	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%
Tribal												
Marine Net	0.0	0.0	-100.0%	0.0	0.0	-100.0%	0.0	0.0	-100.0%	0.0	0.0	-100.0%
Freshwater Net	0.0	0.0	-9.2%	0.1	0.0	-0.5%	0.1	0.0	-1.6%	0.1	0.0	-2.4%
Tribal Subtotal	0.0	0.0	-59.6%	0.1	0.0	-1.6%	0.1	0.0	-18.8%	0.1	0.0	-24.6%
Total	0.0	0.0	-59.6%	0.1	0.0	-1.6%	0.1	0.0	-18.8%	0.1	0.0	-24.6%
Total												
Non-tribal												
Marine Net	0.0	-81.6	-99.9%	0.0	-32.3	-100.0%	0.2	0.0	22.2%	0.2	-112.5	-99.8%
Tribal												
Marine Net	0.0	-84.5	-100.0%	0.0	-36.3	-100.0%	0.0	-5.7	-100.0%	0.0	-125.2	-100.0%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-0.3	-100.0%	0.0	-0.3	-100.0%
Freshwater Net	0.2	-14.2	-98.6%	34.7	9.5	37.5%	0.2	0.0	-3.7%	37.9	-3.2	-7.7%
Tribal Subtotal	0.2	-98.7	-99.8%	34.7	-26.9	-43.7%	0.2	-5.9	-96.8%	37.9	-128.6	-77.3%
Total	0.3	-180.3	-99.9%	34.7	-59.2	-63.1%	0.4	-5.9	-93.7%	38.1	-241.2	-86.4%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-15. Direct changes in processing sector employment (in full-time equivalent jobs) caused by changes in commercial landings under the project alternatives. Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 4 - No Fishing											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Specie	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number		Change from Baseline (%)	Number	Change from Baseline	% Change
Chinook												
Non-tribal												
Marine Net	0.0	-4.3	-100.0%	0.0	-0.4	-100.0%	0.0	0.0	0.0%	0.0	-4.4	-100.0%
Tribal												
Marine Net	0.0	-5.2	-100.0%	0.0	-2.3	-100.0%	0.0	-0.3	-100.0%	0.0	-7.7	-100.0%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-0.2	-100.0%	0.0	-0.2	-100.0%
Freshwater Net	0.0	-0.5	-100.0%	0.0	-5.6	-100.0%	0.0	0.0	-100.0%	0.0	-6.7	-100.0%
Tribal Subtotal	0.0	-5.7	-100.0%	0.0	-8.0	-100.0%	0.0	-0.5	-100.0%	0.0	-14.6	-100.0%
Total	0.0	-10.0	-100.0%	0.0	-8.3	-100.0%	0.0	-0.5	-100.0%	0.0	-19.0	-100.0%
Coho												
Non-tribal												
Marine Net	0.0	-1.4	-100.0%	0.0	-0.5	-100.0%	0.0	-0.2	-100.0%	0.0	-2.0	-100.0%
Tribal												
Marine Net	0.0	-6.4	-100.0%	0.0	-6.3	-100.0%	0.0	-1.8	-100.0%	0.0	-14.7	-100.0%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-0.1	-100.0%	0.0	-0.1	-100.0%
Freshwater Net	0.0	-2.3	-100.0%	0.0	-5.2	-100.0%	0.0	-0.1	-100.0%	0.0	-8.0	-100.0%
Tribal Subtotal	0.0	-8.7	-100.0%	0.0	-11.6	-100.0%	0.0	-2.0	-100.0%	0.0	-22.7	-100.0%
Total	0.0	-10.1	-100.0%	0.0	-12.1	-100.0%	0.0	-2.2	-100.0%	0.0	-24.7	-100.0%
Sockeye												
Non-tribal												
Marine Net	0.0	-20.4	-100.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-19.4	-100.0%
Tribal												
Marine Net	0.0	-21.1	-100.0%	0.0	0.0	0.0%	0.0	-2.2	-100.0%	0.0	-22.1	-100.0%
Freshwater Net	0.0	0.0	-100.0%	0.0	-3.2	-100.0%	0.0	0.0	0.0%	0.0	-3.5	-100.0%
Tribal Subtotal	0.0	-21.2	-100.0%	0.0	-3.2	-100.0%	0.0	-2.2	-100.0%	0.0	-25.6	-100.0%
Total	0.0	-41.6	-100.0%	0.0	-3.2	-100.0%	0.0	-2.2	-100.0%	0.0	-45.0	-100.0%
Pink												
Non-tribal												
Marine Net	0.0	-40.1	-100.0%	0.0	-0.2	-100.0%	0.0	0.0	0.0%	0.0	-38.8	-100.0%
Tribal												
Marine Net	0.0	-38.7	-100.0%	0.0	-1.4	-100.0%	0.0	-0.1	-100.0%	0.0	-38.8	-100.0%
Freshwater Net	0.0	-2.7	-100.0%	0.0	0.0	-100.0%	0.0	0.0	0.0%	0.0	-2.6	-100.0%
Tribal Subtotal	0.0	-41.4	-100.0%	0.0	-1.4	-100.0%	0.0	-0.1	-100.0%	0.0	-41.4	-100.0%
Total	0.0	-81.5	-100.0%	0.0	-1.6	-100.0%	0.0	-0.1	-100.0%	0.0	-80.2	-100.0%
Chum												
Non-tribal												
Marine Net	0.0	-15.5	-100.0%	0.0	-31.2	-100.0%	0.0	0.0	0.0%	0.0	-48.2	-100.0%
Tribal												
Marine Net	0.0	-13.0	-100.0%	0.0	-26.3	-100.0%	0.0	-1.4	-100.0%	0.0	-41.8	-100.0%
Freshwater Net	0.2	-8.6	-98.0%	5.2	-5.8	-52.6%	0.0	0.0	0.0%	5.8	-14.4	-71.3%
Tribal Subtotal	0.2	-21.7	-99.2%	5.2	-32.1	-86.0%	0.0	-1.4	-100.0%	5.8	-56.2	-90.6%
Total	0.2	-37.2	-99.5%	5.2	-63.3	-92.4%	0.0	-1.4	-100.0%	5.8	-104.4	-94.7%
Steelhead												
Non-tribal												
Marine Net	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%
Tribal												
Marine Net	0.0	0.0	-100.0%	0.0	0.0	-100.0%	0.0	0.0	-100.0%	0.0	0.0	-100.0%
Freshwater Net	0.0	0.0	-9.2%	0.0	0.0	-22.0%	0.1	0.0	-1.8%	0.1	0.0	-11.7%
Tribal Subtotal	0.0	0.0	-59.6%	0.0	0.0	-22.9%	0.1	0.0	-19.0%	0.1	-0.1	-31.8%
Total	0.0	0.0	-59.6%	0.0	0.0	-22.9%	0.1	0.0	-19.0%	0.1	-0.1	-31.8%
Total												
Non-tribal												
Marine Net	0.0	-81.6	-100.0%	0.0	-32.3	-100.0%	0.0	-0.2	-100.0%	0.0	-112.8	-100.0%
Tribal												
Marine Net	0.0	-84.5	-100.0%	0.0	-36.3	-100.0%	0.0	-5.7	-100.0%	0.0	-125.2	-100.0%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-0.3	-100.0%	0.0	-0.3	-100.0%
Freshwater Net	0.2	-14.2	-98.6%	5.3	-19.9	-79.1%	0.1	-0.1	-70.0%	5.9	-35.1	-85.6%
Tribal Subtotal	0.2	-98.7	-99.8%	5.3	-56.3	-91.4%	0.1	-6.1	-99.0%	5.9	-160.6	-96.4%
Total	0.2	-180.3	-99.9%	5.3	-88.6	-94.4%	0.1	-6.2	-99.0%	5.9	-273.4	-97.9%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-16. Direct changes in harvesting sector personal income (in 2002 dollars) caused by changes in commercial landings under the project alternatives.

Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

Specie	Alternative 1 - Proposed Action/Status Quo: North Puget Sound	SPS/SHC*	SJF/ NHC*	State Total
Chinook				
Non-tribal				
Marine Net	$122,828	$10,676	$0	$126,889
Tribal				
Marine Net	$150,229	$69,526	$7,533	$221,500
Marine Troll	$0	$0	$8,041	$7,714
Freshwater Net	$15,383	$168,303	$14	$190,520
Tribal Subtotal	$165,612	$237,830	$15,588	$419,735
Total	$288,441	$248,506	$15,588	$546,623
Coho				
Non-tribal				
Marine Net	$19,457	$7,249	$2,180	$27,234
Tribal				
Marine Net	$90,181	$91,097	$24,466	$198,848
Marine Troll	$0	$0	$998	$994
Freshwater Net	$32,199	$75,433	$1,945	$108,264
Tribal Subtotal	$122,380	$166,530	$27,409	$308,105
Total	$141,837	$173,779	$29,590	$335,339
Sockeye				
Non-tribal				
Marine Net	$736,768	$0	$0	$689,480
Tribal				
Marine Net	$763,703	$0	$76,712	$788,554
Freshwater Net	$689	$117,163	$0	$123,700
Tribal Subtotal	$764,392	$117,163	$76,712	$912,254
Total	$1,501,160	$117,163	$76,712	$1,601,734
Pink				
Non-tribal				
Marine Net	$753,599	$4,226	$0	$715,294
Tribal				
Marine Net	$726,365	$27,355	$1,432	$715,286
Freshwater Net	$50,763	$167	$0	$48,059
Tribal Subtotal	$777,128	$27,522	$1,432	$763,345
Total	$1,530,727	$31,748	$1,432	$1,478,639
Chum				
Non-tribal				
Marine Net	$77,981	$163,507	$0	$234,893
Tribal				
Marine Net	$65,635	$137,463	$5,804	$203,909
Freshwater Net	$44,332	$57,811	$0	$98,315
Tribal Subtotal	$109,967	$195,273	$5,804	$302,224
Total	$187,948	$358,780	$5,804	$537,117
Steelhead				
Non-tribal				
Marine Net	$0	$0	$0	$0
Tribal				
Marine Net	$598	$13	$248	$816
Freshwater Net	$480	$1,130	$1,169	$2,762
Tribal Subtotal	$1,078	$1,143	$1,417	$3,578
Total	$1,078	$1,143	$1,417	$3,578
Total				
Non-tribal				
Marine Net	$1,710,634	$185,657	$2,180	$1,793,789
Tribal				
Marine Net	$1,796,710	$325,455	$116,194	$2,128,913
Marine Troll	$0	$0	$9,039	$8,708
Freshwater Net	$143,847	$420,007	$3,128	$571,620
Tribal Subtotal	$1,940,557	$745,461	$128,362	$2,709,241
Total	$3,651,191	$931,118	$130,542	$4,503,030

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-16. Direct changes in harvesting sector personal income (in 2002 dollars) caused by changes in commercial landings under the project alternatives. Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 2 - Escapement Goal Management at the Management Unit Level											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Specie	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change
Chinook												
Non-tribal												
Marine Net	$11	-$122,817	-100.0%	$0	-$10,676	-100.0%	$0	$0	0.0%	$11	-$126,878	-100.0%
Tribal												
Marine Net	$43,202	-$107,027	-71.2%	$0	-$69,526	-100.0%	$0	-$7,533	-100.0%	$40,703	-$180,798	-81.6%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$8,041	-100.0%	$0	-$7,714	-100.0%
Freshwater Net	$4,106	-$11,277	-73.3%	$204,481	$36,178	21.5%	$0	-$14	-100.0%	$217,717	$27,197	14.3%
Tribal Subtotal	$47,308	-$118,304	-71.4%	$204,481	-$33,348	-14.0%	$0	-$15,588	-100.0%	$258,419	-$161,315	-38.4%
Total	$47,319	-$241,121	-83.6%	$204,481	-$44,025	-17.7%	$0	-$15,588	-100.0%	$258,430	-$288,193	-52.7%
Coho												
Non-tribal												
Marine Net	$637	-$18,820	-96.7%	$0	-$7,249	-100.0%	$2,664	$483	22.2%	$3,156	-$24,078	-88.4%
Tribal												
Marine Net	$0	-$90,181	-100.0%	$0	-$91,097	-100.0%	$0	-$24,466	-100.0%	$0	-$198,848	-100.0%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$998	-100.0%	$0	-$994	-100.0%
Freshwater Net	$37,869	$5,670	17.6%	$78,830	$3,396	4.5%	$1,857	-$88	-4.5%	$116,812	$8,548	7.9%
Tribal Subtotal	$37,869	-$84,511	-69.1%	$78,830	-$87,701	-52.7%	$1,857	-$25,553	-93.2%	$116,812	-$191,293	-62.1%
Total	$38,506	-$103,332	-72.9%	$78,830	-$94,949	-54.6%	$4,520	-$25,070	-84.7%	$119,967	-$215,371	-64.2%
Sockeye												
Non-tribal												
Marine Net	$0	-$736,768	-100.0%	$0	$0	0.0%	$0	$0	0.0%	$0	-$689,480	-100.0%
Tribal												
Marine Net	$0	-$763,703	-100.0%	$0	$0	0.0%	$0	-$76,712	-100.0%	$0	-$788,554	-100.0%
Freshwater Net	$0	-$689	-100.0%	$0	-$117,163	-100.0%	$0	$0	0.0%	$0	-$123,700	-100.0%
Tribal Subtotal	$0	-$764,392	-100.0%	$0	-$117,163	-100.0%	$0	-$76,712	-100.0%	$0	-$912,254	-100.0%
Total	$0	-$1,501,160	-100.0%	$0	-$117,163	-100.0%	$0	-$76,712	-100.0%	$0	-$1,601,734	-100.0%
Pink												
Non-tribal												
Marine Net	$0	-$753,599	-100.0%	$0	-$4,226	-100.0%	$0	$0	0.0%	$0	-$715,294	-100.0%
Tribal												
Marine Net	$0	-$726,365	-100.0%	$0	-$27,355	-100.0%	$0	-$1,432	-100.0%	$0	-$715,286	-100.0%
Freshwater Net	$91,179	$40,416	79.6%	$25,619	$25,453	15257.6%	$0	$0	0.0%	$112,932	$64,872	135.0%
Tribal Subtotal	$91,179	-$685,949	-88.3%	$25,619	-$1,903	-6.9%	$0	-$1,432	-100.0%	$112,932	-$650,414	-85.2%
Total	$91,179	-$1,439,548	-94.0%	$25,619	-$6,128	-19.3%	$0	-$1,432	-100.0%	$112,932	-$1,365,708	-92.4%
Chum												
Non-tribal												
Marine Net	$0	-$77,981	-100.0%	$0	-$163,507	-100.0%	$0	$0	0.0%	$0	-$234,893	-100.0%
Tribal												
Marine Net	$0	-$65,635	-100.0%	$0	-$137,463	-100.0%	$0	-$5,804	-100.0%	$0	-$203,909	-100.0%
Freshwater Net	$1,484	-$42,848	-96.7%	$109,632	$51,822	89.6%	$1	$1	0.0%	$111,230	$12,915	13.1%
Tribal Subtotal	$1,484	-$108,483	-98.7%	$109,632	-$85,641	-43.9%	$1	-$5,803	-100.0%	$111,230	-$190,994	-63.2%
Total	$1,484	-$186,464	-99.2%	$109,632	-$249,147	-69.4%	$1	-$5,803	-100.0%	$111,230	-$425,887	-79.3%
Steelhead												
Non-tribal												
Marine Net	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%
Tribal												
Marine Net	$0	-$598	-100.0%	$0	-$13	-100.0%	$0	-$248	-100.0%	$0	-$816	-100.0%
Freshwater Net	$436	-$44	-9.2%	$1,125	-$5	-0.5%	$1,150	-$19	-1.6%	$2,697	-$65	-2.4%
Tribal Subtotal	$436	-$642	-59.6%	$1,125	-$18	-1.6%	$1,150	-$267	-18.8%	$2,697	-$881	-24.6%
Total	$436	-$642	-59.6%	$1,125	-$18	-1.6%	$1,150	-$267	-18.8%	$2,697	-$881	-24.6%
Total												
Non-tribal												
Marine Net	$648	-$1,709,985	-100.0%	$0	-$185,657	-100.0%	$2,664	$483	22.2%	$3,167	-$1,790,623	-99.8%
Tribal												
Marine Net	$43,202	-$1,753,509	-97.6%	$0	-$325,455	-100.0%	$0	-$116,194	-100.0%	$40,703	-$2,088,210	-98.1%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$9,039	-100.0%	$0	-$8,708	-100.0%
Freshwater Net	$135,074	-$8,773	-6.1%	$419,688	-$319	-0.1%	$3,008	-$120	-3.8%	$561,387	-$10,234	-1.8%
Tribal Subtotal	$178,276	-$1,762,282	-90.8%	$419,688	-$325,774	-43.7%	$3,008	-$125,353	-97.7%	$602,090	-$2,107,151	-77.8%
Total	$178,924	-$3,472,267	-95.1%	$419,688	-$511,431	-54.9%	$5,672	-$124,870	-95.7%	$605,256	-$3,897,774	-86.6%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-16. Direct changes in harvesting sector personal income (in 2002 dollars) caused by changes in commercial landings under the project alternatives. Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 3 - Escapement Goal Management at the Population Level/Terminal Fisheries Only											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Specie	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number		Change from Baseline (%)	Number	Change from Baseline	% Change
Chinook												
Non-tribal												
Marine Net	$11	-$122,817	-100.0%	$0	-$10,676	-100.0%	$0	$0	0.0%	$11	-$126,878	-100.0%
Tribal												
Marine Net	$0	-$150,229	-100.0%	$0	-$69,526	-100.0%	$0	-$7,533	-100.0%	$0	-$221,500	-100.0%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$8,041	-100.0%	$0	-$7,714	-100.0%
Freshwater Net	$0	-$15,383	-100.0%	$204,481	$36,178	21.5%	$0	-$14	-100.0%	$213,848	$23,328	12.2%
Tribal Subtotal	$0	-$165,612	-100.0%	$204,481	-$33,348	-14.0%	$0	-$15,588	-100.0%	$213,848	-$205,887	-49.1%
Total	$11	-$288,429	-100.0%	$204,481	-$44,025	-17.7%	$0	-$15,588	-100.0%	$213,859	-$332,765	-60.9%
Coho												
Non-tribal												
Marine Net	$637	-$18,820	-96.7%	$0	-$7,249	-100.0%	$2,664	$483	22.2%	$3,156	-$24,078	-88.4%
Tribal												
Marine Net	$0	-$90,181	-100.0%	$0	-$91,097	-100.0%	$0	-$24,466	-100.0%	$0	-$198,848	-100.0%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$998	-100.0%	$0	-$994	-100.0%
Freshwater Net	$163	-$32,036	-99.5%	$78,830	$3,396	4.5%	$1,857	-$88	-4.5%	$82,471	-$25,792	-23.8%
Tribal Subtotal	$163	-$122,217	-99.9%	$78,830	-$87,701	-52.7%	$1,857	-$25,553	-93.2%	$82,471	-$225,634	-73.2%
Total	$800	-$141,037	-99.4%	$78,830	-$94,949	-54.6%	$4,520	-$25,070	-84.7%	$85,627	-$249,711	-74.5%
Sockeye												
Non-tribal												
Marine Net	$0	-$736,768	-100.0%	$0	$0	0.0%	$0	$0	0.0%	$0	-$689,480	-100.0%
Tribal												
Marine Net	$0	-$763,703	-100.0%	$0	$0	0.0%	$0	-$76,712	-100.0%	$0	-$788,554	-100.0%
Freshwater Net	$0	-$689	-100.0%	$0	-$117,163	-100.0%	$0	$0	0.0%	$0	-$123,700	-100.0%
Tribal Subtotal	$0	-$764,392	-100.0%	$0	-$117,163	-100.0%	$0	-$76,712	-100.0%	$0	-$912,254	-100.0%
Total	$0	-$1,501,160	-100.0%	$0	-$117,163	-100.0%	$0	-$76,712	-100.0%	$0	-$1,601,734	-100.0%
Pink												
Non-tribal												
Marine Net	$0	-$753,599	-100.0%	$0	-$4,226	-100.0%	$0	$0	0.0%	$0	-$715,294	-100.0%
Tribal												
Marine Net	$0	-$726,365	-100.0%	$0	-$27,355	-100.0%	$0	-$1,432	-100.0%	$0	-$715,286	-100.0%
Freshwater Net	$0	-$50,763	-100.0%	$25,619	$25,453	15257.6%	$0	$0	0.0%	$26,924	-$21,135	-44.0%
Tribal Subtotal	$0	-$777,128	-100.0%	$25,619	-$1,903	-6.9%	$0	-$1,432	-100.0%	$26,924	-$736,421	-96.5%
Total	$0	-$1,530,727	-100.0%	$25,619	-$6,128	-19.3%	$0	-$1,432	-100.0%	$26,924	-$1,451,715	-98.2%
Chum												
Non-tribal												
Marine Net	$0	-$77,981	-100.0%	$0	-$163,507	-100.0%	$0	$0	0.0%	$0	-$234,893	-100.0%
Tribal												
Marine Net	$0	-$65,635	-100.0%	$0	-$137,463	-100.0%	$0	-$5,804	-100.0%	$0	-$203,909	-100.0%
Freshwater Net	$868	-$43,465	-98.0%	$109,632	$51,822	89.6%	$1	$1	0.0%	$110,669	$12,354	12.6%
Tribal Subtotal	$868	-$109,099	-99.2%	$109,632	-$85,641	-43.9%	$1	-$5,803	-100.0%	$110,669	-$191,555	-63.4%
Total	$868	-$187,081	-99.5%	$109,632	-$249,147	-69.4%	$1	-$5,803	-100.0%	$110,669	-$426,448	-79.4%
Steelhead												
Non-tribal												
Marine Net	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%
Tribal												
Marine Net	$0	-$598	-100.0%	$0	-$13	-100.0%	$0	-$248	-100.0%	$0	-$816	-100.0%
Freshwater Net	$436	-$44	-9.2%	$1,125	-$5	-0.5%	$1,150	-$19	-1.6%	$2,697	-$65	-2.4%
Tribal Subtotal	$436	-$642	-59.6%	$1,125	-$18	-1.6%	$1,150	-$267	-18.8%	$2,697	-$881	-24.6%
Total	$436	-$642	-59.6%	$1,125	-$18	-1.6%	$1,150	-$267	-18.8%	$2,697	-$881	-24.6%
Total												
Non-tribal												
Marine Net	$648	-$1,709,985	-100.0%	$0	-$185,657	-100.0%	$2,664	$483	22.2%	$3,167	-$1,790,623	-99.8%
Tribal												
Marine Net	$0	-$1,796,710	-100.0%	$0	-$325,455	-100.0%	$0	-$116,194	-100.0%	$0	-$2,128,913	-100.0%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$9,039	-100.0%	$0	-$8,708	-100.0%
Freshwater Net	$1,467	-$142,380	-99.0%	$419,688	-$319	-0.1%	$3,008	-$120	-3.8%	$436,609	-$135,011	-23.6%
Tribal Subtotal	$1,467	-$1,939,091	-99.9%	$419,688	-$325,774	-43.7%	$3,008	-$125,353	-97.7%	$436,609	-$2,272,632	-83.9%
Total	$2,115	-$3,649,076	-99.9%	$419,688	-$511,431	-54.9%	$5,672	-$124,870	-95.7%	$439,776	-$4,063,255	-90.2%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-16. Direct changes in harvesting sector personal income (in 2002 dollars) caused by changes in commercial landings under the project alternatives. Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 4 - No Fishing											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Specie	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number		Change from Baseline (%)	Number	Change from Baseline	% Change
Chinook												
Non-tribal												
Marine Net	$0	-$122,828	-100.0%	$0	-$10,676	-100.0%	$0	$0	0.0%	$0	-$126,889	-100.0%
Tribal												
Marine Net	$0	-$150,229	-100.0%	$0	-$69,526	-100.0%	$0	-$7,533	-100.0%	$0	-$221,500	-100.0%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$8,041	-100.0%	$0	-$7,714	-100.0%
Freshwater Net	$0	-$15,383	-100.0%	$0	-$168,303	-100.0%	$0	-$14	-100.0%	$0	-$190,520	-100.0%
Tribal Subtotal	$0	-$165,612	-100.0%	$0	-$237,830	-100.0%	$0	-$15,588	-100.0%	$0	-$419,735	-100.0%
Total	$0	-$288,441	-100.0%	$0	-$248,506	-100.0%	$0	-$15,588	-100.0%	$0	-$546,623	-100.0%
Coho												
Non-tribal												
Marine Net	$0	-$19,457	-100.0%	$0	-$7,249	-100.0%	$0	-$2,180	-100.0%	$0	-$27,234	-100.0%
Tribal												
Marine Net	$0	-$90,181	-100.0%	$0	-$91,097	-100.0%	$0	-$24,466	-100.0%	$0	-$198,848	-100.0%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$998	-100.0%	$0	-$994	-100.0%
Freshwater Net	$0	-$32,199	-100.0%	$0	-$75,433	-100.0%	$0	-$1,945	-100.0%	$0	-$108,264	-100.0%
Tribal Subtotal	$0	-$122,380	-100.0%	$0	-$166,530	-100.0%	$0	-$27,409	-100.0%	$0	-$308,105	-100.0%
Total	$0	-$141,837	-100.0%	$0	-$173,779	-100.0%	$0	-$29,590	-100.0%	$0	-$335,339	-100.0%
Sockeye												
Non-tribal												
Marine Net	$0	-$736,768	-100.0%	$0	$0	0.0%	$0	$0	0.0%	$0	-$689,480	-100.0%
Tribal												
Marine Net	$0	-$763,703	-100.0%	$0	$0	0.0%	$0	-$76,712	-100.0%	$0	-$788,554	-100.0%
Freshwater Net	$0	-$689	-100.0%	$0	-$117,163	-100.0%	$0	$0	0.0%	$0	-$123,700	-100.0%
Tribal Subtotal	$0	-$764,392	-100.0%	$0	-$117,163	-100.0%	$0	-$76,712	-100.0%	$0	-$912,254	-100.0%
Total	$0	-$1,501,160	-100.0%	$0	-$117,163	-100.0%	$0	-$76,712	-100.0%	$0	-$1,601,734	-100.0%
Pink												
Non-tribal												
Marine Net	$0	-$753,599	-100.0%	$0	-$4,226	-100.0%	$0	$0	0.0%	$0	-$715,294	-100.0%
Tribal												
Marine Net	$0	-$726,365	-100.0%	$0	-$27,355	-100.0%	$0	-$1,432	-100.0%	$0	-$715,286	-100.0%
Freshwater Net	$0	-$50,763	-100.0%	$0	-$167	-100.0%	$0	$0	0.0%	$0	-$48,059	-100.0%
Tribal Subtotal	$0	-$777,128	-100.0%	$0	-$27,522	-100.0%	$0	-$1,432	-100.0%	$0	-$763,345	-100.0%
Total	$0	-$1,530,727	-100.0%	$0	-$31,748	-100.0%	$0	-$1,432	-100.0%	$0	-$1,478,639	-100.0%
Chum												
Non-tribal												
Marine Net	$0	-$77,981	-100.0%	$0	-$163,507	-100.0%	$0	$0	0.0%	$0	-$234,893	-100.0%
Tribal												
Marine Net	$0	-$65,635	-100.0%	$0	-$137,463	-100.0%	$0	-$5,804	-100.0%	$0	-$203,909	-100.0%
Freshwater Net	$868	-$43,465	-98.0%	$27,406	-$30,405	-52.6%	$1	$1	0.0%	$28,259	-$70,057	-71.3%
Tribal Subtotal	$868	-$109,099	-99.2%	$27,406	-$167,867	-86.0%	$1	-$5,803	-100.0%	$28,259	-$273,965	-90.6%
Total	$868	-$187,081	-99.5%	$27,406	-$331,374	-92.4%	$1	-$5,803	-100.0%	$28,259	-$508,859	-94.7%
Steelhead												
Non-tribal												
Marine Net	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%
Tribal												
Marine Net	$0	-$598	-100.0%	$0	-$13	-100.0%	$0	-$248	-100.0%	$0	-$816	-100.0%
Freshwater Net	$436	-$44	-9.2%	$882	-$248	-22.0%	$1,149	-$21	-1.8%	$2,440	-$322	-11.7%
Tribal Subtotal	$436	-$642	-59.6%	$882	-$261	-22.9%	$1,149	-$269	-19.0%	$2,440	-$1,138	-31.8%
Total	$436	-$642	-59.6%	$882	-$261	-22.9%	$1,149	-$269	-19.0%	$2,440	-$1,138	-31.8%
Total												
Non-tribal												
Marine Net	$0	-$1,710,634	-100.0%	$0	-$185,657	-100.0%	$0	-$2,180	-100.0%	$0	-$1,793,789	-100.0%
Tribal												
Marine Net	$0	-$1,796,710	-100.0%	$0	-$325,455	-100.0%	$0	-$116,194	-100.0%	$0	-$2,128,913	-100.0%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$9,039	-100.0%	$0	-$8,708	-100.0%
Freshwater Net	$1,303	-$142,544	-99.1%	$28,288	-$391,719	-93.3%	$1,150	-$1,978	-63.2%	$30,698	-$540,922	-94.6%
Tribal Subtotal	$1,303	-$1,939,254	-99.9%	$28,288	-$717,174	-96.2%	$1,150	-$127,212	-99.1%	$30,698	-$2,678,543	-98.9%
Total	$1,303	-$3,649,888	-100.0%	$28,288	-$902,831	-97.0%	$1,150	-$129,392	-99.1%	$30,698	-$4,472,332	-99.3%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-17. Direct changes in processing sector personal income (in 2002 dollars) caused by changes in commercial landings under the project alternatives.

Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

	Alternative 1 - Proposed Action/Status Quo			
Specie	North Puget Sound	SPS/SHC*	SJF/ NHC*	State Total
Chinook				
Non-tribal				
Marine Net	$107,298	$9,284	$0	$112,790
Tribal				
Marine Net	$131,235	$60,458	$6,706	$196,889
Marine Troll	$0	$0	$4,742	$4,641
Freshwater Net	$13,438	$146,351	$13	$169,351
Tribal Subtotal	$144,673	$206,808	$11,461	$370,881
Total	$251,971	$216,092	$11,461	$483,671
Coho				
Non-tribal				
Marine Net	$34,842	$13,047	$4,081	$51,300
Tribal				
Marine Net	$161,487	$163,974	$45,796	$374,573
Marine Troll	$0	$0	$1,834	$1,798
Freshwater Net	$57,659	$135,780	$3,640	$203,939
Tribal Subtotal	$219,146	$299,755	$51,271	$580,310
Total	$253,988	$312,802	$55,352	$631,611
Sockeye				
Non-tribal				
Marine Net	$513,710	$0	$0	$492,486
Tribal				
Marine Net	$532,490	$0	$54,901	$563,253
Freshwater Net	$481	$83,247	$0	$88,357
Tribal Subtotal	$532,971	$83,247	$54,901	$651,610
Total	$1,046,680	$83,247	$54,901	$1,144,096
Pink				
Non-tribal				
Marine Net	$1,009,285	$5,658	$0	$986,613
Tribal				
Marine Net	$972,810	$36,628	$1,945	$986,601
Freshwater Net	$67,987	$223	$0	$66,289
Tribal Subtotal	$1,040,797	$36,852	$1,945	$1,052,890
Total	$2,050,081	$42,510	$1,945	$2,039,502
Chum				
Non-tribal				
Marine Net	$389,907	$807,314	$0	$1,221,444
Tribal				
Marine Net	$328,174	$678,723	$34,341	$1,060,327
Freshwater Net	$221,661	$285,439	$0	$511,239
Tribal Subtotal	$549,835	$964,162	$34,341	$1,571,566
Total	$939,742	$1,771,476	$34,341	$2,793,010
Steelhead				
Non-tribal				
Marine Net	$0	$0	$0	$0
Tribal				
Marine Net	$801	$18	$337	$1,407
Freshwater Net	$642	$1,513	$1,588	$4,762
Tribal Subtotal	$1,443	$1,531	$1,925	$6,169
Total	$1,443	$1,531	$1,925	$6,169
Total				
Non-tribal				
Marine Net	$2,055,041	$835,303	$4,081	$2,864,633
Tribal				
Marine Net	$2,126,996	$939,801	$144,026	$3,183,050
Marine Troll	$0	$0	$6,576	$6,439
Freshwater Net	$361,868	$652,554	$5,241	$1,043,937
Tribal Subtotal	$2,488,865	$1,592,354	$155,844	$4,233,426
Total	$4,543,906	$2,427,658	$159,926	$7,098,058

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-17. Direct changes in processing sector personal income (in 2002 dollars) caused by changes in commercial landings under the project alternatives. Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 2 - Escapement Goal Management at the Management Unit Level											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Specie	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change
Chinook												
Non-tribal												
Marine Net	$10	-$107,288	-100.0%	$0	-$9,284	-100.0%	$0	$0	0.0%	$10	-$112,780	-100.0%
Tribal												
Marine Net	$37,740	-$93,495	-71.2%	$0	-$60,458	-100.0%	$0	-$6,706	-100.0%	$36,180	-$160,709	-81.6%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$4,742	-100.0%	$0	-$4,641	-100.0%
Freshwater Net	$3,587	-$9,851	-73.3%	$177,810	$31,459	21.5%	$0	-$13	-100.0%	$193,526	$24,175	14.3%
Tribal Subtotal	$41,326	-$103,346	-71.4%	$177,810	-$28,999	-14.0%	$0	-$11,461	-100.0%	$229,706	-$141,175	-38.1%
Total	$41,336	-$210,635	-83.6%	$177,810	-$38,282	-17.7%	$0	-$11,461	-100.0%	$229,716	-$253,955	-52.5%
Coho												
Non-tribal												
Marine Net	$1,141	-$33,701	-96.7%	$0	-$13,047	-100.0%	$4,986	$905	22.2%	$5,945	-$45,356	-88.4%
Tribal												
Marine Net	$0	-$161,487	-100.0%	$0	-$163,974	-100.0%	$0	-$45,796	-100.0%	$0	-$374,573	-100.0%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$1,834	-100.0%	$0	-$1,798	-100.0%
Freshwater Net	$67,812	$10,153	17.6%	$141,894	$6,113	4.5%	$3,475	-$165	-4.5%	$220,040	$16,102	7.9%
Tribal Subtotal	$67,812	-$151,334	-69.1%	$141,894	-$157,861	-52.7%	$3,475	-$47,796	-93.2%	$220,040	-$360,270	-62.1%
Total	$68,953	-$185,035	-72.9%	$141,894	-$170,908	-54.6%	$8,461	-$46,891	-84.7%	$225,985	-$405,625	-64.2%
Sockeye												
Non-tribal												
Marine Net	$0	-$513,710	-100.0%	$0	$0	0.0%	$0	$0	0.0%	$0	-$492,486	-100.0%
Tribal												
Marine Net	$0	-$532,490	-100.0%	$0	$0	0.0%	$0	-$54,901	-100.0%	$0	-$563,253	-100.0%
Freshwater Net	$0	-$481	-100.0%	$0	-$83,247	-100.0%	$0	$0	0.0%	$0	-$88,357	-100.0%
Tribal Subtotal	$0	-$532,971	-100.0%	$0	-$83,247	-100.0%	$0	-$54,901	-100.0%	$0	-$651,610	-100.0%
Total	$0	-$1,046,680	-100.0%	$0	-$83,247	-100.0%	$0	-$54,901	-100.0%	$0	-$1,144,096	-100.0%
Pink												
Non-tribal												
Marine Net	$0	-$1,009,285	-100.0%	$0	-$5,658	-100.0%	$0	$0	0.0%	$0	-$986,613	-100.0%
Tribal												
Marine Net	$0	-$972,810	-100.0%	$0	-$36,628	-100.0%	$0	-$1,945	-100.0%	$0	-$986,601	-100.0%
Freshwater Net	$122,115	$54,128	79.6%	$34,304	$34,081	15257.6%	$0	$0	0.0%	$155,768	$89,479	135.0%
Tribal Subtotal	$122,115	-$918,682	-88.3%	$34,304	-$2,548	-6.9%	$0	-$1,945	-100.0%	$155,768	-$897,122	-85.2%
Total	$122,115	-$1,927,966	-94.0%	$34,304	-$8,206	-19.3%	$0	-$1,945	-100.0%	$155,768	-$1,883,735	-92.4%
Chum												
Non-tribal												
Marine Net	$0	-$389,907	-100.0%	$0	-$807,314	-100.0%	$0	$0	0.0%	$0	-$1,221,444	-100.0%
Tribal												
Marine Net	$0	-$328,174	-100.0%	$0	-$678,723	-100.0%	$0	-$34,341	-100.0%	$0	-$1,060,327	-100.0%
Freshwater Net	$7,420	-$214,241	-96.7%	$541,310	$255,871	89.6%	$8	$8	0.0%	$578,398	$67,159	13.1%
Tribal Subtotal	$7,420	-$542,415	-98.7%	$541,310	-$422,852	-43.9%	$8	-$34,333	-100.0%	$578,398	-$993,168	-63.2%
Total	$7,420	-$932,322	-99.2%	$541,310	-$1,230,166	-69.4%	$8	-$34,333	-100.0%	$578,398	-$2,214,612	-79.3%
Steelhead												
Non-tribal												
Marine Net	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%
Tribal												
Marine Net	$0	-$801	-100.0%	$0	-$18	-100.0%	$0	-$337	-100.0%	$0	-$1,407	-100.0%
Freshwater Net	$583	-$59	-9.2%	$1,506	-$7	-0.5%	$1,563	-$26	-1.6%	$4,650	-$112	-2.4%
Tribal Subtotal	$583	-$860	-59.6%	$1,506	-$25	-1.6%	$1,563	-$363	-18.8%	$4,650	-$1,519	-24.6%
Total	$583	-$860	-59.6%	$1,506	-$25	-1.6%	$1,563	-$363	-18.8%	$4,650	-$1,519	-24.6%
Total												
Non-tribal												
Marine Net	$1,151	-$2,053,891	-99.9%	$0	-$835,303	-100.0%	$4,986	$905	22.2%	$5,954	-$2,858,679	-99.8%
Tribal												
Marine Net	$37,740	-$2,089,257	-98.2%	$0	-$939,801	-100.0%	$0	-$144,026	-100.0%	$36,180	-$3,146,870	-98.9%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$6,576	-100.0%	$0	-$6,439	-100.0%
Freshwater Net	$201,518	-$160,351	-44.3%	$896,824	$244,270	37.4%	$5,046	-$195	-3.7%	$1,152,381	$108,444	10.4%
Tribal Subtotal	$239,257	-$2,249,608	-90.4%	$896,824	-$695,531	-43.7%	$5,046	-$150,798	-96.8%	$1,188,562	-$3,044,864	-71.9%
Total	$240,408	-$4,303,498	-94.7%	$896,824	-$1,530,834	-63.1%	$10,032	-$149,894	-93.7%	$1,194,516	-$5,903,543	-83.2%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-17. Direct changes in processing sector personal income (in 2002 dollars) caused by changes in commercial landings under the project alternatives.
Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

Alternative 3 - Escapement Goal Management at the Population Level/Terminal Fisheries Only											
North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number		Change from Baseline (%)	Number	Change from Baseline	% Change
$10	-$107,288	-100.0%	$0	-$9,284	-100.0%	$0	$0	0.0%	$10	-$112,780	-100.0%
$0	-$131,235	-100.0%	$0	-$60,458	-100.0%	$0	-$6,706	-100.0%	$0	-$196,889	-100.0%
$0	$0	0.0%	$0	$0	0.0%	$0	-$4,742	-100.0%	$0	-$4,641	-100.0%
$0	-$13,438	-100.0%	$177,810	$31,459	21.5%	$0	-$13	-100.0%	$190,087	$20,736	12.2%
$0	-$144,673	-100.0%	$177,810	-$28,999	-14.0%	$0	-$11,461	-100.0%	$190,087	-$180,794	-48.7%
$10	-$251,961	-100.0%	$177,810	-$38,282	-17.7%	$0	-$11,461	-100.0%	$190,097	-$293,574	-60.7%
$1,141	-$33,701	-96.7%	$0	-$13,047	-100.0%	$4,986	$905	22.2%	$5,945	-$45,356	-88.4%
$0	-$161,487	-100.0%	$0	-$163,974	-100.0%	$0	-$45,796	-100.0%	$0	-$374,573	-100.0%
$0	$0	0.0%	$0	$0	0.0%	$0	-$1,834	-100.0%	$0	-$1,798	-100.0%
$293	-$57,366	-99.5%	$141,894	$6,113	4.5%	$3,475	-$165	-4.5%	$155,353	-$48,586	-23.8%
$293	-$218,854	-99.9%	$141,894	-$157,861	-52.7%	$3,475	-$47,796	-93.2%	$155,353	-$424,957	-73.2%
$1,433	-$252,555	-99.4%	$141,894	-$170,908	-54.6%	$8,461	-$46,891	-84.7%	$161,297	-$470,313	-74.5%
$0	-$513,710	-100.0%	$0	$0	0.0%	$0	$0	0.0%	$0	-$492,486	-100.0%
$0	-$532,490	-100.0%	$0	$0	0.0%	$0	-$54,901	-100.0%	$0	-$563,253	-100.0%
$0	-$481	-100.0%	$0	-$83,247	-100.0%	$0	$0	0.0%	$0	-$88,357	-100.0%
$0	-$532,971	-100.0%	$0	-$83,247	-100.0%	$0	-$54,901	-100.0%	$0	-$651,610	-100.0%
$0	-$1,046,680	-100.0%	$0	-$83,247	-100.0%	$0	-$54,901	-100.0%	$0	-$1,144,096	-100.0%
$0	-$1,009,285	-100.0%	$0	-$5,658	-100.0%	$0	$0	0.0%	$0	-$986,613	-100.0%
$0	-$972,810	-100.0%	$0	-$36,628	-100.0%	$0	-$1,945	-100.0%	$0	-$986,601	-100.0%
$0	-$67,987	-100.0%	$34,304	$34,081	15257.6%	$0	$0	0.0%	$37,137	-$29,152	-44.0%
$0	-$1,040,797	-100.0%	$34,304	-$2,548	-6.9%	$0	-$1,945	-100.0%	$37,137	-$1,015,753	-96.5%
$0	-$2,050,081	-100.0%	$34,304	-$8,206	-19.3%	$0	-$1,945	-100.0%	$37,137	-$2,002,366	-98.2%
$0	-$389,907	-100.0%	$0	-$807,314	-100.0%	$0	$0	0.0%	$0	-$1,221,444	-100.0%
$0	-$328,174	-100.0%	$0	-$678,723	-100.0%	$0	-$34,341	-100.0%	$0	-$1,060,327	-100.0%
$4,338	-$217,323	-98.0%	$541,310	$255,871	89.6%	$8	$8	0.0%	$575,478	$64,239	12.6%
$4,338	-$545,497	-99.2%	$541,310	-$422,852	-43.9%	$8	-$34,333	-100.0%	$575,478	-$996,088	-63.4%
$4,338	-$935,404	-99.5%	$541,310	-$1,230,166	-69.4%	$8	-$34,333	-100.0%	$575,478	-$2,217,532	-79.4%
$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%
$0	-$801	-100.0%	$0	-$18	-100.0%	$0	-$337	-100.0%	$0	-$1,407	-100.0%
$583	-$59	-9.2%	$1,506	-$7	-0.5%	$1,563	-$26	-1.6%	$4,650	-$112	-2.4%
$583	-$860	-59.6%	$1,506	-$25	-1.6%	$1,563	-$363	-18.8%	$4,650	-$1,519	-24.6%
$583	-$860	-59.6%	$1,506	-$25	-1.6%	$1,563	-$363	-18.8%	$4,650	-$1,519	-24.6%
$1,151	-$2,053,891	-99.9%	$0	-$835,303	-100.0%	$4,986	$905	22.2%	$5,954	-$2,858,679	-99.8%
$0	-$2,126,996	-100.0%	$0	-$939,801	-100.0%	$0	-$144,026	-100.0%	$0	-$3,183,050	-100.0%
$0	$0	0.0%	$0	$0	0.0%	$0	-$6,576	-100.0%	$0	-$6,439	-100.0%
$5,214	-$356,654	-98.6%	$896,824	$244,270	37.4%	$5,046	-$195	-3.7%	$962,705	-$81,232	-7.8%
$5,214	-$2,483,651	-99.8%	$896,824	-$695,531	-43.7%	$5,046	-$150,798	-96.8%	$962,705	-$3,270,721	-77.3%
$6,365	-$4,537,541	-99.9%	$896,824	-$1,530,834	-63.1%	$10,032	-$149,894	-93.7%	$968,659	-$6,129,400	-86.4%

Table D-17. Direct changes in processing sector personal income (in 2002 dollars) caused by changes in commercial landings under the project alternatives. Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

Alternative 4 - No Fishing											
North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number		Change from Baseline (%)	Number	Change from Baseline	% Change
$0	-$107,298	-100.0%	$0	-$9,284	-100.0%	$0	$0	0.0%	$0	-$112,790	-100.0%
$0	-$131,235	-100.0%	$0	-$60,458	-100.0%	$0	-$6,706	-100.0%	$0	-$196,889	-100.0%
$0	$0	0.0%	$0	$0	0.0%	$0	-$4,742	-100.0%	$0	-$4,641	-100.0%
$0	-$13,438	-100.0%	$0	-$146,351	-100.0%	$0	-$13	-100.0%	$0	-$169,351	-100.0%
$0	-$144,673	-100.0%	$0	-$206,808	-100.0%	$0	-$11,461	-100.0%	$0	-$370,881	-100.0%
$0	-$251,971	-100.0%	$0	-$216,092	-100.0%	$0	-$11,461	-100.0%	$0	-$483,671	-100.0%
$0	-$34,842	-100.0%	$0	-$13,047	-100.0%	$0	-$4,081	-100.0%	$0	-$51,300	-100.0%
$0	-$161,487	-100.0%	$0	-$163,974	-100.0%	$0	-$45,796	-100.0%	$0	-$374,573	-100.0%
$0	$0	0.0%	$0	$0	0.0%	$0	-$1,834	-100.0%	$0	-$1,798	-100.0%
$0	-$57,659	-100.0%	$0	-$135,780	-100.0%	$0	-$3,640	-100.0%	$0	-$203,939	-100.0%
$0	-$219,146	-100.0%	$0	-$299,755	-100.0%	$0	-$51,271	-100.0%	$0	-$580,310	-100.0%
$0	-$253,988	-100.0%	$0	-$312,802	-100.0%	$0	-$55,352	-100.0%	$0	-$631,611	-100.0%
$0	-$513,710	-100.0%	$0	$0	0.0%	$0	$0	0.0%	$0	-$492,486	-100.0%
$0	-$532,490	-100.0%	$0	$0	0.0%	$0	-$54,901	-100.0%	$0	-$563,253	-100.0%
$0	-$481	-100.0%	$0	-$83,247	-100.0%	$0	$0	0.0%	$0	-$88,357	-100.0%
$0	-$532,971	-100.0%	$0	-$83,247	-100.0%	$0	-$54,901	-100.0%	$0	-$651,610	-100.0%
$0	-$1,046,680	-100.0%	$0	-$83,247	-100.0%	$0	-$54,901	-100.0%	$0	-$1,144,096	-100.0%
$0	-$1,009,285	-100.0%	$0	-$5,658	-100.0%	$0	$0	0.0%	$0	-$986,613	-100.0%
$0	-$972,810	-100.0%	$0	-$36,628	-100.0%	$0	-$1,945	-100.0%	$0	-$986,601	-100.0%
$0	-$67,987	-100.0%	$0	-$223	-100.0%	$0	$0	0.0%	$0	-$66,289	-100.0%
$0	-$1,040,797	-100.0%	$0	-$36,852	-100.0%	$0	-$1,945	-100.0%	$0	-$1,052,890	-100.0%
$0	-$2,050,081	-100.0%	$0	-$42,510	-100.0%	$0	-$1,945	-100.0%	$0	-$2,039,502	-100.0%
$0	-$389,907	-100.0%	$0	-$807,314	-100.0%	$0	$0	0.0%	$0	-$1,221,444	-100.0%
$0	-$328,174	-100.0%	$0	-$678,723	-100.0%	$0	-$34,341	-100.0%	$0	-$1,060,327	-100.0%
$4,338	-$217,323	-98.0%	$135,316	-$150,123	-52.6%	$8	$8	0.0%	$146,945	-$364,294	-71.3%
$4,338	-$545,497	-99.2%	$135,316	-$828,846	-86.0%	$8	-$34,333	-100.0%	$146,945	-$1,424,620	-90.6%
$4,338	-$935,404	-99.5%	$135,316	-$1,636,160	-92.4%	$8	-$34,333	-100.0%	$146,945	-$2,646,065	-94.7%
$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%
$0	-$801	-100.0%	$0	-$18	-100.0%	$0	-$337	-100.0%	$0	-$1,407	-100.0%
$583	-$59	-9.2%	$1,181	-$332	-22.0%	$1,560	-$28	-1.8%	$4,207	-$555	-11.7%
$583	-$860	-59.6%	$1,181	-$350	-22.9%	$1,560	-$365	-19.0%	$4,207	-$1,962	-31.8%
$583	-$860	-59.6%	$1,181	-$350	-22.9%	$1,560	-$365	-19.0%	$4,207	-$1,962	-31.8%
$0	-$2,055,041	-100.0%	$0	-$835,303	-100.0%	$0	-$4,081	-100.0%	$0	-$2,864,633	-100.0%
$0	-$2,126,996	-100.0%	$0	-$939,801	-100.0%	$0	-$144,026	-100.0%	$0	-$3,183,050	-100.0%
$0	$0	0.0%	$0	$0	0.0%	$0	-$6,576	-100.0%	$0	-$6,439	-100.0%
$4,922	-$356,947	-98.6%	$136,497	-$516,057	-79.1%	$1,568	-$3,673	-70.1%	$151,152	-$892,785	-85.5%
$4,922	-$2,483,943	-99.8%	$136,497	-$1,455,857	-91.4%	$1,568	-$154,276	-99.0%	$151,152	-$4,082,274	-96.4%
$4,922	-$4,538,985	-99.9%	$136,497	-$2,291,161	-94.4%	$1,568	-$158,357	-99.0%	$151,152	-$6,946,907	-97.9%

D3 Sport Fishing Activity and Values

D3.1 Methods

Estimates of the number of sport fishing trips in marine and fresh waters of Puget Sound were developed for each alternative by the fishery modeling group and provided to the economic analysis team. For purposes of the economic analysis, these estimates of sport fishing trips were assigned to one of the three economic regions where they occurred (freshwater trips) or to the marina or launch area where they originated (marine trips). The number of trips and the level of spending by residents and non-residents of the region also were estimated to evaluate the effects on the regional economy. Lastly, the net economic value (net benefits to anglers) associated with the alternatives was estimated. The following steps were undertaken to accomplish these tasks.

D3.1.1 Step 1: Allocate Sport Fishing Trips to Economic Regions

Estimated sport fishing trips in *marine waters* were allocated to the economic regions based on angler catch records information from the Washington Department of Fish and Wildlife (WDFW). The WDFW data report the percentage of the 2001 sport harvest in each Marine Catch Area that was caught by persons residing in each county and region. Using this information, the estimated number of sport fishing trips was allocated to the three economic regions as shown in Table D-18.

Table D-18. Allocation of marine and freshwater sport fishing trips to each economic region.

Region	Marine	Freshwater
Strait of Juan de Fuca/ South Hood Canal	49.9%	8.1%
South Puget Sound/ South Hood Canal	32.8%	40.2%
North Puget Sound	17.3%	51.7%

Estimated sport fishing trips in *fresh waters* were allocated to the economic regions based on the location where the streams and rivers are located (Table D-18). In cases where the predicted number of sport fishing trips in fresh waters included trips in rivers and streams in more than one economic region (e.g., Marine Catch Areas 8 and 9 and Marine Catch Area 12), the trips were apportioned based on the percentage of the trips that occurred in each region. For Marine Catch Areas 8 and 9, it was estimated that about 90 percent of the trips were to fresh waters in the North Puget Sound region and 10 percent of the trips were to rivers and streams in the Strait of Juan de Fuca/North Hood Canal region. For Marine Catch Area 12, it was estimated that about 83 percent of the trips were to rivers and streams in the South Puget Sound/South Hood Canal region, and that 17 percent of the trips were to rivers and streams in the Strait of Juan de Fuca/North Hood Canal region.

D3.1.2 Step 2: Allocate Sport Fishing Trips to Locals and Non-Locals

The number of sport fishing trips by region (Step 1) was then apportioned to trips made by local residents (i.e., residents of a region of interest), trips made by non-local residents (i.e., persons who live outside the region of interest but within the state), and trips made by non-residents (i.e., persons who live outside the state). The percentages of trips made by local residents, non-local residents, and non-residents were derived from Washington Department of Fish and Wildlife information on the proportion of the 2001 sport catch of salmon in marine waters by county of origin of anglers (Table D.A-12). For example, the average proportion of the 2001 sport harvest in catch areas 5 and 6 (the primary catch areas in proximity to the Strait of Juan de Fuca/South Hood Canal region) caught by persons living in Clallam and Jefferson Counties was 42 percent (16.8% + 67.6% divided by 2). Similar calculations were made for the proportion of catch by persons residing in the South Puget Sound/South Hood Canal region (85 percent) and North Puget Sound Region (72%). Note that the calculated proportion for persons residing in the South Puget Sound/South Hood Canal region (78%) was adjusted upwards to 85 percent to account for the relatively large population that lives in that region.

D3.1.3 Step 3: Allocate Marine Sport Fishing Trips by Mode of Fishing

The number of marine sport fishing trips by region and by residency (Step 2) was then allocated by mode of fishing. (Note that freshwater sport fishing trips were not allocated by mode because information on spending by mode was not available.) Three modes of marine sport fishing were considered: private/rental boat fishing, charter boat fishing, and shore fishing. The percentages used to allocate sport fishing trips by mode were as follows: private/rental boat fishing, 90 percent of all sport fishing trips; charter boat fishing, 5 percent of all sport fishing trips; and shore fishing, 5 percent of all sport fishing trips. These percentages were developed from information reported in an economic report on salmon and sturgeon fishing prepared for the Washington Department of Community Development (ICF Technology Incorporated 1988), and on recent discussions with staff at the Washington Department of Fish and Wildlife (personal communication with Pat Pattillo, Washington Department of Fish and Wildlife, December 20, 2003).

D3.1.4 Step 4: Convert Sport Fishing Trips in Each Region to Spending

The number of sport fishing trips by local residents, non-local residents, and non-residents was then converted to spending within each region. Estimates of average spending per trip were developed based on information from two previous studies (The Research Group 1991 and Gentner et al. 2001) of expenditures associated with sport fishing in marine and fresh waters in the Pacific Northwest. As shown in Table D-19, regional spending by local and non-local residents who sport fish for salmon and steelhead *in marine waters* of the Puget Sound is estimated to average about $52 per angler day for fishing from the shore, $46 per angler day for fishing from private boats, and $152 per angler day for fishing from charter boats (in 2002 dollars). Regional spending by non-residents who sport fish for salmon and steelhead *in marine waters* of the Puget Sound is estimated to average about $105 per angler day for fishing from the shore, $96 per angler day for fishing from private boats, and $208 per angler day for fishing from charter boats (in 2002 dollars). Expenditures associated with sport fishing for salmon and steelhead *in fresh waters* of Puget Sound are estimated at about $66 per angler day by local and non-local residents and about $65 per angler day by non-residents.

It should be noted that these spending estimates do not include spending outside the region of interest. For example, most non-residents who come to the Puget Sound area to sportfish also incur costs outside the Puget Sound area (i.e., at home or en-route to their fishing destination); these costs, however, are not included in the estimates in Table D-19 because they do not affect the Puget Sound regional economy.

D3.1.5 Step 3: Estimate Net Economic Value

Net economic values associated with sport fishing include the value that the Puget Sound salmon fishery generates for consumers and producers. Net economic value to consumers is measured by the dollar amount anglers would be willing to pay over and above what they actually pay to participate in sport fishing. Net economic value to producers (e.g., charter boat operators, guides, and other sport fishing-related businesses) is measured by the net income (or profit) generated by sales to recreational anglers.

For this analysis, only net economic values to sport anglers are evaluated. It is assumed that most changes in the net income to producers (i.e., businesses that directly supply goods and services to anglers) would be offset by a change in net income to producers of other goods and services. For example, if sport anglers have fewer opportunities to sport fish for salmon in Puget Sound, the reduction in net income to sport fishery-related producers associated with the reduction in angler spending would be offset by increases in net income to producers of other goods and services as anglers shift their spending patterns. Consequently, there likely would be little net change in net income from a regional or state perspective; however, it should be recognized that suppliers of sport fishing-related goods and services would likely experience a net loss in income.

Table D-19. Average angler spending per trip by mode and angler group.

Angler Group/Expenditure Sector	Marine Charter	Marine Private Boat	Marine Shore	Freshwater
Local Residents:				
Transportation	$31.67	$17.57	$22.08	$15.15
Food	$22.06	$10.01	$12.93	$16.24
Lodging	$28.26	$7.56	$11.95	$0.60
Boat Fuel	$0.00	$6.66	$0.00	$12.04
Party/Charter Fees	$52.91	$0.00	$0.00	$2.15
Access/Boat Launching	$0.22	$1.45	$0.18	$0.00
Equipment Rental	$15.81	$0.37	$1.46	$2.46
Bait and Ice	$1.07	$3.00	$3.54	$17.55
Total	$152.00	$46.62	$52.14	$66.20
Non-Local Residents:				
Transportation	$31.67	$17.57	$22.08	$10.43
Food	$22.06	$10.01	$12.93	$19.09
Lodging	$28.26	$7.56	$11.95	$4.56
Boat Fuel	$0.00	$6.66	$0.00	$10.84
Party/Charter Fees	$52.91	$0.00	$0.00	$3.73
Access/Boat Launching	$0.22	$1.45	$0.18	$0.00
Equipment Rental	$15.81	$0.37	$1.46	$2.24
Bait and Ice	$1.07	$3.00	$3.54	$15.31
Total	$152.00	$46.62	$52.14	$66.20
Non-residents of the State:				
Transportation	$99.45	$44.07	$55.57	$5.58
Food	$21.87	$21.60	$17.03	$21.46
Lodging	$25.37	$12.68	$16.10	$8.33
Boat Fuel	$0.00	$10.34	$0.00	$9.43
Party/Charter Fees	$34.39	$0.00	$0.00	$5.18
Access/Boat Launching	$2.12	$1.97	$4.30	$0.00
Equipment Rental	$23.40	$1.45	$6.73	$1.98
Bait and Ice	$1.27	$4.20	$5.61	$12.78
Total	$207.87	$96.31	$105.34	$64.74

As discussed in Section 3.6, the net economic value to sport anglers is estimated based on a study of sport fishing for salmon and steelhead in the Pacific Northwest (Olsen et al. 1991). The average net economic value of sport fishing for salmon and steelhead in Puget Sound waters (including tributaries) was estimated at about $47 per angler day (in 1989 dollars). When adjusted to 2000 dollars using the consumer price index, the value is $65 per angler day. This factor was applied to the estimated number of angler days provided by the fishery modeling group to estimate the net economic value of sport fishing under the Proposed Action and alternatives.

D3.2 Assumptions Used in the Analysis

The following key assumptions were incorporated into the assessment of sport fishing activity and values.

- Ninety percent (90%) of the sport fishing trips in the marine waters of Puget Sound occur with the use of private/rental boats, 5 percent occurs with the use of charter boats, and 5 percent occurs from the shore.
- Changes (reductions) in net income to sport fishing-related businesses associated with reductions in angler spending were assumed to be offset by increases in net income to producers of other goods and services.

D3.3 Estimated Values

The estimated regional distributions of sport fishing trips and angler spending resulting from the methodology and assumptions described above are presented in Tables D-20 and D-21 for all alternatives under Scenario B (2003 abundance and 2003 Canadian/Alaskan fisheries).

Table D-20. Estimated sport fishing angler trips by angler group, angler mode, and economic region.
Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

Angler Group	Alternative 1 - Proposed Action/Status Quo			
	North Puget Sound	SPS/SHC*	SJF/ NHC*	State Total
Local Residents				
Marine Charter Boat	4,997	10,224	4,902	20,123
Marine Private Boat	89,945	184,024	88,235	362,204
Marine Shore	4,997	10,224	4,902	20,123
Freshwater (all modes)	267,433	242,080	24,567	534,080
Subtotal	367,372	446,552	122,606	936,530
Non-Local Residents				
Marine Charter Boat	1,027	1,247	11,826	14,100
Marine Private Boat	18,484	22,448	212,866	253,798
Marine Shore	1,027	1,247	11,826	14,100
Freshwater (all modes)	92,859	34,176	29,246	156,281
Subtotal	113,397	59,118	265,764	438,279
Non-residents of the State				
Marine Charter Boat	232	279	1,235	1,746
Marine Private Boat	4,180	5,023	22,232	31,435
Marine Shore	232	279	1,235	1,746
Freshwater (all modes)	11,143	8,544	4,679	24,366
Subtotal	15,787	14,125	29,381	59,293
Total				
Marine Charter Boat	6,256	11,750	17,963	35,969
Marine Private Boat	112,609	211,495	323,333	647,437
Marine Shore	6,256	11,750	17,963	35,969
Freshwater (all modes)	371,435	284,800	58,492	714,727
Total	496,556	519,795	417,751	1,434,102

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-20. Estimated sport fishing angler trips by angler group, angler mode, and economic region, *continued*.

Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 2 - Escapement Goal Management at the Management Unit Level											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Angler Group	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change
Local Residents												
Marine Charter Boat	0	-4,997	-100.0%	0	-10,224	-100.0%	0	-4,902	-100.0%	0	-20,123	-100.0%
Marine Private Boat	0	-89,945	-100.0%	0	-184,024	-100.0%	0	-88,235	-100.0%	0	-362,204	-100.0%
Marine Shore	0	-4,997	-100.0%	0	-10,224	-100.0%	0	-4,902	-100.0%	0	-20,123	-100.0%
reshwater (all modes)	81,460	-185,973	-69.5%	86,084	-155,996	-64.4%	3,808	-20,759	-84.5%	171,352	-362,728	-67.9%
Subtotal	81,460	-285,912	-77.8%	86,084	-360,468	-80.7%	3,808	-118,798	-96.9%	171,352	-765,178	-81.7%
Non-Local Residents												
Marine Charter Boat	0	-1,027	-100.0%	0	-1,247	-100.0%	0	-11,826	-100.0%	0	-14,100	-100.0%
Marine Private Boat	0	-18,484	-100.0%	0	-22,448	-100.0%	0	-212,866	-100.0%	0	-253,798	-100.0%
Marine Shore	0	-1,027	-100.0%	0	-1,247	-100.0%	0	-11,826	-100.0%	0	-14,100	-100.0%
reshwater (all modes)	28,285	-64,574	-69.5%	12,153	-22,023	-64.4%	4,534	-24,712	-84.5%	44,972	-111,309	-71.2%
Subtotal	28,285	-85,112	-75.1%	12,153	-46,965	-79.4%	4,534	-261,230	-98.3%	44,972	-393,307	-89.7%
Non-residents of the State												
Marine Charter Boat	0	-232	-100.0%	0	-279	-100.0%	0	-1,235	-100.0%	0	-1,746	-100.0%
Marine Private Boat	0	-4,180	-100.0%	0	-5,023	-100.0%	0	-22,232	-100.0%	0	-31,435	-100.0%
Marine Shore	0	-232	-100.0%	0	-279	-100.0%	0	-1,235	-100.0%	0	-1,746	-100.0%
reshwater (all modes)	3,394	-7,749	-69.5%	3,038	-5,506	-64.4%	725	-3,954	-84.5%	7,157	-17,209	-70.6%
Subtotal	3,394	-12,393	-78.5%	3,038	-11,087	-78.5%	725	-28,656	-97.5%	7,157	-52,136	-87.9%
Total												
Marine Charter Boat	0	-6,256	-100.0%	0	-11,750	-100.0%	0	-17,963	-100.0%	0	-35,969	-100.0%
Marine Private Boat	0	-112,609	-100.0%	0	-211,495	-100.0%	0	-323,333	-100.0%	0	-647,437	-100.0%
Marine Shore	0	-6,256	-100.0%	0	-11,750	-100.0%	0	-17,963	-100.0%	0	-35,969	-100.0%
reshwater (all modes)	113,139	-258,296	-69.5%	101,275	-183,525	-64.4%	9,067	-49,425	-84.5%	223,481	-491,246	-68.7%
Total	113,139	-383,417	-77.2%	101,275	-418,520	-80.5%	9,067	-408,684	-97.8%	223,481	-1,210,621	-84.4%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-20. Estimated sport fishing angler trips by angler group, angler mode, and economic region, *continued*.

Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 3 - Escapement Goal Management at the Population Level/Terminal Fisheries Only											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Angler Group	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number		Change from Baseline (%)	Number	Change from Baseline	% Change
Local Residents												
Marine Charter Boat	0	-4,997	-100.0%	0	-10,224	-100.0%	0	-4,902	-100.0%	0	-20,123	-100.0%
Marine Private Boat	0	-89,945	-100.0%	0	-184,024	-100.0%	0	-88,235	-100.0%	0	-362,204	-100.0%
Marine Shore	0	-4,997	-100.0%	0	-10,224	-100.0%	0	-4,902	-100.0%	0	-20,123	-100.0%
reshwater (all modes)	46,152	-221,281	-82.7%	86,086	-155,994	-64.4%	1,520	-23,047	-93.8%	133,758	-400,322	-75.0%
Subtotal	46,152	-321,220	-87.4%	86,086	-360,466	-80.7%	1,520	-121,086	-98.8%	133,758	-802,772	-85.7%
Non-Local Residents												
Marine Charter Boat	0	-1,027	-100.0%	0	-1,247	-100.0%	0	-11,826	-100.0%	0	-14,100	-100.0%
Marine Private Boat	0	-18,484	-100.0%	0	-22,448	-100.0%	0	-212,866	-100.0%	0	-253,798	-100.0%
Marine Shore	0	-1,027	-100.0%	0	-1,247	-100.0%	0	-11,826	-100.0%	0	-14,100	-100.0%
reshwater (all modes)	16,025	-76,834	-82.7%	12,153	-22,023	-64.4%	1,809	-27,437	-93.8%	29,987	-126,294	-80.8%
Subtotal	16,025	-97,372	-85.9%	12,153	-46,965	-79.4%	1,809	-263,955	-99.3%	29,987	-408,292	-93.2%
Non-residents of the State												
Marine Charter Boat	0	-232	-100.0%	0	-279	-100.0%	0	-1,235	-100.0%	0	-1,746	-100.0%
Marine Private Boat	0	-4,180	-100.0%	0	-5,023	-100.0%	0	-22,232	-100.0%	0	-31,435	-100.0%
Marine Shore	0	-232	-100.0%	0	-279	-100.0%	0	-1,235	-100.0%	0	-1,746	-100.0%
reshwater (all modes)	1,923	-9,220	-82.7%	3,038	-5,506	-64.4%	289	-4,390	-93.8%	5,250	-19,116	-78.5%
Subtotal	1,923	-13,864	-87.8%	3,038	-11,087	-78.5%	289	-29,092	-99.0%	5,250	-54,043	-91.1%
Total												
Marine Charter Boat	0	-6,256	-100.0%	0	-11,750	-100.0%	0	-17,963	-100.0%	0	-35,969	-100.0%
Marine Private Boat	0	-112,609	-100.0%	0	-211,495	-100.0%	0	-323,333	-100.0%	0	-647,437	-100.0%
Marine Shore	0	-6,256	-100.0%	0	-11,750	-100.0%	0	-17,963	-100.0%	0	-35,969	-100.0%
reshwater (all modes)	64,100	-307,335	-82.7%	101,277	-183,523	-64.4%	3,618	-54,874	-93.8%	168,995	-545,732	-76.4%
Total	64,100	-432,456	-87.1%	101,277	-418,518	-80.5%	3,618	-414,133	-99.1%	168,995	-1,265,107	-88.2%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-20. Estimated sport fishing angler trips by angler group, angler mode, and economic region, *continued* .

Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 4 - No Fishing											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Angler Group	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number		Change from Baseline (%)	Number	Change from Baseline	% Change
Local Residents												
Marine Charter Boat	0	-4,997	-100.0%	0	-10,224	-100.0%	0	-4,902	-100.0%	0	-20,123	-100.0%
Marine Private Boat	0	-89,945	-100.0%	0	-184,024	-100.0%	0	-88,235	-100.0%	0	-362,204	-100.0%
Marine Shore	0	-4,997	-100.0%	0	-10,224	-100.0%	0	-4,902	-100.0%	0	-20,123	-100.0%
reshwater (all modes)	1,476	-265,957	-99.4%	1,801	-240,279	-99.3%	59	-24,508	-99.8%	3,336	-530,744	-99.4%
Subtotal	1,476	-365,896	-99.6%	1,801	-444,751	-99.6%	59	-122,547	-100.0%	3,336	-933,194	-99.6%
Non-Local Residents												
Marine Charter Boat	0	-1,027	-100.0%	0	-1,247	-100.0%	0	-11,826	-100.0%	0	-14,100	-100.0%
Marine Private Boat	0	-18,484	-100.0%	0	-22,448	-100.0%	0	-212,866	-100.0%	0	-253,798	-100.0%
Marine Shore	0	-1,027	-100.0%	0	-1,247	-100.0%	0	-11,826	-100.0%	0	-14,100	-100.0%
reshwater (all modes)	513	-92,346	-99.4%	254	-33,922	-99.3%	70	-29,176	-99.8%	837	-155,444	-99.5%
Subtotal	513	-112,884	-99.5%	254	-58,864	-99.6%	70	-265,694	-100.0%	837	-437,442	-99.8%
Non-residents of the State												
Marine Charter Boat	0	-232	-100.0%	0	-279	-100.0%	0	-1,235	-100.0%	0	-1,746	-100.0%
Marine Private Boat	0	-4,180	-100.0%	0	-5,023	-100.0%	0	-22,232	-100.0%	0	-31,435	-100.0%
Marine Shore	0	-232	-100.0%	0	-279	-100.0%	0	-1,235	-100.0%	0	-1,746	-100.0%
reshwater (all modes)	62	-11,081	-99.4%	64	-8,480	-99.3%	11	-4,668	-99.8%	137	-24,229	-99.4%
Subtotal	62	-15,725	-99.6%	64	-14,061	-99.5%	11	-29,370	-100.0%	137	-59,156	-99.8%
Total												
Marine Charter Boat	0	-6,256	-100.0%	0	-11,750	-100.0%	0	-17,963	-100.0%	0	-35,969	-100.0%
Marine Private Boat	0	-112,609	-100.0%	0	-211,495	-100.0%	0	-323,333	-100.0%	0	-647,437	-100.0%
Marine Shore	0	-6,256	-100.0%	0	-11,750	-100.0%	0	-17,963	-100.0%	0	-35,969	-100.0%
reshwater (all modes)	2,051	-369,384	-99.4%	2,119	-282,681	-99.3%	140	-58,352	-99.8%	4,310	-710,417	-99.4%
Total	2,051	-494,505	-99.6%	2,119	-517,676	-99.6%	140	-417,611	-100.0%	4,310	-1,429,792	-99.7%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-21. Estimated sport fishing expenditures (in 2002 dollars) in the economic regions with implementation of the alternatives. Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

	Average Angler Spending Per Trip within the Region				Average Spending Per Trip by Non-Resident Anglers Within the State but Outside of the Region				Alternative 1 - Proposed Action/Status Quo			
Spending Sectors	Marine Charter	Marine Private Boat	Marine Shore	Freshwater	Marine Charter	Marine Private Boat	Marine Shore	Freshwater	North Puget Sound	SPS/SHC*	SJF/ NHC*	State Total
Local Residents												
Transportation	$31.67	$17.57	$22.08	$15.15	NA	NA	NA	NA	$5,852,511	$7,352,101	$2,138,853	$15,343,466
Food	$22.06	$10.01	$12.93	$16.24	NA	NA	NA	NA	$5,449,288	$6,194,586	$1,484,114	$13,127,988
Lodging	$28.26	$7.56	$11.95	$0.60	NA	NA	NA	NA	$900,158	$1,658,646	$740,376	$3,299,180
Boat Fuel	$0.00	$6.66	$0.00	$12.04	NA	NA	NA	NA	$4,083,318	$4,681,195	$1,142,797	$9,907,310
Party/Charter Fees	$52.91	$0.00	$0.00	$2.15	NA	NA	NA	NA	$576,080	$522,721	$53,897	$1,152,699
ccess/Boat Launching	$0.22	$1.45	$0.18	$0.00	NA	NA	NA	NA	$210,322	$430,317	$206,324	$846,963
Equipment Rental	$15.81	$0.37	$1.46	$2.46	NA	NA	NA	NA	$703,807	$689,472	$105,484	$1,498,763
Bait and Ice	$1.07	$3.00	$3.54	$17.55	NA	NA	NA	NA	$5,740,518	$6,390,817	$1,458,313	$13,589,647
Total	$152.00	$46.62	$52.14	$66.19	NA	NA	NA	NA	$23,516,003	$27,919,855	$7,330,157	$58,766,015
Non-Local Residents												
Transportation	$31.67	$17.57	$22.08	$10.43	NA	NA	NA	NA	$1,348,485	$817,893	$4,680,739	$6,847,117
Food	$22.06	$10.01	$12.93	$19.09	NA	NA	NA	NA	$1,993,638	$920,757	$3,102,887	$6,017,281
Lodging	$28.26	$7.56	$11.95	$4.56	NA	NA	NA	NA	$604,472	$375,691	$2,218,152	$3,198,315
Boat Fuel	$0.00	$6.66	$0.00	$10.84	NA	NA	NA	NA	$1,129,695	$519,972	$1,734,714	$3,384,381
Party/Charter Fees	$52.91	$0.00	$0.00	$3.73	NA	NA	NA	NA	$400,703	$193,455	$734,801	$1,328,959
ccess/Boat Launching	$0.22	$1.45	$0.18	$0.00	NA	NA	NA	NA	$27,213	$33,048	$313,386	$373,647
Equipment Rental	$15.81	$0.37	$1.46	$2.24	NA	NA	NA	NA	$232,580	$106,396	$348,506	$687,482
Bait and Ice	$1.07	$3.00	$3.54	$15.31	NA	NA	NA	NA	$1,481,858	$596,327	$1,140,872	$3,219,057
Total	$152.00	$46.62	$52.14	$66.20	NA	NA	NA	NA	$7,218,642	$3,563,540	$14,274,058	$25,056,239
Non-residents of the State												
Transportation	$99.45	$44.07	$55.57	$5.58	$11.05	$4.90	$6.17	$2.44	$282,355	$312,290	$1,197,323	$2,035,518
Food	$21.87	$21.60	$17.03	$21.46	$2.43	$2.40	$1.89	$3.08	$338,442	$302,704	$628,664	$1,427,844
Lodging	$25.37	$12.68	$16.10	$8.33	$2.82	$1.41	$1.79	$0.50	$155,445	$146,433	$372,093	$738,527
Boat Fuel	$0.00	$10.34	$0.00	$9.43	$0.00	$1.15	$0.00	$1.39	$148,300	$132,508	$274,002	$624,828
Party/Charter Fees	$34.39	$0.00	$0.00	$5.18	$3.82	$0.00	$0.00	$0.00	$65,699	$53,853	$66,709	$192,931
ccess/Boat Launching	$2.12	$1.97	$4.30	$0.00	$0.24	$0.22	$0.48	$0.00	$9,724	$11,686	$51,726	$81,309
Equipment Rental	$23.40	$1.45	$6.73	$1.98	$2.60	$0.16	$0.75	$0.00	$35,114	$32,607	$78,711	$157,311
Bait and Ice	$1.27	$4.20	$5.61	$12.78	$0.14	$0.47	$0.62	$0.00	$161,560	$132,208	$161,669	$471,538
Total	$207.87	$96.31	$105.34	$64.74	$23.10	$10.71	$11.70	$7.41	$1,196,638	$1,124,289	$2,830,897	$5,729,806
Net Impact**												
Transportation	NA	NA	NA	NA	NA	NA	NA	NA	$7,483,351	$8,482,284	$8,016,915	$24,226,101
Food	NA	NA	NA	NA	NA	NA	NA	NA	$7,781,367	$7,418,047	$5,215,664	$20,573,113
Lodging	NA	NA	NA	NA	NA	NA	NA	NA	$1,660,075	$2,180,771	$3,330,621	$7,236,022
Boat Fuel	NA	NA	NA	NA	NA	NA	NA	NA	$5,361,313	$5,333,674	$3,151,513	$13,916,519
Party/Charter Fees	NA	NA	NA	NA	NA	NA	NA	NA	$1,042,482	$770,029	$855,408	$2,674,589
ccess/Boat Launching	NA	NA	NA	NA	NA	NA	NA	NA	$247,259	$475,051	$571,436	$1,301,919
Equipment Rental	NA	NA	NA	NA	NA	NA	NA	NA	$971,501	$828,475	$532,702	$2,343,556
Bait and Ice	NA	NA	NA	NA	NA	NA	NA	NA	$7,383,935	$7,119,353	$2,760,854	$17,280,243
Total	NA	NA	NA	NA	NA	NA	NA	NA	$31,931,283	$32,607,684	$24,435,112	$89,552,061

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

** For Puget Sound regions, the net impact represents effects caused by changes in non-local and non-resident spending relative to baseline spending.
For Washington, the net impact represents effects caused by changes in non-resident spending relative to baseline spending.
The baseline includes local, non-local, and non-resident spending effects.

Table D-21. Estimated sport fishing expenditures (in 2002 dollars) in the economic regions with implementation of the alternatives.
Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 2 - Escapement Goal Management at the Management Unit Level											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Spending Sectors	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change
Local Residents												
Transportation	$1,234,119	-$4,618,392	-0.789130006	$1,304,173	-$6,047,928	-0.822612258	$57,691	-$2,081,162	-0.973027042	$2,595,983	-$12,747,483	-83.1%
Food	$1,322,910	-$4,126,377	-0.757232422	$1,398,004	-$4,796,582	-0.774318387	$61,842	-$1,422,272	-0.958330743	$2,782,756	-$10,345,231	-78.8%
Lodging	$48,876	-$851,282	-0.945702875	$51,650	-$1,606,996	-0.968859906	$2,285	-$738,091	-0.996913999	$102,811	-$3,196,369	-96.9%
Boat Fuel	$980,778	-$3,102,540	-0.759808487	$1,036,451	-$3,644,744	-0.778592563	$45,848	-$1,096,948	-0.959880595	$2,063,078	-$7,844,232	-79.2%
Party/Charter Fees	$175,139	-$400,941	-0.695981614	$185,081	-$337,641	-0.645928706	$8,187	-$45,710	-0.848096822	$368,407	-$784,292	-68.0%
cess/Boat Launching	$0	-$210,322	-1	$0	-$430,317	-1	$0	-$206,324	-1	$0	-$846,963	-100.0%
Equipment Rental	$200,392	-$503,416	-0.715274881	$211,767	-$477,706	-0.692856973	$9,368	-$96,116	-0.911193213	$421,526	-$1,077,238	-71.9%
Bait and Ice	$1,429,623	-$4,310,895	-0.750959214	$1,510,774	-$4,880,043	-0.763602336	$66,830	-$1,391,483	-0.954172799	$3,007,228	-$10,582,420	-77.9%
Total	$5,391,837	-$18,124,165	-0.770716246	$5,697,900	-$22,221,955	-0.795919431	$252,052	-$7,078,106	-0.965614446	$11,341,789	-$47,424,227	-80.7%
Non-Local Residents												
Transportation	$295,013	-$1,053,472	-0.781226592	$126,756	-$691,138	-0.845021604	$47,290	-$4,633,449	-0.989896975	$469,058	-$6,378,059	-93.1%
Food	$539,961	-$1,453,677	-0.729158111	$232,001	-$688,756	-0.748032534	$86,554	-$3,016,332	-0.972105309	$858,515	-$5,158,766	-85.7%
Lodging	$128,980	-$475,492	-0.786624272	$55,418	-$320,274	-0.852491451	$20,675	-$2,197,477	-0.990679161	$205,072	-$2,993,243	-93.6%
Boat Fuel	$306,609	-$823,086	-0.728590991	$131,739	-$388,233	-0.746642816	$49,149	-$1,685,566	-0.971667633	$487,496	-$2,896,884	-85.6%
Party/Charter Fees	$105,503	-$295,200	-0.736704879	$45,331	-$148,125	-0.765678678	$16,912	-$717,889	-0.976984497	$167,746	-$1,161,214	-87.4%
cess/Boat Launching	$0	-$27,213	-1	$0	-$33,048	-1	$0	-$313,386	-1	$0	-$373,647	-100.0%
Equipment Rental	$63,358	-$169,221	-0.727583937	$27,223	-$79,173	-0.744137004	$10,156	-$338,350	-0.970858045	$100,737	-$586,744	-85.3%
Bait and Ice	$433,043	-$1,048,814	-0.707769962	$186,062	-$410,265	-0.687986024	$69,416	-$1,071,457	-0.939155722	$688,521	-$2,530,536	-78.6%
Total	$1,872,467	-$5,346,175	-0.740606739	$804,529	-$2,759,011	-0.774233289	$300,151	-$13,973,907	-0.978972286	$2,977,146	-$22,079,093	-88.1%
Non-residents of the State												
Transportation	$18,939	-$263,417	-0.932926607	$16,952	-$295,338	-0.945716943	$4,046	-$1,193,277	-0.996621212	$57,399	-$1,978,119	-97.2%
Food	$72,835	-$265,606	-0.784792282	$65,195	-$237,509	-0.784623098	$15,559	-$613,106	-0.975251487	$175,633	-$1,252,211	-87.7%
Lodging	$28,272	-$127,173	-0.818121604	$25,307	-$121,127	-0.827180418	$6,039	-$366,054	-0.983769527	$63,196	-$675,330	-91.4%
Boat Fuel	$32,005	-$116,294	-0.784184175	$28,648	-$103,859	-0.783798743	$6,837	-$267,165	-0.975048526	$77,439	-$547,390	-87.6%
Party/Charter Fees	$17,581	-$48,118	-0.732402911	$15,737	-$38,116	-0.707780088	$3,756	-$62,953	-0.943703139	$37,073	-$155,857	-80.8%
cess/Boat Launching	$0	-$9,724	-1	$0	-$11,686	-1	$0	-$51,726	-1	$0	-$81,309	-100.0%
Equipment Rental	$6,720	-$28,394	-0.808621559	$6,015	-$26,592	-0.815521576	$1,436	-$77,276	-0.981762482	$14,171	-$143,140	-91.0%
Bait and Ice	$43,375	-$118,184	-0.731521413	$38,826	-$93,383	-0.706330095	$9,266	-$152,403	-0.942688392	$91,466	-$380,072	-80.6%
Total	$219,728	-$976,911	-0.816379308	$196,680	-$927,609	-0.82506271	$46,937	-$2,783,960	-0.983419918	$516,378	-$5,213,429	-91.0%
Net Impact**												
Transportation	$313,951	-$1,316,889	-0.175975794	$143,708	-$986,475	-0.116298295	$51,335	-$5,826,727	-0.726804087	$57,399	-$1,978,119	-8.2%
Food	$612,796	-$1,719,284	-0.220948776	$297,196	-$926,265	-0.124866389	$102,113	-$3,629,438	-0.695872615	$175,633	-$1,252,211	-6.1%
Lodging	$157,252	-$602,665	-0.363034761	$80,724	-$441,400	-0.202405669	$26,714	-$2,563,531	-0.769685607	$63,196	-$675,330	-9.3%
Boat Fuel	$338,615	-$939,380	-0.175214518	$160,387	-$492,092	-0.092261429	$55,985	-$1,952,731	-0.619616977	$77,439	-$547,390	-3.9%
Party/Charter Fees	$123,084	-$343,318	-0.329327356	$61,068	-$186,240	-0.241861524	$20,667	-$780,843	-0.912831251	$37,073	-$155,857	-5.8%
cess/Boat Launching	$0	-$36,937	-0.149384459	$0	-$44,735	-0.094168516	$0	-$365,112	-0.638937895	$0	-$81,309	-6.2%
Equipment Rental	$70,079	-$197,615	-0.203412344	$33,238	-$105,764	-0.127661658	$11,592	-$415,626	-0.780223164	$14,171	-$143,140	-6.1%
Bait and Ice	$476,419	-$1,166,999	-0.158045648	$224,888	-$503,648	-0.070743455	$78,681	-$1,223,860	-0.443290358	$91,466	-$380,072	-2.2%
Total	$2,092,195	-$6,323,085	-0.198021654	$1,001,209	-$3,686,620	-0.113059857	$347,087	-$16,757,867	-0.685810946	$516,378	-$5,213,429	-5.8%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

** For Puget Sound regions, the net impact represents effects caused by changes in non-local and non-resident spending relative to baseline spending.

For Washington, the net impact represents effects caused by changes in non-resident spending relative to baseline spending.

The baseline includes local, non-local, and non-resident spending effects.

Table D-21. Estimated sport fishing expenditures (in 2002 dollars) in the economic regions with implementation of the alternatives.
Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 3 - Escapement Goal Management at the Population Level/Terminal Fisheries Only											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Spending Sectors	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number		Change from Baseline (%)	Number	Change from Baseline	% Change
Local Residents												
Transportation	$699,203	-$5,153,308	-0.880529438	$1,304,203	-$6,047,898	-0.822608137	$23,028	-$2,115,825	-0.989233483	$2,026,434	-$13,317,032	-86.8%
Food	$749,508	-$4,699,779	-0.862457534	$1,398,037	-$4,796,549	-0.774313144	$24,685	-$1,459,429	-0.983367313	$2,172,230	-$10,955,758	-83.5%
Lodging	$27,691	-$872,467	-0.969237406	$51,652	-$1,606,995	-0.968859182	$912	-$739,464	-0.998768193	$80,255	-$3,218,925	-97.6%
Boat Fuel	$555,670	-$3,527,648	-0.86391703	$1,036,475	-$3,644,719	-0.778587419	$18,301	-$1,124,496	-0.983985952	$1,610,446	-$8,296,863	-83.7%
Party/Charter Fees	$99,227	-$476,853	-0.82775526	$185,085	-$337,636	-0.64592048	$3,268	-$50,629	-0.939366379	$287,580	-$865,119	-75.1%
cess/Boat Launching	$0	-$210,322	-1	$0	-$430,317	-1	$0	-$206,324	-1	$0	-$846,963	-100.0%
Equipment Rental	$113,534	-$590,273	-0.838686058	$211,772	-$477,701	-0.692849837	$3,739	-$101,745	-0.964551913	$329,045	-$1,169,719	-78.0%
Bait and Ice	$809,968	-$4,930,550	-0.858903384	$1,510,809	-$4,880,008	-0.763596844	$26,676	-$1,431,637	-0.98170763	$2,347,453	-$11,242,195	-82.7%
Total	$3,054,801	-$20,461,202	-0.870096933	$5,698,032	-$22,221,823	-0.79591469	$100,609	-$7,229,549	-0.986274674	$8,853,442	-$49,912,573	-84.9%
Non-Local Residents												
Transportation	$167,141	-$1,181,344	-0.876052895	$126,756	-$691,138	-0.845021604	$18,868	-$4,661,871	-0.99596904	$312,764	-$6,534,352	-95.4%
Food	$305,917	-$1,687,721	-0.846553252	$232,001	-$688,756	-0.748032534	$34,534	-$3,068,353	-0.988870425	$572,452	-$5,444,829	-90.5%
Lodging	$73,074	-$531,398	-0.879110976	$55,418	-$320,274	-0.852491451	$8,249	-$2,209,903	-0.996281121	$136,741	-$3,061,575	-95.7%
Boat Fuel	$173,711	-$955,984	-0.846231948	$131,739	-$388,233	-0.746642816	$19,610	-$1,715,105	-0.988695798	$325,059	-$3,059,322	-90.4%
Party/Charter Fees	$59,773	-$340,929	-0.850828909	$45,331	-$148,125	-0.765678678	$6,748	-$728,054	-0.990817149	$111,852	-$1,217,108	-91.6%
cess/Boat Launching	$0	-$27,213	-1	$0	-$33,048	-1	$0	-$313,386	-1	$0	-$373,647	-100.0%
Equipment Rental	$35,896	-$196,684	-0.845661396	$27,223	-$79,173	-0.744137004	$4,052	-$344,454	-0.988372784	$67,171	-$620,311	-90.2%
Bait and Ice	$245,343	-$1,236,515	-0.834435695	$186,062	-$410,265	-0.687986024	$27,696	-$1,113,176	-0.975724019	$459,101	-$2,759,956	-85.7%
Total	$1,060,855	-$6,157,787	-0.853039526	$804,529	-$2,759,011	-0.774233289	$119,756	-$14,154,302	-0.991610248	$1,985,139	-$23,071,100	-92.1%
Non-residents of the State												
Transportation	$10,730	-$271,625	-0.961997014	$16,952	-$295,338	-0.945716943	$1,613	-$1,195,710	-0.998653145	$42,105	-$1,993,413	-97.9%
Food	$41,268	-$297,174	-0.878065869	$65,195	-$237,509	-0.784623098	$6,202	-$622,462	-0.990134731	$128,835	-$1,299,009	-91.0%
Lodging	$16,019	-$139,426	-0.896949866	$25,307	-$121,127	-0.827180418	$2,407	-$369,686	-0.993530198	$46,358	-$692,169	-93.7%
Boat Fuel	$18,134	-$130,166	-0.877721322	$28,648	-$103,859	-0.783798743	$2,725	-$271,277	-0.990053826	$56,805	-$568,023	-90.9%
Party/Charter Fees	$9,961	-$55,738	-0.848382675	$15,737	-$38,116	-0.707780088	$1,497	-$65,212	-0.977558906	$27,195	-$165,736	-85.9%
cess/Boat Launching	$0	-$9,724	-1	$0	-$11,686	-1	$0	-$51,726	-1	$0	-$81,309	-100.0%
Equipment Rental	$3,808	-$31,307	-0.891567253	$6,015	-$26,592	-0.815521576	$572	-$78,139	-0.992730148	$10,395	-$146,916	-93.4%
Bait and Ice	$24,576	-$136,984	-0.847883228	$38,826	-$93,383	-0.706330095	$3,693	-$157,975	-0.977154407	$67,095	-$404,443	-85.8%
Total	$124,495	-$1,072,143	-0.895962702	$196,680	-$927,609	-0.82506271	$18,710	-$2,812,187	-0.993390836	$378,788	-$5,351,019	-93.4%
Net Impact**												
Transportation	$177,871	-$1,452,969	-0.194160159	$143,708	-$986,475	-0.116298295	$20,480	-$5,857,581	-0.730652778	$42,105	-$1,993,413	-8.2%
Food	$347,185	-$1,984,895	-0.255083016	$297,196	-$926,265	-0.124866389	$40,736	-$3,690,815	-0.707640399	$128,835	-$1,299,009	-6.3%
Lodging	$89,093	-$670,824	-0.404092574	$80,724	-$441,400	-0.202405669	$10,656	-$2,579,589	-0.774506894	$46,358	-$692,169	-9.6%
Boat Fuel	$191,845	-$1,086,150	-0.202590262	$160,387	-$492,092	-0.092261429	$22,335	-$1,986,381	-0.630294541	$56,805	-$568,023	-4.1%
Party/Charter Fees	$69,734	-$396,667	-0.380502889	$61,068	-$186,240	-0.241861524	$8,245	-$793,266	-0.927353837	$27,195	-$165,736	-6.2%
cess/Boat Launching	$0	-$36,937	-0.149384459	$0	-$44,735	-0.094168516	$0	-$365,112	-0.638937895	$0	-$81,309	-6.2%
Equipment Rental	$39,704	-$227,990	-0.234678373	$33,238	-$105,764	-0.127661658	$4,624	-$422,593	-0.793302304	$10,395	-$146,916	-6.3%
Bait and Ice	$269,919	-$1,373,499	-0.186011764	$224,888	-$503,648	-0.070743455	$31,389	-$1,271,152	-0.460419779	$67,095	-$404,443	-2.3%
Total	$1,185,350	-$7,229,930	-0.226421533	$1,001,209	-$3,686,620	-0.113059857	$138,466	-$16,966,489	-0.694348728	$378,788	-$5,351,019	-6.0%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

** For Puget Sound regions, the net impact represents effects caused by changes in non-local and non-resident spending relative to baseline spending.

For Washington, the net impact represents effects caused by changes in non-resident spending relative to baseline spending.

The baseline includes local, non-local, and non-resident spending effects.

Table D-21. Estimated sport fishing expenditures (in 2002 dollars) in the economic regions with implementation of the alternatives. Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 4 - No Fishing											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Spending Sectors	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number		Change from Baseline (%)	Number	Change from Baseline	% Change
Local Residents												
Transportation	$22,361	-$5,830,150	-0.996179179	$27,285	-$7,324,816	-0.996288796	$894	-$2,137,959	-0.999582089	$50,540	-$15,292,925	-99.7%
Food	$23,970	-$5,425,318	-0.995601216	$29,248	-$6,165,338	-0.995278419	$958	-$1,483,156	-0.999354389	$54,177	-$13,073,811	-99.6%
Lodging	$886	-$899,273	-0.999016173	$1,081	-$1,657,566	-0.999348505	$35	-$740,340	-0.999952186	$2,002	-$3,297,178	-99.9%
Boat Fuel	$17,771	-$4,065,547	-0.995647893	$21,684	-$4,659,511	-0.995367841	$710	-$1,142,086	-0.999378402	$40,165	-$9,867,144	-99.6%
Party/Charter Fees	$3,173	-$572,907	-0.994491393	$3,872	-$518,849	-0.992592324	$127	-$53,771	-0.997646458	$7,172	-$1,145,527	-99.4%
cess/Boat Launching	$0	-$210,322	-1	$0	-$430,317	-1	$0	-$206,324	-1	$0	-$846,963	-100.0%
Equipment Rental	$3,631	-$700,176	-0.994840974	$4,430	-$685,042	-0.99357413	$145	-$105,339	-0.998624055	$8,207	-$1,490,557	-99.5%
Bait and Ice	$25,904	-$5,714,614	-0.99548755	$31,608	-$6,359,209	-0.995054224	$1,035	-$1,457,277	-0.999289967	$58,547	-$13,531,101	-99.6%
Total	$97,696	-$23,418,306	-0.995845534	$119,208	-$27,800,647	-0.995730344	$3,905	-$7,326,252	-0.999467241	$220,810	-$58,545,206	-99.6%
Non-Local Residents												
Transportation	$5,351	-$1,343,134	-0.996032146	$2,649	-$815,244	-0.996760922	$730	-$4,680,009	-0.99984402	$8,730	-$6,838,387	-99.9%
Food	$9,793	-$1,983,845	-0.995087789	$4,849	-$915,908	-0.994733832	$1,336	-$3,101,550	-0.999569336	$15,978	-$6,001,303	-99.7%
Lodging	$2,339	-$602,132	-0.996130042	$1,158	-$374,533	-0.996917043	$319	-$2,217,833	-0.999856096	$3,817	-$3,194,499	-99.9%
Boat Fuel	$5,561	-$1,124,134	-0.995077503	$2,753	-$517,218	-0.994704787	$759	-$1,733,955	-0.999562579	$9,073	-$3,375,308	-99.7%
Party/Charter Fees	$1,913	-$398,789	-0.995224663	$947	-$192,508	-0.99510264	$261	-$734,540	-0.999644666	$3,122	-$1,325,837	-99.8%
cess/Boat Launching	$0	-$27,213	-1	$0	-$33,048	-1	$0	-$313,386	-1	$0	-$373,647	-100.0%
Equipment Rental	$1,149	-$231,430	-0.995059238	$569	-$105,827	-0.994652415	$157	-$348,350	-0.99955008	$1,875	-$685,607	-99.7%
Bait and Ice	$7,854	-$1,474,004	-0.994699876	$3,889	-$592,438	-0.993478849	$1,072	-$1,139,800	-0.999060631	$12,814	-$3,206,243	-99.6%
Total	$33,961	-$7,184,681	-0.995295431	$16,815	-$3,546,725	-0.995281433	$4,634	-$14,269,424	-0.999675355	$55,409	-$25,000,830	-99.8%
Non-residents of the State												
Transportation	$346	-$282,009	-0.998774735	$357	-$311,933	-0.998856446	$61	-$1,197,261	-0.999948736	$1,099	-$2,034,420	-99.9%
Food	$1,331	-$337,111	-0.996068686	$1,373	-$301,331	-0.995462764	$236	-$628,428	-0.999624505	$3,362	-$1,424,482	-99.8%
Lodging	$516	-$154,928	-0.996677531	$533	-$145,900	-0.996359298	$92	-$372,002	-0.999753745	$1,210	-$737,317	-99.8%
Boat Fuel	$585	-$147,715	-0.996057578	$604	-$131,904	-0.995445398	$104	-$273,898	-0.999621426	$1,482	-$623,346	-99.8%
Party/Charter Fees	$321	-$65,378	-0.995111662	$332	-$53,521	-0.993843952	$57	-$66,652	-0.999145841	$710	-$192,221	-99.6%
cess/Boat Launching	$0	-$9,724	-1	$0	-$11,686	-1	$0	-$51,726	-1	$0	-$81,309	-100.0%
Equipment Rental	$123	-$34,992	-0.996503988	$127	-$32,480	-0.996113687	$22	-$78,690	-0.999723293	$271	-$157,040	-99.8%
Bait and Ice	$792	-$160,767	-0.995095559	$818	-$131,391	-0.993813406	$141	-$161,528	-0.999130445	$1,751	-$469,788	-99.6%
Total	$4,014	-$1,192,624	-0.996645703	$4,143	-$1,120,146	-0.996314685	$712	-$2,830,185	-0.99974844	$9,885	-$5,719,922	-99.8%
Net Impact**												
Transportation	$5,697	-$1,625,143	-0.217167838	$3,006	-$1,127,177	-0.132885984	$791	-$5,877,270	-0.733108711	$1,099	-$2,034,420	-8.4%
Food	$11,124	-$2,320,956	-0.298270946	$6,222	-$1,217,239	-0.164091531	$1,572	-$3,729,978	-0.715149201	$3,362	-$1,424,482	-6.9%
Lodging	$2,856	-$757,061	-0.456040151	$1,691	-$520,433	-0.23864646	$411	-$2,589,835	-0.777583071	$1,210	-$737,317	-10.2%
Boat Fuel	$6,146	-$1,271,849	-0.237227171	$3,357	-$649,122	-0.121702669	$863	-$2,007,854	-0.637107873	$1,482	-$623,346	-4.5%
Party/Charter Fees	$2,235	-$464,167	-0.44525195	$1,279	-$246,029	-0.319506093	$318	-$801,192	-0.936620191	$710	-$192,221	-7.2%
cess/Boat Launching	$0	-$36,937	-0.149384459	$0	-$44,735	-0.094168516	$0	-$365,112	-0.638937895	$0	-$81,309	-6.2%
Equipment Rental	$1,272	-$266,422	-0.274237423	$696	-$138,307	-0.166941402	$179	-$427,039	-0.801648063	$271	-$157,040	-6.7%
Bait and Ice	$8,646	-$1,634,771	-0.221395648	$4,707	-$723,829	-0.101670622	$1,212	-$1,301,329	-0.471350068	$1,751	-$469,788	-2.7%
Total	$37,974	-$8,377,306	-0.26235418	$20,958	-$4,666,871	-0.143121806	$5,346	-$17,099,608	-0.699796606	$9,885	-$5,719,922	-6.4%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.
** For Puget Sound regions, the net impact represents effects caused by changes in non-local and non-resident spending relative to baseline spending.
For Washington, the net impact represents effects caused by changes in non-resident spending relative to baseline spending.
The baseline includes local, non-local, and non-resident spending effects.

D4 Effects on the Local and Regional Economy

D4.1 Methods

Changes in revenues received by commercial fishermen and processors and expenditures made by sport anglers would result in changes in economic activity statewide and within each region. For purposes of the economic analysis, these changes were characterized by total (i.e., direct, indirect, and induced) changes in employment and personal income. The following steps were employed to estimate changes in regional economic activity caused by changes in fishing activity under the alternatives.

D4.1.1 Step 1: Estimate Total Economic Effects Resulting from Changes in Commercial Fishing Activity

Total changes in employment (full-time equivalent) and personal income (wages, profits, and other income) resulting from changes in commercial salmon fishing landings were estimated using regional and statewide multipliers developed by The Research Group (Attachment B) for this project.

As described in more detail in Attachment B, the 2000 IMPLAN database was used by The Research Group to construct a Fisheries Economic Assessment Model (FEAM) for the four geographic areas used in the assessment (i.e., three economic regions and statewide). The FEAM model uses basic input-output relationships from the IMPLAN model (Minnesota IMPLAN Group 2002). Custom commercial fishing industry sectors, consisting of aggregated and disaggregated IMPLAN industrial sectors, were developed for the model. To assess economic effects using the FEAM model, the input/output relationships for the custom sectors are applied to spending patterns from the harvesting and processing components of the fishing industry to generate estimates of direct, indirect, and induced impacts on local economies and the state of Washington. Inputs to the FEAM model include landing weights for salmon species, prices, product forms, and budgets for fishing industry businesses. Coefficients and multiplier factors based on landed weight were derived from FEAM outputs.

The FEAM factors were used to estimate the regional economic impacts of the Proposed Action and alternatives to the Proposed Action generated by commercial harvests. Average per unit impact factors were used to estimate the total economic contributions of baseline (i.e., the Proposed Action) harvest conditions; marginal per unit impact factors were used to calculate impacts resulting from changes in harvests under the alternatives to the Proposed Action.

Tables D-22 and D-23 show the multipliers generated by the FEAM model for use in the assessment of Puget Sound harvest management alternatives. These multipliers were applied to the commercial fishing landings estimated for each alternative to arrive at estimates of total regional and statewide employment and personal income generated by commercial salmon harvests.

Table D-22. Multipliers (full-time-equivalent jobs per million pounds of landings) used to estimate total regional employment effects resulting from changes in commercial fishing landings.

	North Puget Sound		South Puget Sound/South Hood Canal		The Straits of Juan de Fuca/North Hood Canal		Statewide	
Species	Average	Marginal	Average	Marginal	Average	Marginal	Average	Marginal
Chinook:								
Net	50.9	57.2	47.5	53.3	52.3	58.8	48.9	54.9
Troll	60.9	68.4	56.8	63.8	63.2	71.0	59.1	66.4
Chum	28.1	31.6	26.3	29.6	28.0	31.4	26.7	30.0
Coho:								
Net	37.3	41.9	34.7	39.0	37.9	42.6	35.8	40.2
Troll	35.5	39.9	35.5	39.9	35.5	39.9	34.0	38.2
Pink	40.9	45.9	38.1	42.8	42.4	47.7	39.8	44.7
Sockeye	57.8	65.0	53.9	60.5	59.3	66.6	55.1	62.0
Steelhead	40.9	45.9	38.1	42.8	42.4	47.7	39.8	44.7

Table D-23. Multipliers (personal income per pound of landings) used to estimate total income effects resulting from changes in commercial fishing landings.

	North Puget Sound		South Puget Sound/South Hood Canal		The Straits of Juan de Fuca/North Hood Canal		Statewide	
Species	Average	Marginal	Average	Marginal	Average	Marginal	Average	Marginal
Chinook:								
Net	$1.63	$1.83	$1.72	$1.93	$1.55	$1.74	$1.70	$1.91
Troll	$1.95	$2.19	$2.06	$2.31	$1.87	$2.10	$2.06	$2.31
Chum	$0.90	$1.01	$0.95	$1.07	$0.83	$0.93	$0.93	$1.04
Coho:								
Net	$1.19	$1.34	$1.25	$1.41	$1.12	$1.26	$1.24	$1.40
Troll	$1.05	$1.18	$1.05	$1.18	$1.05	$1.18	$1.18	$1.33
Pink	$1.31	$1.47	$1.38	$1.55	$1.25	$1.41	$1.38	$1.56
Sockeye	$1.85	$2.08	$1.95	$2.19	$1.75	$1.97	$1.92	$2.15
Steelhead	$1.31	$1.47	$1.38	$1.55	$1.25	$1.41	$1.38	$1.56

D4.1.2 Step 2: Estimate Total Economic Effects Resulting from Changes in Sport Fishing Expenditures

Total changes in employment (full-time equivalent) and personal income (wages, profits, and other income) resulting from changes in sport fishing expenditures were estimated using regional and statewide coefficients and multipliers developed by The Research Group (Attachment D to this appendix) through its FEAM model. Using a methodology similar to the one employed to develop commercial fishing factors (Step 1), sport fishing impact factors (i.e., coefficients and multipliers) were developed for custom sport fishing industry sectors consisting of aggregated and disaggregated

IMPLAN industrial sectors. The coefficients represent the total number of full-time-equivalent jobs and total personal income generated per million dollars and per dollar, respectively, of angler expenditures in the following sectors: transportation, food, lodging, boat fuel, party/charter fees, access/boat launching, equipment rental, and bait and ice.

Table D-24 shows the multipliers generated by the FEAM model and used in the analysis.. These multipliers were applied to expenditures by non-local (i.e., residing outside of the region) anglers estimated for each alternative to arrive at estimates of total regional jobs and personal income generated by estimated salmon sport fishing expenditures. Only expenditures by non-local (i.e., not residing in the affected region) and non-resident (i.e., not residing in Washington) anglers were considered in the evaluation of regional economic impacts because expenditures by local residents would only shift sales, jobs, and personal income within each region, and would likely not generate a net change in regional economic activity.

Table D-24. Multipliers used to estimate total regional economic effects resulting from changes in sport fishing expenditures.

	North Puget Sound		South Puget Sound/South Hood Canal		The Straits of Juan de Fuca/North Hood Canal		Statewide	
Sector	Jobs[1]	Personal Income[2]	Jobs[1]	Personal Income[2]	Jobs[1]	Personal Income[2]	Jobs[1]	Personal Income[2]
Transportation	17.4	$0.62	15.6	$0.68	18.9	$0.55	14.9	$0.69
Food	23.3	$0.63	20.4	$0.74	22.5	$0.49	23.3	$0.78
Lodging	25.8	$0.82	22.4	$0.91	29.2	$0.76	25.3	$0.92
Boat fuel	9.5	$0.51	9.0	$0.57	12.1	$0.46	9.8	$0.58
Party/Charter Fees	37.4	$0.84	39.5	$0.92	38.8	$0.80	41.4	$0.94
Access/Boat Launching	27.8	$0.75	28.4	$0.85	29.2	$0.67	30.1	$0.86
Equipment Rental	16.3	$0.68	14.8	$0.83	18.7	$0.55	16.5	$0.83
Bait and Ice	13.5	$0.83	10.5	$0.87	13.1	$0.81	12.3	$0.89

Notes:

[1] Represents the number of full-time-equivalent jobs per million dollars of angler expenditures.

[2] Represents the amount of personal income per dollar of angler expenditures.

D4.2 Key Assumptions Used in the Analysis

The following key assumption was incorporated into the assessment of regional economic effects:

> Changes in sport fishing expenditures by local residents of an economic region would result in no net changes in regional employment or personal income.

D4.3 Estimated Values

The estimated regional and statewide effects on sales, employment, and personal income resulting from the methodology and assumptions described above are presented in Tables D-25 through D-28 for all alternatives under Scenario B (2003 abundance and 2003 Canadian/Alaskan fisheries).

Table D-25. Total changes in employment (in full-time equivalent jobs) caused by changes in commercial landings under the project alternatives.
Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

	Alternative 1 - Proposed Action/Status Quo			
Specie	North Puget Sound	SPS/SHC*	SJF/ NHC*	State Total
Chinook				
Non-tribal				
Marine Net	14.6	1.3	0.0	15.4
Tribal				
Marine Net	17.8	8.5	0.9	26.8
Marine Troll	0.0	0.0	0.8	0.8
Freshwater Net	1.8	20.7	0.0	23.1
Tribal Subtotal	19.7	29.2	1.8	50.7
Total	34.2	30.5	1.8	66.0
Coho				
Non-tribal				
Marine Net	3.4	1.3	0.4	5.0
Tribal				
Marine Net	15.9	16.7	4.6	36.9
Marine Troll	0.0	0.0	0.2	0.2
Freshwater Net	5.7	13.8	0.4	20.1
Tribal Subtotal	21.5	30.6	5.2	57.1
Total	25.0	31.9	5.6	62.2
Sockeye				
Non-tribal				
Marine Net	79.2	0.0	0.0	75.5
Tribal				
Marine Net	82.1	0.0	8.7	86.4
Freshwater Net	0.1	13.2	0.0	13.6
Tribal Subtotal	82.2	13.2	8.7	100.0
Total	161.5	13.2	8.7	175.5
Pink				
Non-tribal				
Marine Net	111.6	0.6	0.0	109.3
Tribal				
Marine Net	107.6	4.2	0.2	109.3
Freshwater Net	7.5	0.0	0.0	7.3
Tribal Subtotal	115.1	4.2	0.2	116.7
Total	226.8	4.9	0.2	226.0
Chum				
Non-tribal				
Marine Net	29.6	64.0	0.0	93.1
Tribal				
Marine Net	24.9	53.8	2.6	80.8
Freshwater Net	16.8	22.6	0.0	39.0
Tribal Subtotal	41.8	76.4	2.6	119.8
Total	71.4	140.4	2.6	212.9
Steelhead				
Non-tribal				
Marine Net	0.0	0.0	0.0	0.0
Tribal				
Marine Net	0.1	0.0	0.0	0.1
Freshwater Net	0.1	0.2	0.2	0.4
Tribal Subtotal	0.2	0.2	0.2	0.5
Total	0.2	0.2	0.2	0.5
Total				
Non-tribal				
Marine Net	238.5	67.3	0.4	298.4
Tribal				
Marine Net	248.5	83.3	17.2	340.4
Marine Troll	0.0	0.0	1.0	1.0
Freshwater Net	32.0	70.6	0.6	103.4
Tribal Subtotal	280.5	153.8	18.8	444.8
Total	519.0	221.1	19.2	743.1

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-25. Total changes in employment (in full-time equivalent jobs) caused by changes in commercial landings under the project alternatives. Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 2 - Escapement Goal Management at the Management Unit Level											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Specie	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change
Chinook												
Non-tribal												
Marine Net	0.0	-14.6	-100.0%	0.0	-1.3	-100.0%	0.0	0.0	0.0%	0.0	-15.4	-100.0%
Tribal												
Marine Net	5.1	-12.7	-71.2%	0.0	-8.5	-100.0%	0.0	-0.9	-100.0%	4.9	-21.9	-81.6%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-0.8	-100.0%	0.0	-0.8	-100.0%
Freshwater Net	0.5	-1.3	-73.3%	25.1	4.4	21.5%	0.0	0.0	-100.0%	26.3	3.3	14.3%
Tribal Subtotal	5.6	-14.0	-71.4%	25.1	-4.1	-14.0%	0.0	-1.8	-100.0%	31.3	-19.4	-38.3%
Total	5.6	-28.6	-83.6%	25.1	-5.4	-17.7%	0.0	-1.8	-100.0%	31.3	-34.7	-52.6%
Coho												
Non-tribal												
Marine Net	0.1	-3.3	-96.7%	0.0	-1.3	-100.0%	0.5	0.1	22.2%	0.6	-4.5	-88.4%
Tribal												
Marine Net	0.0	-15.9	-100.0%	0.0	-16.7	-100.0%	0.0	-4.6	-100.0%	0.0	-36.9	-100.0%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-0.2	-100.0%	0.0	-0.2	-100.0%
Freshwater Net	6.7	1.0	17.6%	14.5	0.6	4.5%	0.4	0.0	-4.5%	21.7	1.6	7.9%
Tribal Subtotal	6.7	-14.9	-69.1%	14.5	-16.1	-52.7%	0.4	-4.8	-93.2%	21.7	-35.5	-62.1%
Total	6.8	-18.2	-72.9%	14.5	-17.4	-54.6%	0.9	-4.8	-84.7%	22.2	-39.9	-64.2%
Sockeye												
Non-tribal												
Marine Net	0.0	-79.2	-100.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-75.5	-100.0%
Tribal												
Marine Net	0.0	-82.1	-100.0%	0.0	0.0	0.0%	0.0	-8.7	-100.0%	0.0	-86.4	-100.0%
Freshwater Net	0.0	-0.1	-100.0%	0.0	-13.2	-100.0%	0.0	0.0	0.0%	0.0	-13.6	-100.0%
Tribal Subtotal	0.0	-82.2	-100.0%	0.0	-13.2	-100.0%	0.0	-8.7	-100.0%	0.0	-100.0	-100.0%
Total	0.0	-161.5	-100.0%	0.0	-13.2	-100.0%	0.0	-8.7	-100.0%	0.0	-175.5	-100.0%
Pink												
Non-tribal												
Marine Net	0.0	-111.6	-100.0%	0.0	-0.6	-100.0%	0.0	0.0	0.0%	0.0	-109.3	-100.0%
Tribal												
Marine Net	0.0	-107.6	-100.0%	0.0	-4.2	-100.0%	0.0	-0.2	-100.0%	0.0	-109.3	-100.0%
Freshwater Net	13.5	6.0	79.6%	3.9	3.9	15257.6%	0.0	0.0	0.0%	17.3	9.9	135.0%
Tribal Subtotal	13.5	-101.6	-88.3%	3.9	-0.3	-6.9%	0.0	-0.2	-100.0%	17.3	-99.4	-85.2%
Total	13.5	-213.3	-94.0%	3.9	-0.9	-19.3%	0.0	-0.2	-100.0%	17.3	-208.7	-92.4%
Chum												
Non-tribal												
Marine Net	0.0	-29.6	-100.0%	0.0	-64.0	-100.0%	0.0	0.0	0.0%	0.0	-93.1	-100.0%
Tribal												
Marine Net	0.0	-24.9	-100.0%	0.0	-53.8	-100.0%	0.0	-2.6	-100.0%	0.0	-80.8	-100.0%
Freshwater Net	0.6	-16.3	-96.7%	42.9	20.3	89.6%	0.0	0.0	0.0%	44.1	5.1	13.1%
Tribal Subtotal	0.6	-41.2	-98.7%	42.9	-33.5	-43.9%	0.0	-2.6	-100.0%	44.1	-75.7	-63.2%
Total	0.6	-70.9	-99.2%	42.9	-97.5	-69.4%	0.0	-2.6	-100.0%	44.1	-168.8	-79.3%
Steelhead												
Non-tribal												
Marine Net	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%
Tribal												
Marine Net	0.0	-0.1	-100.0%	0.0	0.0	-100.0%	0.0	0.0	-100.0%	0.0	-0.1	-100.0%
Freshwater Net	0.1	0.0	-9.2%	0.2	0.0	-0.5%	0.2	0.0	-1.6%	0.4	0.0	-2.4%
Tribal Subtotal	0.1	-0.1	-59.6%	0.2	0.0	-1.6%	0.2	0.0	-18.8%	0.4	-0.1	-24.6%
Total	0.1	-0.1	-59.6%	0.2	0.0	-1.6%	0.2	0.0	-18.8%	0.4	-0.1	-24.6%
Total												
Non-tribal												
Marine Net	0.1	-238.4	-100.0%	0.0	-67.3	-100.0%	0.5	0.1	22.2%	0.6	-297.8	-99.8%
Tribal												
Marine Net	5.1	-243.3	-97.9%	0.0	-83.3	-100.0%	0.0	-17.2	-100.0%	4.9	-335.4	-98.6%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-1.0	-100.0%	0.0	-1.0	-100.0%
Freshwater Net	21.3	-10.7	-33.5%	86.6	16.1	22.8%	0.5	0.0	-3.8%	109.8	6.3	6.1%
Tribal Subtotal	26.4	-254.1	-90.6%	86.6	-67.2	-43.7%	0.5	-18.3	-97.2%	114.7	-330.1	-74.2%
Total	26.5	-492.5	-94.9%	86.6	-134.5	-60.8%	1.0	-18.2	-94.6%	115.3	-627.9	-84.5%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-25. Total changes in employment (in full-time equivalent jobs) caused by changes in commercial landings under the project alternatives.
Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 3 - Escapement Goal Management at the Population Level/Terminal Fisheries Only											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Specie	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number		Change from Baseline (%)	Number	Change from Baseline	% Change
Chinook												
Non-tribal												
Marine Net	0.0	-14.6	-100.0%	0.0	-1.3	-100.0%	0.0	0.0	0.0%	0.0	-15.4	-100.0%
Tribal												
Marine Net	0.0	-17.8	-100.0%	0.0	-8.5	-100.0%	0.0	-0.9	-100.0%	0.0	-26.8	-100.0%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-0.8	-100.0%	0.0	-0.8	-100.0%
Freshwater Net	0.0	-1.8	-100.0%	25.1	4.4	21.5%	0.0	0.0	-100.0%	25.9	2.8	12.2%
Tribal Subtotal	0.0	-19.7	-100.0%	25.1	-4.1	-14.0%	0.0	-1.8	-100.0%	25.9	-24.8	-48.9%
Total	0.0	-34.2	-100.0%	25.1	-5.4	-17.7%	0.0	-1.8	-100.0%	25.9	-40.1	-60.8%
Coho												
Non-tribal												
Marine Net	0.1	-3.3	-96.7%	0.0	-1.3	-100.0%	0.5	0.1	22.2%	0.6	-4.5	-88.4%
Tribal												
Marine Net	0.0	-15.9	-100.0%	0.0	-16.7	-100.0%	0.0	-4.6	-100.0%	0.0	-36.9	-100.0%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-0.2	-100.0%	0.0	-0.2	-100.0%
Freshwater Net	0.0	-5.6	-99.5%	14.5	0.6	4.5%	0.4	0.0	-4.5%	15.3	-4.8	-23.8%
Tribal Subtotal	0.0	-21.5	-99.9%	14.5	-16.1	-52.7%	0.4	-4.8	-93.2%	15.3	-41.8	-73.2%
Total	0.1	-24.8	-99.4%	14.5	-17.4	-54.6%	0.9	-4.8	-84.7%	15.9	-46.3	-74.5%
Sockeye												
Non-tribal												
Marine Net	0.0	-79.2	-100.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-75.5	-100.0%
Tribal												
Marine Net	0.0	-82.1	-100.0%	0.0	0.0	0.0%	0.0	-8.7	-100.0%	0.0	-86.4	-100.0%
Freshwater Net	0.0	-0.1	-100.0%	0.0	-13.2	-100.0%	0.0	0.0	0.0%	0.0	-13.6	-100.0%
Tribal Subtotal	0.0	-82.2	-100.0%	0.0	-13.2	-100.0%	0.0	-8.7	-100.0%	0.0	-100.0	-100.0%
Total	0.0	-161.5	-100.0%	0.0	-13.2	-100.0%	0.0	-8.7	-100.0%	0.0	-175.5	-100.0%
Pink												
Non-tribal												
Marine Net	0.0	-111.6	-100.0%	0.0	-0.6	-100.0%	0.0	0.0	0.0%	0.0	-109.3	-100.0%
Tribal												
Marine Net	0.0	-107.6	-100.0%	0.0	-4.2	-100.0%	0.0	-0.2	-100.0%	0.0	-109.3	-100.0%
Freshwater Net	0.0	-7.5	-100.0%	3.9	3.9	15257.6%	0.0	0.0	0.0%	4.1	-3.2	-44.0%
Tribal Subtotal	0.0	-115.1	-100.0%	3.9	-0.3	-6.9%	0.0	-0.2	-100.0%	4.1	-112.5	-96.5%
Total	0.0	-226.8	-100.0%	3.9	-0.9	-19.3%	0.0	-0.2	-100.0%	4.1	-221.9	-98.2%
Chum												
Non-tribal												
Marine Net	0.0	-29.6	-100.0%	0.0	-64.0	-100.0%	0.0	0.0	0.0%	0.0	-93.1	-100.0%
Tribal												
Marine Net	0.0	-24.9	-100.0%	0.0	-53.8	-100.0%	0.0	-2.6	-100.0%	0.0	-80.8	-100.0%
Freshwater Net	0.3	-16.5	-98.0%	42.9	20.3	89.6%	0.0	0.0	0.0%	43.9	4.9	12.6%
Tribal Subtotal	0.3	-41.5	-99.2%	42.9	-33.5	-43.9%	0.0	-2.6	-100.0%	43.9	-75.9	-63.4%
Total	0.3	-71.1	-99.5%	42.9	-97.5	-69.4%	0.0	-2.6	-100.0%	43.9	-169.1	-79.4%
Steelhead												
Non-tribal												
Marine Net	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%
Tribal												
Marine Net	0.0	-0.1	-100.0%	0.0	0.0	-100.0%	0.0	0.0	-100.0%	0.0	-0.1	-100.0%
Freshwater Net	0.1	0.0	-9.2%	0.2	0.0	-0.5%	0.2	0.0	-1.6%	0.4	0.0	-2.4%
Tribal Subtotal	0.1	-0.1	-59.6%	0.2	0.0	-1.6%	0.2	0.0	-18.8%	0.4	-0.1	-24.6%
Total	0.1	-0.1	-59.6%	0.2	0.0	-1.6%	0.2	0.0	-18.8%	0.4	-0.1	-24.6%
Total												
Non-tribal												
Marine Net	0.1	-238.4	-100.0%	0.0	-67.3	-100.0%	0.5	0.1	22.2%	0.6	-297.8	-99.8%
Tribal												
Marine Net	0.0	-248.5	-100.0%	0.0	-83.3	-100.0%	0.0	-17.2	-100.0%	0.0	-340.4	-100.0%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-1.0	-100.0%	0.0	-1.0	-100.0%
Freshwater Net	0.4	-31.6	-98.7%	86.6	16.1	22.8%	0.5	0.0	-3.8%	89.6	-13.9	-13.4%
Tribal Subtotal	0.4	-280.1	-99.8%	86.6	-67.2	-43.7%	0.5	-18.3	-97.2%	89.6	-355.2	-79.9%
Total	0.5	-518.5	-99.9%	86.6	-134.5	-60.8%	1.0	-18.2	-94.6%	90.2	-653.0	-87.9%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-25. Total changes in employment (in full-time equivalent jobs) caused by changes in commercial landings under the project alternatives. Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 4 - No Fishing											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Specie	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number		Change from Baseline (%)	Number	Change from Baseline	% Change
Chinook												
Non-tribal												
Marine Net	0.0	-14.6	-100.0%	0.0	-1.3	-100.0%	0.0	0.0	0.0%	0.0	-15.4	-100.0%
Tribal												
Marine Net	0.0	-17.8	-100.0%	0.0	-8.5	-100.0%	0.0	-0.9	-100.0%	0.0	-26.8	-100.0%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-0.8	-100.0%	0.0	-0.8	-100.0%
Freshwater Net	0.0	-1.8	-100.0%	0.0	-20.7	-100.0%	0.0	0.0	-100.0%	0.0	-23.1	-100.0%
Tribal Subtotal	0.0	-19.7	-100.0%	0.0	-29.2	-100.0%	0.0	-1.8	-100.0%	0.0	-50.7	-100.0%
Total	0.0	-34.2	-100.0%	0.0	-30.5	-100.0%	0.0	-1.8	-100.0%	0.0	-66.0	-100.0%
Coho												
Non-tribal												
Marine Net	0.0	-3.4	-100.0%	0.0	-1.3	-100.0%	0.0	-0.4	-100.0%	0.0	-5.0	-100.0%
Tribal												
Marine Net	0.0	-15.9	-100.0%	0.0	-16.7	-100.0%	0.0	-4.6	-100.0%	0.0	-36.9	-100.0%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-0.2	-100.0%	0.0	-0.2	-100.0%
Freshwater Net	0.0	-5.7	-100.0%	0.0	-13.8	-100.0%	0.0	-0.4	-100.0%	0.0	-20.1	-100.0%
Tribal Subtotal	0.0	-21.5	-100.0%	0.0	-30.6	-100.0%	0.0	-5.2	-100.0%	0.0	-57.1	-100.0%
Total	0.0	-25.0	-100.0%	0.0	-31.9	-100.0%	0.0	-5.6	-100.0%	0.0	-62.2	-100.0%
Sockeye												
Non-tribal												
Marine Net	0.0	-79.2	-100.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-75.5	-100.0%
Tribal												
Marine Net	0.0	-82.1	-100.0%	0.0	0.0	0.0%	0.0	-8.7	-100.0%	0.0	-86.4	-100.0%
Freshwater Net	0.0	-0.1	-100.0%	0.0	-13.2	-100.0%	0.0	0.0	0.0%	0.0	-13.6	-100.0%
Tribal Subtotal	0.0	-82.2	-100.0%	0.0	-13.2	-100.0%	0.0	-8.7	-100.0%	0.0	-100.0	-100.0%
Total	0.0	-161.5	-100.0%	0.0	-13.2	-100.0%	0.0	-8.7	-100.0%	0.0	-175.5	-100.0%
Pink												
Non-tribal												
Marine Net	0.0	-111.6	-100.0%	0.0	-0.6	-100.0%	0.0	0.0	0.0%	0.0	-109.3	-100.0%
Tribal												
Marine Net	0.0	-107.6	-100.0%	0.0	-4.2	-100.0%	0.0	-0.2	-100.0%	0.0	-109.3	-100.0%
Freshwater Net	0.0	-7.5	-100.0%	0.0	0.0	-100.0%	0.0	0.0	0.0%	0.0	-7.3	-100.0%
Tribal Subtotal	0.0	-115.1	-100.0%	0.0	-4.2	-100.0%	0.0	-0.2	-100.0%	0.0	-116.7	-100.0%
Total	0.0	-226.8	-100.0%	0.0	-4.9	-100.0%	0.0	-0.2	-100.0%	0.0	-226.0	-100.0%
Chum												
Non-tribal												
Marine Net	0.0	-29.6	-100.0%	0.0	-64.0	-100.0%	0.0	0.0	0.0%	0.0	-93.1	-100.0%
Tribal												
Marine Net	0.0	-24.9	-100.0%	0.0	-53.8	-100.0%	0.0	-2.6	-100.0%	0.0	-80.8	-100.0%
Freshwater Net	0.3	-16.5	-98.0%	10.7	-11.9	-52.6%	0.0	0.0	0.0%	11.2	-27.8	-71.3%
Tribal Subtotal	0.3	-41.5	-99.2%	10.7	-65.7	-86.0%	0.0	-2.6	-100.0%	11.2	-108.6	-90.6%
Total	0.3	-71.1	-99.5%	10.7	-129.7	-92.4%	0.0	-2.6	-100.0%	11.2	-201.7	-94.7%
Steelhead												
Non-tribal												
Marine Net	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%
Tribal												
Marine Net	0.0	-0.1	-100.0%	0.0	0.0	-100.0%	0.0	0.0	-100.0%	0.0	-0.1	-100.0%
Freshwater Net	0.1	0.0	-9.2%	0.1	0.0	-22.0%	0.2	0.0	-1.8%	0.4	0.0	-11.7%
Tribal Subtotal	0.1	-0.1	-59.6%	0.1	0.0	-22.9%	0.2	0.0	-19.0%	0.4	-0.2	-31.8%
Total	0.1	-0.1	-59.6%	0.1	0.0	-22.9%	0.2	0.0	-19.0%	0.4	-0.2	-31.8%
Total												
Non-tribal												
Marine Net	0.0	-238.5	-100.0%	0.0	-67.3	-100.0%	0.0	-0.4	-100.0%	0.0	-298.4	-100.0%
Tribal												
Marine Net	0.0	-248.5	-100.0%	0.0	-83.3	-100.0%	0.0	-17.2	-100.0%	0.0	-340.4	-100.0%
Marine Troll	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	-1.0	-100.0%	0.0	-1.0	-100.0%
Freshwater Net	0.4	-31.6	-98.8%	10.9	-59.7	-84.6%	0.2	-0.4	-67.5%	11.6	-91.9	-88.8%
Tribal Subtotal	0.4	-280.1	-99.9%	10.9	-143.0	-92.9%	0.2	-18.6	-99.0%	11.6	-433.2	-97.4%
Total	0.4	-518.6	-99.9%	10.9	-210.3	-95.1%	0.2	-19.0	-99.1%	11.6	-731.6	-98.4%

Table D-26. Total changes in personal income (in 2002 dollars) caused by changes in commercial landings under the project alternatives.
Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

	Alternative 1 - Proposed Action/Status Quo			
Specie	North Puget Sound	SPS/SHC*	SJF/ NHC*	State Total
Chinook				
Non-tribal				
Marine Net	$466,788	$47,523	$0	$533,805
Tribal				
Marine Net	$570,920	$309,485	$27,809	$931,826
Marine Troll	$0	$0	$25,101	$27,651
Freshwater Net	$58,461	$749,176	$53	$801,495
Tribal Subtotal	$629,382	$1,058,662	$52,963	$1,760,971
Total	$1,096,169	$1,106,185	$52,963	$2,294,776
Coho				
Non-tribal				
Marine Net	$109,222	$47,940	$12,230	$174,909
Tribal				
Marine Net	$506,229	$602,493	$137,231	$1,277,107
Marine Troll	$0	$0	$5,532	$6,217
Freshwater Net	$180,749	$498,898	$10,908	$695,328
Tribal Subtotal	$686,979	$1,101,391	$153,672	$1,978,653
Total	$796,201	$1,149,332	$165,903	$2,153,561
Sockeye				
Non-tribal				
Marine Net	$2,536,466	$0	$0	$2,632,440
Tribal				
Marine Net	$2,629,194	$0	$257,057	$3,010,705
Freshwater Net	$2,373	$477,167	$0	$472,288
Tribal Subtotal	$2,631,567	$477,167	$257,057	$3,482,994
Total	$5,168,033	$477,167	$257,057	$6,115,434
Pink				
Non-tribal				
Marine Net	$3,575,829	$23,534	$0	$3,790,438
Tribal				
Marine Net	$3,446,602	$152,341	$6,595	$3,790,394
Freshwater Net	$240,873	$929	$0	$254,673
Tribal Subtotal	$3,687,474	$153,270	$6,595	$4,045,067
Total	$7,263,304	$176,804	$6,595	$7,835,505
Chum				
Non-tribal				
Marine Net	$949,063	$2,311,477	$0	$3,243,513
Tribal				
Marine Net	$798,800	$1,943,299	$78,408	$2,815,669
Freshwater Net	$539,541	$817,262	$0	$1,357,582
Tribal Subtotal	$1,338,342	$2,760,560	$78,408	$4,173,252
Total	$2,287,405	$5,072,038	$78,408	$7,416,765
Steelhead				
Non-tribal				
Marine Net	$0	$0	$0	$0
Tribal				
Marine Net	$2,837	$74	$1,142	$4,324
Freshwater Net	$2,276	$6,292	$5,386	$14,636
Tribal Subtotal	$5,113	$6,366	$6,529	$18,960
Total	$5,113	$6,366	$6,529	$18,960
Total				
Non-tribal				
Marine Net	$7,637,368	$2,430,475	$12,230	$10,375,105
Tribal				
Marine Net	$7,954,583	$3,007,692	$508,244	$11,830,026
Marine Troll	$0	$0	$30,633	$33,868
Freshwater Net	$1,024,273	$2,549,724	$16,347	$3,596,002
Tribal Subtotal	$8,978,856	$5,557,417	$555,224	$15,459,896
Total	$16,616,225	$7,987,892	$567,454	$25,835,001

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-26. Total changes in personal income (in 2002 dollars) caused by changes in commercial landings under the project alternatives. Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 2 - Escapement Goal Management at the Management Unit Level											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Specie	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change
Chinook												
Non-tribal												
Marine Net	$43	-$466,745	-100.0%	$0	-$47,523	-100.0%	$0	$0	0.0%	$45	-$533,760	-100.0%
Tribal												
Marine Net	$164,182	-$406,739	-71.2%	$0	-$309,485	-100.0%	$0	-$27,809	-100.0%	$171,232	-$760,593	-81.6%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$25,101	-100.0%	$0	-$27,651	-100.0%
Freshwater Net	$15,604	-$42,857	-73.3%	$910,217	$161,040	21.5%	$0	-$53	-100.0%	$915,907	$114,413	14.3%
Tribal Subtotal	$179,786	-$449,596	-71.4%	$910,217	-$148,445	-14.0%	$0	-$52,963	-100.0%	$1,087,140	-$673,832	-38.3%
Total	$179,829	-$916,340	-83.6%	$910,217	-$195,968	-17.7%	$0	-$52,963	-100.0%	$1,087,185	-$1,207,591	-52.6%
Coho												
Non-tribal												
Marine Net	$3,576	-$105,646	-96.7%	$0	-$47,940	-100.0%	$14,941	$2,711	22.2%	$20,268	-$154,641	-88.4%
Tribal												
Marine Net	$0	-$506,229	-100.0%	$0	-$602,493	-100.0%	$0	-$137,231	-100.0%	$0	-$1,277,107	-100.0%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$5,532	-100.0%	$0	-$6,217	-100.0%
Freshwater Net	$212,576	$31,827	17.6%	$521,361	$22,463	4.5%	$10,413	-$495	-4.5%	$750,227	$54,899	7.9%
Tribal Subtotal	$212,576	-$474,403	-69.1%	$521,361	-$580,030	-52.7%	$10,413	-$143,259	-93.2%	$750,227	-$1,228,425	-62.1%
Total	$216,152	-$580,049	-72.9%	$521,361	-$627,970	-54.6%	$25,354	-$140,548	-84.7%	$770,495	-$1,383,066	-64.2%
Sockeye												
Non-tribal												
Marine Net	$0	-$2,536,466	-100.0%	$0	$0	0.0%	$0	$0	0.0%	$0	-$2,632,440	-100.0%
Tribal												
Marine Net	$0	-$2,629,194	-100.0%	$0	$0	0.0%	$0	-$257,057	-100.0%	$0	-$3,010,705	-100.0%
Freshwater Net	$0	-$2,373	-100.0%	$0	-$477,167	-100.0%	$0	$0	0.0%	$0	-$472,288	-100.0%
Tribal Subtotal	$0	-$2,631,567	-100.0%	$0	-$477,167	-100.0%	$0	-$257,057	-100.0%	$0	-$3,482,994	-100.0%
Total	$0	-$5,168,033	-100.0%	$0	-$477,167	-100.0%	$0	-$257,057	-100.0%	$0	-$6,115,434	-100.0%
Pink												
Non-tribal												
Marine Net	$0	-$3,575,829	-100.0%	$0	-$23,534	-100.0%	$0	$0	0.0%	$0	-$3,790,438	-100.0%
Tribal												
Marine Net	$0	-$3,446,602	-100.0%	$0	-$152,341	-100.0%	$0	-$6,595	-100.0%	$0	-$3,790,394	-100.0%
Freshwater Net	$432,646	$191,773	79.6%	$142,675	$141,746	15257.6%	$0	$0	0.0%	$598,439	$343,767	135.0%
Tribal Subtotal	$432,646	-$3,254,829	-88.3%	$142,675	-$10,595	-6.9%	$0	-$6,595	-100.0%	$598,439	-$3,446,627	-85.2%
Total	$432,646	-$6,830,658	-94.0%	$142,675	-$34,129	-19.3%	$0	-$6,595	-100.0%	$598,439	-$7,237,065	-92.4%
Chum												
Non-tribal												
Marine Net	$0	-$949,063	-100.0%	$0	-$2,311,477	-100.0%	$0	$0	0.0%	$0	-$3,243,513	-100.0%
Tribal												
Marine Net	$0	-$798,800	-100.0%	$0	-$1,943,299	-100.0%	$0	-$78,408	-100.0%	$0	-$2,815,669	-100.0%
Freshwater Net	$18,062	-$521,479	-96.7%	$1,549,864	$732,602	89.6%	$18	$18	0.0%	$1,535,920	$178,338	13.1%
Tribal Subtotal	$18,062	-$1,320,280	-98.7%	$1,549,864	-$1,210,697	-43.9%	$18	-$78,390	-100.0%	$1,535,920	-$2,637,332	-63.2%
Total	$18,062	-$2,269,343	-99.2%	$1,549,864	-$3,522,174	-69.4%	$18	-$78,390	-100.0%	$1,535,920	-$5,880,845	-79.3%
Steelhead												
Non-tribal												
Marine Net	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%
Tribal												
Marine Net	$0	-$2,837	-100.0%	$0	-$74	-100.0%	$0	-$1,142	-100.0%	$0	-$4,324	-100.0%
Freshwater Net	$2,067	-$209	-9.2%	$6,263	-$29	-0.5%	$5,299	-$87	-1.6%	$14,291	-$345	-2.4%
Tribal Subtotal	$2,067	-$3,047	-59.6%	$6,263	-$103	-1.6%	$5,299	-$1,229	-18.8%	$14,291	-$4,669	-24.6%
Total	$2,067	-$3,047	-59.6%	$6,263	-$103	-1.6%	$5,299	-$1,229	-18.8%	$14,291	-$4,669	-24.6%
Total												
Non-tribal												
Marine Net	$3,619	-$7,633,749	-100.0%	$0	-$2,430,475	-100.0%	$14,941	$2,711	22.2%	$20,313	-$10,354,792	-99.8%
Tribal												
Marine Net	$164,182	-$7,790,402	-97.9%	$0	-$3,007,692	-100.0%	$0	-$508,244	-100.0%	$171,232	-$11,658,793	-98.6%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$30,633	-100.0%	$0	-$33,868	-100.0%
Freshwater Net	$680,955	-$343,318	-33.5%	$3,130,380	$580,655	22.8%	$15,731	-$616	-3.8%	$3,814,784	$218,782	6.1%
Tribal Subtotal	$845,136	-$8,133,720	-90.6%	$3,130,380	-$2,427,037	-43.7%	$15,731	-$539,493	-97.2%	$3,986,017	-$11,473,879	-74.2%
Total	$848,756	-$15,767,469	-94.9%	$3,130,380	-$4,857,512	-60.8%	$30,672	-$536,782	-94.6%	$4,006,330	-$21,828,671	-84.5%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-26. Total changes in personal income (in 2002 dollars) caused by changes in commercial landings under the project alternatives.
Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 3 - Escapement Goal Management at the Population Level/Terminal Fisheries Only											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Specie	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number		Change from Baseline (%)	Number	Change from Baseline	% Change
Chinook												
Non-tribal												
Marine Net	$43	-$466,745	-100.0%	$0	-$47,523	-100.0%	$0	$0	0.0%	$45	-$533,760	-100.0%
Tribal												
Marine Net	$0	-$570,920	-100.0%	$0	-$309,485	-100.0%	$0	-$27,809	-100.0%	$0	-$931,826	-100.0%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$25,101	-100.0%	$0	-$27,651	-100.0%
Freshwater Net	$0	-$58,461	-100.0%	$910,217	$161,040	21.5%	$0	-$53	-100.0%	$899,633	$98,138	12.2%
Tribal Subtotal	$0	-$629,382	-100.0%	$910,217	-$148,445	-14.0%	$0	-$52,963	-100.0%	$899,633	-$861,338	-48.9%
Total	$43	-$1,096,126	-100.0%	$910,217	-$195,968	-17.7%	$0	-$52,963	-100.0%	$899,678	-$1,395,098	-60.8%
Coho												
Non-tribal												
Marine Net	$3,576	-$105,646	-96.7%	$0	-$47,940	-100.0%	$14,941	$2,711	22.2%	$20,268	-$154,641	-88.4%
Tribal												
Marine Net	$0	-$506,229	-100.0%	$0	-$602,493	-100.0%	$0	-$137,231	-100.0%	$0	-$1,277,107	-100.0%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$5,532	-100.0%	$0	-$6,217	-100.0%
Freshwater Net	$917	-$179,832	-99.5%	$521,361	$22,463	4.5%	$10,413	-$495	-4.5%	$529,675	-$165,653	-23.8%
Tribal Subtotal	$917	-$686,062	-99.9%	$521,361	-$580,030	-52.7%	$10,413	-$143,259	-93.2%	$529,675	-$1,448,978	-73.2%
Total	$4,493	-$791,707	-99.4%	$521,361	-$627,970	-54.6%	$25,354	-$140,548	-84.7%	$549,943	-$1,603,618	-74.5%
Sockeye												
Non-tribal												
Marine Net	$0	-$2,536,466	-100.0%	$0	$0	0.0%	$0	$0	0.0%	$0	-$2,632,440	-100.0%
Tribal												
Marine Net	$0	-$2,629,194	-100.0%	$0	$0	0.0%	$0	-$257,057	-100.0%	$0	-$3,010,705	-100.0%
Freshwater Net	$0	-$2,373	-100.0%	$0	-$477,167	-100.0%	$0	$0	0.0%	$0	-$472,288	-100.0%
Tribal Subtotal	$0	-$2,631,567	-100.0%	$0	-$477,167	-100.0%	$0	-$257,057	-100.0%	$0	-$3,482,994	-100.0%
Total	$0	-$5,168,033	-100.0%	$0	-$477,167	-100.0%	$0	-$257,057	-100.0%	$0	-$6,115,434	-100.0%
Pink												
Non-tribal												
Marine Net	$0	-$3,575,829	-100.0%	$0	-$23,534	-100.0%	$0	$0	0.0%	$0	-$3,790,438	-100.0%
Tribal												
Marine Net	$0	-$3,446,602	-100.0%	$0	-$152,341	-100.0%	$0	-$6,595	-100.0%	$0	-$3,790,394	-100.0%
Freshwater Net	$0	-$240,873	-100.0%	$142,675	$141,746	15257.6%	$0	$0	0.0%	$142,675	-$111,998	-44.0%
Tribal Subtotal	$0	-$3,687,474	-100.0%	$142,675	-$10,595	-6.9%	$0	-$6,595	-100.0%	$142,675	-$3,902,392	-96.5%
Total	$0	-$7,263,304	-100.0%	$142,675	-$34,129	-19.3%	$0	-$6,595	-100.0%	$142,675	-$7,692,830	-98.2%
Chum												
Non-tribal												
Marine Net	$0	-$949,063	-100.0%	$0	-$2,311,477	-100.0%	$0	$0	0.0%	$0	-$3,243,513	-100.0%
Tribal												
Marine Net	$0	-$798,800	-100.0%	$0	-$1,943,299	-100.0%	$0	-$78,408	-100.0%	$0	-$2,815,669	-100.0%
Freshwater Net	$10,559	-$528,982	-98.0%	$1,549,864	$732,602	89.6%	$18	$18	0.0%	$1,528,167	$170,585	12.6%
Tribal Subtotal	$10,559	-$1,327,782	-99.2%	$1,549,864	-$1,210,697	-43.9%	$18	-$78,390	-100.0%	$1,528,167	-$2,645,084	-63.4%
Total	$10,559	-$2,276,845	-99.5%	$1,549,864	-$3,522,174	-69.4%	$18	-$78,390	-100.0%	$1,528,167	-$5,888,598	-79.4%
Steelhead												
Non-tribal												
Marine Net	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%
Tribal												
Marine Net	$0	-$2,837	-100.0%	$0	-$74	-100.0%	$0	-$1,142	-100.0%	$0	-$4,324	-100.0%
Freshwater Net	$2,067	-$209	-9.2%	$6,263	-$29	-0.5%	$5,299	-$87	-1.6%	$14,291	-$345	-2.4%
Tribal Subtotal	$2,067	-$3,047	-59.6%	$6,263	-$103	-1.6%	$5,299	-$1,229	-18.8%	$14,291	-$4,669	-24.6%
Total	$2,067	-$3,047	-59.6%	$6,263	-$103	-1.6%	$5,299	-$1,229	-18.8%	$14,291	-$4,669	-24.6%
Total												
Non-tribal												
Marine Net	$3,619	-$7,633,749	-100.0%	$0	-$2,430,475	-100.0%	$14,941	$2,711	22.2%	$20,313	-$10,354,792	-99.8%
Tribal												
Marine Net	$0	-$7,954,583	-100.0%	$0	-$3,007,692	-100.0%	$0	-$508,244	-100.0%	$0	-$11,830,026	-100.0%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$30,633	-100.0%	$0	-$33,868	-100.0%
Freshwater Net	$13,543	-$1,010,730	-98.7%	$3,130,380	$580,655	22.8%	$15,731	-$616	-3.8%	$3,114,441	-$481,561	-13.4%
Tribal Subtotal	$13,543	-$8,965,313	-99.8%	$3,130,380	-$2,427,037	-43.7%	$15,731	-$539,493	-97.2%	$3,114,441	-$12,345,455	-79.9%
Total	$17,163	-$16,599,062	-99.9%	$3,130,380	-$4,857,512	-60.8%	$30,672	-$536,782	-94.6%	$3,134,754	-$22,700,247	-87.9%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-26. Total changes in personal income (in 2002 dollars) caused by changes in commercial landings under the project alternatives. Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 4 - No Fishing											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Specie	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number		Change from Baseline (%)	Number	Change from Baseline	% Change
Chinook												
Non-tribal												
Marine Net	$0	-$466,788	-100.0%	$0	-$47,523	-100.0%	$0	$0	0.0%	$0	-$533,805	-100.0%
Tribal												
Marine Net	$0	-$570,920	-100.0%	$0	-$309,485	-100.0%	$0	-$27,809	-100.0%	$0	-$931,826	-100.0%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$25,101	-100.0%	$0	-$27,651	-100.0%
Freshwater Net	$0	-$58,461	-100.0%	$0	-$749,176	-100.0%	$0	-$53	-100.0%	$0	-$801,495	-100.0%
Tribal Subtotal	$0	-$629,382	-100.0%	$0	-$1,058,662	-100.0%	$0	-$52,963	-100.0%	$0	-$1,760,971	-100.0%
Total	$0	-$1,096,169	-100.0%	$0	-$1,106,185	-100.0%	$0	-$52,963	-100.0%	$0	-$2,294,776	-100.0%
Coho												
Non-tribal												
Marine Net	$0	-$109,222	-100.0%	$0	-$47,940	-100.0%	$0	-$12,230	-100.0%	$0	-$174,909	-100.0%
Tribal												
Marine Net	$0	-$506,229	-100.0%	$0	-$602,493	-100.0%	$0	-$137,231	-100.0%	$0	-$1,277,107	-100.0%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$5,532	-100.0%	$0	-$6,217	-100.0%
Freshwater Net	$0	-$180,749	-100.0%	$0	-$498,898	-100.0%	$0	-$10,908	-100.0%	$0	-$695,328	-100.0%
Tribal Subtotal	$0	-$686,979	-100.0%	$0	-$1,101,391	-100.0%	$0	-$153,672	-100.0%	$0	-$1,978,653	-100.0%
Total	$0	-$796,201	-100.0%	$0	-$1,149,332	-100.0%	$0	-$165,903	-100.0%	$0	-$2,153,561	-100.0%
Sockeye												
Non-tribal												
Marine Net	$0	-$2,536,466	-100.0%	$0	$0	0.0%	$0	$0	0.0%	$0	-$2,632,440	-100.0%
Tribal												
Marine Net	$0	-$2,629,194	-100.0%	$0	$0	0.0%	$0	-$257,057	-100.0%	$0	-$3,010,705	-100.0%
Freshwater Net	$0	-$2,373	-100.0%	$0	-$477,167	-100.0%	$0	$0	0.0%	$0	-$472,288	-100.0%
Tribal Subtotal	$0	-$2,631,567	-100.0%	$0	-$477,167	-100.0%	$0	-$257,057	-100.0%	$0	-$3,482,994	-100.0%
Total	$0	-$5,168,033	-100.0%	$0	-$477,167	-100.0%	$0	-$257,057	-100.0%	$0	-$6,115,434	-100.0%
Pink												
Non-tribal												
Marine Net	$0	-$3,575,829	-100.0%	$0	-$23,534	-100.0%	$0	$0	0.0%	$0	-$3,790,438	-100.0%
Tribal												
Marine Net	$0	-$3,446,602	-100.0%	$0	-$152,341	-100.0%	$0	-$6,595	-100.0%	$0	-$3,790,394	-100.0%
Freshwater Net	$0	-$240,873	-100.0%	$0	-$929	-100.0%	$0	$0	0.0%	$0	-$254,673	-100.0%
Tribal Subtotal	$0	-$3,687,474	-100.0%	$0	-$153,270	-100.0%	$0	-$6,595	-100.0%	$0	-$4,045,067	-100.0%
Total	$0	-$7,263,304	-100.0%	$0	-$176,804	-100.0%	$0	-$6,595	-100.0%	$0	-$7,835,505	-100.0%
Chum												
Non-tribal												
Marine Net	$0	-$949,063	-100.0%	$0	-$2,311,477	-100.0%	$0	$0	0.0%	$0	-$3,243,513	-100.0%
Tribal												
Marine Net	$0	-$798,800	-100.0%	$0	-$1,943,299	-100.0%	$0	-$78,408	-100.0%	$0	-$2,815,669	-100.0%
Freshwater Net	$10,559	-$528,982	-98.0%	$387,434	-$429,828	-52.6%	$18	$18	0.0%	$390,209	-$967,373	-71.3%
Tribal Subtotal	$10,559	-$1,327,782	-99.2%	$387,434	-$2,373,127	-86.0%	$18	-$78,390	-100.0%	$390,209	-$3,783,042	-90.6%
Total	$10,559	-$2,276,845	-99.5%	$387,434	-$4,684,604	-92.4%	$18	-$78,390	-100.0%	$390,209	-$7,026,555	-94.7%
Steelhead												
Non-tribal												
Marine Net	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%
Tribal												
Marine Net	$0	-$2,837	-100.0%	$0	-$74	-100.0%	$0	-$1,142	-100.0%	$0	-$4,324	-100.0%
Freshwater Net	$2,067	-$209	-9.2%	$4,911	-$1,381	-22.0%	$5,291	-$96	-1.8%	$12,929	-$1,707	-11.7%
Tribal Subtotal	$2,067	-$3,047	-59.6%	$4,911	-$1,455	-22.9%	$5,291	-$1,238	-19.0%	$12,929	-$6,031	-31.8%
Total	$2,067	-$3,047	-59.6%	$4,911	-$1,455	-22.9%	$5,291	-$1,238	-19.0%	$12,929	-$6,031	-31.8%
Total												
Non-tribal												
Marine Net	$0	-$7,637,368	-100.0%	$0	-$2,430,475	-100.0%	$0	-$12,230	-100.0%	$0	-$10,375,105	-100.0%
Tribal												
Marine Net	$0	-$7,954,583	-100.0%	$0	-$3,007,692	-100.0%	$0	-$508,244	-100.0%	$0	-$11,830,026	-100.0%
Marine Troll	$0	$0	0.0%	$0	$0	0.0%	$0	-$30,633	-100.0%	$0	-$33,868	-100.0%
Freshwater Net	$12,626	-$1,011,647	-98.8%	$392,344	-$2,157,380	-84.6%	$5,309	-$11,038	-67.5%	$403,138	-$3,192,864	-88.8%
Tribal Subtotal	$12,626	-$8,966,230	-99.9%	$392,344	-$5,165,072	-92.9%	$5,309	-$549,915	-99.0%	$403,138	-$15,056,758	-97.4%
Total	$12,626	-$16,603,598	-99.9%	$392,344	-$7,595,547	-95.1%	$5,309	-$562,145	-99.1%	$403,138	-$25,431,863	-98.4%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.

Table D-27. Total changes in employment (in full-time equivalent jobs) caused by changes in sport fishing trips under the project alternatives.
Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

	Alternative 1 - Proposed Action/Status Quo			
Angler Group/Sector	North Puget Sound	SPS/SHC*	SJF/ NHC*	State Total
Local Residents				
Transportation	102.1	114.5	40.4	228.3
Food	127.0	126.4	33.4	305.9
Lodging	23.2	37.2	21.6	83.5
Boat Fuel	38.8	42.1	13.8	97.1
Party/Charter Fees	21.5	20.6	2.1	47.7
ccess/Boat Launching	5.8	12.2	6.0	25.5
Equipment Rental	11.5	10.2	2.0	24.7
Bait and Ice	77.5	67.1	19.1	167.2
Total	407.4	430.3	138.4	979.9
Non-Local Residents				
Transportation	23.5	12.7	88.4	101.9
Food	46.5	18.8	69.8	140.2
Lodging	15.6	8.4	64.8	80.9
Boat Fuel	10.7	4.7	21.0	33.2
Party/Charter Fees	15.0	7.6	28.5	55.0
ccess/Boat Launching	0.8	0.9	9.2	11.2
Equipment Rental	3.8	1.6	6.5	11.3
Bait and Ice	20.0	6.3	14.9	39.6
Total	135.8	61.0	303.1	473.4
Non-residents of the State				
Transportation	4.9	4.9	22.6	30.3
Food	7.9	6.2	14.1	33.3
Lodging	4.0	3.3	10.9	18.7
Boat Fuel	1.4	1.2	3.3	6.1
Party/Charter Fees	2.5	2.1	2.6	8.0
ccess/Boat Launching	0.3	0.3	1.5	2.4
Equipment Rental	0.6	0.5	1.5	2.6
Bait and Ice	2.2	1.4	2.1	5.8
Total	23.7	19.8	58.6	107.2
Net Impact**				
Transportation	130.5	132.1	151.4	360.5
Food	181.3	151.3	117.4	479.4
Lodging	42.8	48.8	97.3	183.1
Boat Fuel	50.9	48.0	38.1	136.4
Party/Charter Fees	39.0	30.4	33.2	110.7
ccess/Boat Launching	6.9	13.5	16.7	39.2
Equipment Rental	15.8	12.3	10.0	38.7
Bait and Ice	99.7	74.8	36.2	212.5
Total	567.0	511.2	500.1	1,560.4

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.
** For Puget Sound regions, the net impact represents effects caused by changes in non-local and non-resident spending relative to baseline spending.
For Washington, the net impact represents effects caused by changes in non-resident spending relative to baseline spending.
The baseline includes local, non-local, and non-resident spending effects.

Table D-27. Total changes in employment (in full-time equivalent jobs) caused by changes in sport fishing trips under the project alternatives. Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 2 - Escapement Goal Management at the Management Unit Level											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Angler Group/Sector	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change
Local Residents												
Transportation	21.5	-80.5	-78.9%	20.3	-94.2	-82.3%	1.1	-39.3	-97.3%	38.6	-189.7	-83.1%
Food	30.8	-96.1	-75.7%	28.5	-97.9	-77.4%	1.4	-32.0	-95.8%	64.8	-241.0	-78.8%
Lodging	1.3	-22.0	-94.6%	1.2	-36.0	-96.9%	0.1	-21.6	-99.7%	2.6	-80.9	-96.9%
Boat Fuel	9.3	-29.5	-76.0%	9.3	-32.8	-77.9%	0.6	-13.3	-96.0%	20.2	-76.9	-79.2%
Party/Charter Fees	6.6	-15.0	-69.6%	7.3	-13.3	-64.6%	0.3	-1.8	-84.8%	15.3	-32.5	-68.0%
ccess/Boat Launching	0.0	-5.8	-100.0%	0.0	-12.2	-100.0%	0.0	-6.0	-100.0%	0.0	-25.5	-100.0%
Equipment Rental	3.3	-8.2	-71.5%	3.1	-7.1	-69.3%	0.2	-1.8	-91.1%	7.0	-17.8	-71.9%
Bait and Ice	19.3	-58.2	-75.1%	15.9	-51.2	-76.4%	0.9	-18.2	-95.4%	37.0	-130.2	-77.9%
Total	92.0	-315.4	-77.4%	85.6	-344.7	-80.1%	4.5	-133.9	-96.8%	185.5	-794.4	-81.1%
Non-Local Residents												
Transportation	5.1	-18.4	-78.1%	2.0	-10.8	-84.5%	0.9	-87.5	-99.0%	7.0	-94.9	-93.1%
Food	12.6	-33.9	-72.9%	4.7	-14.1	-74.8%	1.9	-67.9	-97.2%	20.0	-120.2	-85.7%
Lodging	3.3	-12.3	-78.7%	1.2	-7.2	-85.2%	0.6	-64.2	-99.1%	5.2	-75.7	-93.6%
Boat Fuel	2.9	-7.8	-72.9%	1.2	-3.5	-74.7%	0.6	-20.4	-97.2%	4.8	-28.4	-85.6%
Party/Charter Fees	3.9	-11.0	-73.7%	1.8	-5.9	-76.6%	0.7	-27.9	-97.7%	6.9	-48.1	-87.4%
ccess/Boat Launching	0.0	-0.8	-100.0%	0.0	-0.9	-100.0%	0.0	-9.2	-100.0%	0.0	-11.2	-100.0%
Equipment Rental	1.0	-2.8	-72.8%	0.4	-1.2	-74.4%	0.2	-6.3	-97.1%	1.7	-9.7	-85.3%
Bait and Ice	5.8	-14.2	-70.8%	2.0	-4.3	-68.8%	0.9	-14.0	-93.9%	8.5	-31.1	-78.6%
Total	34.8	-101.0	-74.4%	13.3	-47.7	-78.2%	5.8	-297.3	-98.1%	54.0	-419.4	-88.6%
Non-residents of the State												
Transportation	0.3	-4.6	-93.3%	0.3	-4.6	-94.6%	0.1	-22.5	-99.7%	0.9	-29.4	-97.2%
Food	1.7	-6.2	-78.5%	1.3	-4.8	-78.5%	0.4	-13.8	-97.5%	4.1	-29.2	-87.7%
Lodging	0.7	-3.3	-81.8%	0.6	-2.7	-82.7%	0.2	-10.7	-98.4%	1.6	-17.1	-91.4%
Boat Fuel	0.3	-1.1	-78.4%	0.3	-0.9	-78.4%	0.1	-3.2	-97.5%	0.8	-5.4	-87.6%
Party/Charter Fees	0.7	-1.8	-73.2%	0.6	-1.5	-70.8%	0.1	-2.4	-94.4%	1.5	-6.5	-80.8%
ccess/Boat Launching	0.0	-0.3	-100.0%	0.0	-0.3	-100.0%	0.0	-1.5	-100.0%	0.0	-2.4	-100.0%
Equipment Rental	0.1	-0.5	-80.9%	0.1	-0.4	-81.6%	0.0	-1.4	-98.2%	0.2	-2.4	-91.0%
Bait and Ice	0.6	-1.6	-73.2%	0.4	-1.0	-70.6%	0.1	-2.0	-94.3%	1.1	-4.7	-80.6%
Total	4.4	-19.3	-81.4%	3.5	-16.3	-82.2%	1.0	-57.6	-98.3%	10.2	-97.0	-90.5%
Net Impact**												
Transportation	5.5	-23.0	-17.6%	2.2	-15.4	-11.6%	1.0	-110.0	-72.7%	0.9	-29.4	-8.2%
Food	14.3	-40.1	-22.1%	6.1	-18.9	-12.5%	2.3	-81.7	-69.6%	4.1	-29.2	-6.1%
Lodging	4.1	-15.5	-36.3%	1.8	-9.9	-20.2%	0.8	-74.9	-77.0%	1.6	-17.1	-9.3%
Boat Fuel	3.2	-8.9	-17.5%	1.4	-4.4	-9.2%	0.7	-23.6	-62.0%	0.8	-5.4	-3.9%
Party/Charter Fees	4.6	-12.8	-32.9%	2.4	-7.4	-24.2%	0.8	-30.3	-91.3%	1.5	-6.5	-5.8%
ccess/Boat Launching	0.0	-1.0	-14.9%	0.0	-1.3	-9.4%	0.0	-10.7	-63.9%	0.0	-2.4	-6.2%
Equipment Rental	1.1	-3.2	-20.3%	0.5	-1.6	-12.8%	0.2	-7.8	-78.0%	0.2	-2.4	-6.1%
Bait and Ice	6.4	-15.8	-15.8%	2.4	-5.3	-7.1%	1.0	-16.0	-44.3%	1.1	-4.7	-2.2%
Total	39.2	-120.3	-21.2%	16.8	-64.1	-12.5%	6.8	-354.9	-71.0%	10.2	-97.0	-6.2%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.
** For Puget Sound regions, the net impact represents effects caused by changes in non-local and non-resident spending relative to baseline spending.
For Washington, the net impact represents effects caused by changes in non-resident spending relative to baseline spending.
The baseline includes local, non-local, and non-resident spending effects.

Table D-27. Total changes in employment (in full-time equivalent jobs) caused by changes in sport fishing trips under the project alternatives.
Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 3 - Escapement Goal Management at the Population Level/Terminal Fisheries Only											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Angler Group/Sector	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number		Change from Baseline (%)	Number	Change from Baseline	% Change
Local Residents												
Transportation	12.2	-89.9	-88.1%	20.3	-94.2	-82.3%	0.4	-39.9	-98.9%	30.2	-198.2	-86.8%
Food	17.5	-109.5	-86.2%	28.5	-97.8	-77.4%	0.6	-32.8	-98.3%	50.6	-255.3	-83.5%
Lodging	0.7	-22.5	-96.9%	1.2	-36.0	-96.9%	0.0	-21.6	-99.9%	2.0	-81.4	-97.6%
Boat Fuel	5.3	-33.5	-86.4%	9.3	-32.8	-77.9%	0.2	-13.6	-98.4%	15.8	-81.3	-83.7%
Party/Charter Fees	3.7	-17.8	-82.8%	7.3	-13.3	-64.6%	0.1	-2.0	-93.9%	11.9	-35.8	-75.1%
cess/Boat Launching	0.0	-5.8	-100.0%	0.0	-12.2	-100.0%	0.0	-6.0	-100.0%	0.0	-25.5	-100.0%
Equipment Rental	1.9	-9.6	-83.9%	3.1	-7.1	-69.3%	0.1	-1.9	-96.5%	5.4	-19.3	-78.0%
Bait and Ice	10.9	-66.6	-85.9%	15.9	-51.2	-76.4%	0.3	-18.8	-98.2%	28.9	-138.3	-82.7%
Total	52.1	-355.3	-87.2%	85.6	-344.7	-80.1%	1.8	-136.6	-98.7%	144.8	-835.1	-85.2%
Non-Local Residents												
Transportation	2.9	-20.6	-87.6%	2.0	-10.8	-84.5%	0.4	-88.0	-99.6%	4.7	-97.2	-95.4%
Food	7.1	-39.3	-84.7%	4.7	-14.1	-74.8%	0.8	-69.0	-98.9%	13.3	-126.9	-90.5%
Lodging	1.9	-13.7	-87.9%	1.2	-7.2	-85.2%	0.2	-64.5	-99.6%	3.5	-77.5	-95.7%
Boat Fuel	1.7	-9.1	-84.6%	1.2	-3.5	-74.7%	0.2	-20.8	-98.9%	3.2	-30.0	-90.4%
Party/Charter Fees	2.2	-12.8	-85.1%	1.8	-5.9	-76.6%	0.3	-28.2	-99.1%	4.6	-50.4	-91.6%
cess/Boat Launching	0.0	-0.8	-100.0%	0.0	-0.9	-100.0%	0.0	-9.2	-100.0%	0.0	-11.2	-100.0%
Equipment Rental	0.6	-3.2	-84.6%	0.4	-1.2	-74.4%	0.1	-6.4	-98.8%	1.1	-10.2	-90.2%
Bait and Ice	3.3	-16.7	-83.4%	2.0	-4.3	-68.8%	0.4	-14.6	-97.6%	5.6	-33.9	-85.7%
Total	19.7	-116.1	-85.5%	13.3	-47.7	-78.2%	2.3	-300.8	-99.2%	36.0	-437.4	-92.4%
Non-residents of the State												
Transportation	0.2	-4.7	-96.2%	0.3	-4.6	-94.6%	0.0	-22.6	-99.9%	0.6	-29.7	-97.9%
Food	1.0	-6.9	-87.8%	1.3	-4.8	-78.5%	0.1	-14.0	-99.0%	3.0	-30.3	-91.0%
Lodging	0.4	-3.6	-89.7%	0.6	-2.7	-82.7%	0.1	-10.8	-99.4%	1.2	-17.5	-93.7%
Boat Fuel	0.2	-1.2	-87.8%	0.3	-0.9	-78.4%	0.0	-3.3	-99.0%	0.6	-5.6	-90.9%
Party/Charter Fees	0.4	-2.1	-84.8%	0.6	-1.5	-70.8%	0.1	-2.5	-97.8%	1.1	-6.9	-85.9%
cess/Boat Launching	0.0	-0.3	-100.0%	0.0	-0.3	-100.0%	0.0	-1.5	-100.0%	0.0	-2.4	-100.0%
Equipment Rental	0.1	-0.5	-89.2%	0.1	-0.4	-81.6%	0.0	-1.5	-99.3%	0.2	-2.4	-93.4%
Bait and Ice	0.3	-1.8	-84.8%	0.4	-1.0	-70.6%	0.0	-2.1	-97.7%	0.8	-5.0	-85.8%
Total	2.5	-21.2	-89.5%	3.5	-16.3	-82.2%	0.4	-58.2	-99.3%	7.5	-99.7	-93.0%
Net Impact**												
Transportation	3.1	-25.3	-19.4%	2.2	-15.4	-11.6%	0.4	-110.6	-73.1%	0.6	-29.7	-8.2%
Food	8.1	-46.2	-25.5%	6.1	-18.9	-12.5%	0.9	-83.0	-70.8%	3.0	-30.3	-6.3%
Lodging	2.3	-17.3	-40.4%	1.8	-9.9	-20.2%	0.3	-75.3	-77.5%	1.2	-17.5	-9.6%
Boat Fuel	1.8	-10.3	-20.3%	1.4	-4.4	-9.2%	0.3	-24.0	-63.0%	0.6	-5.6	-4.1%
Party/Charter Fees	2.6	-14.8	-38.1%	2.4	-7.4	-24.2%	0.3	-30.8	-92.7%	1.1	-6.9	-6.2%
cess/Boat Launching	0.0	-1.0	-14.9%	0.0	-1.3	-9.4%	0.0	-10.7	-63.9%	0.0	-2.4	-6.2%
Equipment Rental	0.6	-3.7	-23.5%	0.5	-1.6	-12.8%	0.1	-7.9	-79.3%	0.2	-2.4	-6.3%
Bait and Ice	3.6	-18.5	-18.6%	2.4	-5.3	-7.1%	0.4	-16.7	-46.0%	0.8	-5.0	-2.3%
Total	22.2	-137.3	-24.2%	16.8	-64.1	-12.5%	2.7	-359.0	-71.8%	7.5	-99.7	-6.4%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.
** For Puget Sound regions, the net impact represents effects caused by changes in non-local and non-resident spending relative to baseline spending.
For Washington, the net impact represents effects caused by changes in non-resident spending relative to baseline spending.
The baseline includes local, non-local, and non-resident spending effects.

Table D-27. Total changes in employment (in full-time equivalent jobs) caused by changes in sport fishing trips under the project alternatives.
Scenario B: 2003 abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 4 - No Fishing											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Angler Group/Sector	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number		Change from Baseline (%)	Number	Change from Baseline	% Change
Local Residents												
Transportation	0.4	-101.7	-99.6%	0.4	-114.0	-99.6%	0.0	-40.4	-100.0%	0.8	-227.6	-99.7%
Food	0.6	-126.4	-99.6%	0.6	-125.8	-99.5%	0.0	-33.4	-99.9%	1.3	-304.6	-99.6%
Lodging	0.0	-23.2	-99.9%	0.0	-37.1	-99.9%	0.0	-21.6	-100.0%	0.1	-83.4	-99.9%
Boat Fuel	0.2	-38.6	-99.6%	0.2	-41.9	-99.5%	0.0	-13.8	-99.9%	0.4	-96.7	-99.6%
Party/Charter Fees	0.1	-21.4	-99.4%	0.2	-20.5	-99.3%	0.0	-2.1	-99.8%	0.3	-47.4	-99.4%
cess/Boat Launching	0.0	-5.8	-100.0%	0.0	-12.2	-100.0%	0.0	-6.0	-100.0%	0.0	-25.5	-100.0%
Equipment Rental	0.1	-11.4	-99.5%	0.1	-10.1	-99.4%	0.0	-2.0	-99.9%	0.1	-24.6	-99.5%
Bait and Ice	0.3	-77.1	-99.5%	0.3	-66.8	-99.5%	0.0	-19.1	-99.9%	0.7	-166.4	-99.6%
Total	1.7	-405.7	-99.6%	1.8	-428.5	-99.6%	0.1	-138.3	-99.9%	3.6	-976.2	-99.6%
Non-Local Residents												
Transportation	0.1	-23.4	-99.6%	0.0	-12.7	-99.7%	0.0	-88.4	-100.0%	0.1	-101.8	-99.9%
Food	0.2	-46.2	-99.5%	0.1	-18.7	-99.5%	0.0	-69.8	-100.0%	0.4	-139.8	-99.7%
Lodging	0.1	-15.5	-99.6%	0.0	-8.4	-99.7%	0.0	-64.8	-100.0%	0.1	-80.8	-99.9%
Boat Fuel	0.1	-10.7	-99.5%	0.0	-4.7	-99.5%	0.0	-21.0	-100.0%	0.1	-33.1	-99.7%
Party/Charter Fees	0.1	-14.9	-99.5%	0.0	-7.6	-99.5%	0.0	-28.5	-100.0%	0.1	-54.9	-99.8%
cess/Boat Launching	0.0	-0.8	-100.0%	0.0	-0.9	-100.0%	0.0	-9.2	-100.0%	0.0	-11.2	-100.0%
Equipment Rental	0.0	-3.8	-99.5%	0.0	-1.6	-99.5%	0.0	-6.5	-100.0%	0.0	-11.3	-99.7%
Bait and Ice	0.1	-19.9	-99.5%	0.0	-6.2	-99.3%	0.0	-14.9	-99.9%	0.2	-39.4	-99.6%
Total	0.6	-135.2	-99.5%	0.3	-60.8	-99.5%	0.1	-303.0	-100.0%	1.0	-472.4	-99.8%
Non-residents of the State												
Transportation	0.0	-4.9	-99.9%	0.0	-4.9	-99.9%	0.0	-22.6	-100.0%	0.0	-30.3	-99.9%
Food	0.0	-7.9	-99.6%	0.0	-6.1	-99.5%	0.0	-14.1	-100.0%	0.1	-33.2	-99.8%
Lodging	0.0	-4.0	-99.7%	0.0	-3.3	-99.6%	0.0	-10.9	-100.0%	0.0	-18.7	-99.8%
Boat Fuel	0.0	-1.4	-99.6%	0.0	-1.2	-99.5%	0.0	-3.3	-100.0%	0.0	-6.1	-99.8%
Party/Charter Fees	0.0	-2.4	-99.5%	0.0	-2.1	-99.4%	0.0	-2.6	-99.9%	0.0	-8.0	-99.6%
cess/Boat Launching	0.0	-0.3	-100.0%	0.0	-0.3	-100.0%	0.0	-1.5	-100.0%	0.0	-2.4	-100.0%
Equipment Rental	0.0	-0.6	-99.7%	0.0	-0.5	-99.6%	0.0	-1.5	-100.0%	0.0	-2.6	-99.8%
Bait and Ice	0.0	-2.2	-99.5%	0.0	-1.4	-99.4%	0.0	-2.1	-99.9%	0.0	-5.8	-99.6%
Total	0.1	-23.6	-99.7%	0.1	-19.8	-99.6%	0.0	-58.6	-100.0%	0.2	-107.0	-99.8%
Net Impact**												
Transportation	0.1	-28.3	-21.7%	0.0	-17.6	-13.3%	0.0	-111.0	-73.3%	0.0	-30.3	-8.4%
Food	0.3	-54.1	-29.8%	0.1	-24.8	-16.4%	0.0	-83.9	-71.5%	0.1	-33.2	-6.9%
Lodging	0.1	-19.5	-45.6%	0.0	-11.7	-23.9%	0.0	-75.6	-77.8%	0.0	-18.7	-10.2%
Boat Fuel	0.1	-12.1	-23.7%	0.0	-5.8	-12.2%	0.0	-24.3	-63.7%	0.0	-6.1	-4.5%
Party/Charter Fees	0.1	-17.4	-44.5%	0.1	-9.7	-32.0%	0.0	-31.1	-93.7%	0.0	-8.0	-7.2%
cess/Boat Launching	0.0	-1.0	-14.9%	0.0	-1.3	-9.4%	0.0	-10.7	-63.9%	0.0	-2.4	-6.2%
Equipment Rental	0.0	-4.3	-27.4%	0.0	-2.0	-16.7%	0.0	-8.0	-80.2%	0.0	-2.6	-6.7%
Bait and Ice	0.1	-22.1	-22.1%	0.0	-7.6	-10.2%	0.0	-17.0	-47.1%	0.0	-5.8	-2.7%
Total	0.7	-158.8	-28.0%	0.4	-80.5	-15.8%	0.1	-361.6	-72.3%	0.2	-107.0	-6.9%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.
** For Puget Sound regions, the net impact represents effects caused by changes in non-local and non-resident spending relative to baseline spending.
For Washington, the net impact represents effects caused by changes in non-resident spending relative to baseline spending.
The baseline includes local, non-local, and non-resident spending effects.

Table D-28. Total changes in personal income (in 2002 dollars) caused by changes in sport fishing trips under the project alternatives.
Scenario B: 2003 Abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

	Alternative 1 - Proposed Action/Status Quo			
Angler Group/Sector	North Puget Sound	SPS/SHC*	SJF/ NHC*	State Total
Local Residents				
Transportation	$3,601,273	$5,025,029	$1,170,252	$10,585,672
Food	$3,451,797	$4,586,478	$733,296	$10,187,463
Lodging	$739,805	$1,506,522	$564,722	$3,031,943
Boat Fuel	$2,072,823	$2,670,191	$528,523	$5,707,453
Party/Charter Fees	$486,618	$480,234	$43,181	$1,079,662
ccess/Boat Launching	$157,525	$367,628	$138,158	$732,568
Equipment Rental	$477,333	$573,178	$58,258	$1,245,418
Bait and Ice	$4,779,342	$5,580,193	$1,176,148	$12,029,420
Total	$15,766,516	$20,789,453	$4,412,539	$44,599,598
Non-Local Residents				
Transportation	$829,774	$559,015	$2,561,019	$4,723,922
Food	$1,262,850	$681,729	$1,533,127	$4,669,476
Lodging	$496,792	$341,234	$1,691,898	$2,939,249
Boat Fuel	$573,469	$296,596	$802,274	$1,949,691
Party/Charter Fees	$338,476	$177,731	$588,697	$1,244,754
ccess/Boat Launching	$20,381	$28,234	$209,849	$323,180
Equipment Rental	$157,739	$88,450	$192,479	$571,273
Bait and Ice	$1,233,740	$520,688	$920,128	$2,849,477
Total	$4,913,221	$2,693,678	$8,499,472	$19,271,021
Non-residents of the State				
Transportation	$173,744	$213,444	$655,103	$1,404,333
Food	$214,382	$224,122	$310,621	$1,108,022
Lodging	$127,754	$133,003	$283,815	$678,705
Boat Fuel	$75,282	$75,583	$126,721	$359,954
Party/Charter Fees	$55,496	$49,476	$53,445	$180,706
ccess/Boat Launching	$7,283	$9,984	$34,637	$70,327
Equipment Rental	$23,815	$27,107	$43,472	$130,720
Bait and Ice	$134,509	$115,439	$130,388	$417,401
Total	$812,265	$848,159	$1,638,201	$4,350,169
Net Impact**				
Transportation	$4,604,790	$5,797,488	$4,386,375	$16,713,926
Food	$4,929,029	$5,492,329	$2,577,044	$15,964,962
Lodging	$1,364,351	$1,980,759	$2,540,435	$6,649,897
Boat Fuel	$2,721,574	$3,042,370	$1,457,518	$8,017,098
Party/Charter Fees	$880,590	$707,441	$685,323	$2,505,121
ccess/Boat Launching	$185,190	$405,846	$382,644	$1,126,075
Equipment Rental	$658,887	$688,735	$294,210	$1,947,411
Bait and Ice	$6,147,591	$6,216,320	$2,226,665	$15,296,298
Total	$21,492,002	$24,331,289	$14,550,212	$68,220,788

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.
** For Puget Sound regions, the net impact represents effects caused by changes in non-local and non-resident spending relative to baseline spending.
For Washington, the net impact represents effects caused by changes in non-resident spending relative to baseline spending.
The baseline includes local, non-local, and non-resident spending effects.

Table D-28. Total changes in personal income (in 2002 dollars) caused by changes in sport fishing trips under the project alternatives.
Scenario B: 2003 Abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 2 - Escapement Goal Management at the Management Unit Level											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Angler Group/Sector	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change
Local Residents												
Transportation	$759,400	-$2,841,872	-78.9%	$891,378	-$4,133,650	-82.3%	$31,565	-$1,138,687	-97.3%	$1,791,005	-$8,794,667	-83.1%
Food	$837,984	-$2,613,813	-75.7%	$1,035,084	-$3,551,394	-77.4%	$30,556	-$702,740	-95.8%	$2,159,450	-$8,028,013	-78.8%
Lodging	$40,169	-$699,636	-94.6%	$46,913	-$1,459,609	-96.9%	$1,743	-$562,980	-99.7%	$94,483	-$2,937,460	-96.9%
Boat Fuel	$497,875	-$1,574,949	-76.0%	$591,200	-$2,078,991	-77.9%	$21,204	-$507,319	-96.0%	$1,188,508	-$4,518,944	-79.2%
Party/Charter Fees	$147,941	-$338,677	-69.6%	$170,037	-$310,197	-64.6%	$6,559	-$36,621	-84.8%	$345,064	-$734,598	-68.0%
ccess/Boat Launching	$0	-$157,525	-100.0%	$0	-$367,628	-100.0%	$0	-$138,158	-100.0%	$0	-$732,568	-100.0%
Equipment Rental	$135,909	-$341,424	-71.5%	$176,048	-$397,131	-69.3%	$5,174	-$53,085	-91.1%	$350,273	-$895,146	-71.9%
Bait and Ice	$1,190,251	-$3,589,091	-75.1%	$1,319,145	-$4,261,048	-76.4%	$53,900	-$1,122,249	-95.4%	$2,661,968	-$9,367,452	-77.9%
Total	$3,609,529	-$12,156,987	-77.1%	$4,229,805	-$16,559,648	-79.7%	$150,700	-$4,261,839	-96.6%	$8,590,751	-$36,008,847	-80.7%
Non-Local Residents												
Transportation	$181,532	-$648,241	-78.1%	$86,635	-$472,380	-84.5%	$25,874	-$2,535,145	-99.0%	$323,610	-$4,400,312	-93.1%
Food	$342,033	-$920,817	-72.9%	$171,774	-$509,956	-74.8%	$42,766	-$1,490,361	-97.2%	$666,217	-$4,003,259	-85.7%
Lodging	$106,003	-$390,788	-78.7%	$50,335	-$290,899	-85.2%	$15,770	-$1,676,128	-99.1%	$188,461	-$2,750,787	-93.6%
Boat Fuel	$155,645	-$417,825	-72.9%	$75,145	-$221,451	-74.7%	$22,730	-$779,544	-97.2%	$280,839	-$1,668,852	-85.6%
Party/Charter Fees	$89,119	-$249,357	-73.7%	$41,646	-$136,085	-76.6%	$13,549	-$575,148	-97.7%	$157,117	-$1,087,637	-87.4%
ccess/Boat Launching	$0	-$20,381	-100.0%	$0	-$28,234	-100.0%	$0	-$209,849	-100.0%	$0	-$323,180	-100.0%
Equipment Rental	$42,971	-$114,768	-72.8%	$22,631	-$65,819	-74.4%	$5,609	-$186,870	-97.1%	$83,709	-$487,563	-85.3%
Bait and Ice	$360,536	-$873,204	-70.8%	$162,462	-$358,226	-68.8%	$55,985	-$864,144	-93.9%	$609,472	-$2,240,005	-78.6%
Total	$1,277,839	-$3,635,382	-74.0%	$610,628	-$2,083,050	-77.3%	$182,283	-$8,317,189	-97.9%	$2,309,426	-$16,961,595	-88.0%
Non-residents of the State												
Transportation	$11,654	-$162,090	-93.3%	$11,586	-$201,858	-94.6%	$2,213	-$652,890	-99.7%	$39,600	-$1,364,732	-97.2%
Food	$46,137	-$168,246	-78.5%	$48,271	-$175,852	-78.5%	$7,687	-$302,934	-97.5%	$136,293	-$971,729	-87.7%
Lodging	$23,236	-$104,518	-81.8%	$22,986	-$110,017	-82.7%	$4,606	-$279,208	-98.4%	$58,077	-$620,628	-91.4%
Boat Fuel	$16,247	-$59,035	-78.4%	$16,341	-$59,242	-78.4%	$3,162	-$123,559	-97.5%	$44,611	-$315,343	-87.6%
Party/Charter Fees	$14,851	-$40,646	-73.2%	$14,458	-$35,018	-70.8%	$3,009	-$50,436	-94.4%	$34,724	-$145,982	-80.8%
ccess/Boat Launching	$0	-$7,283	-100.0%	$0	-$9,984	-100.0%	$0	-$34,637	-100.0%	$0	-$70,327	-100.0%
Equipment Rental	$4,558	-$19,257	-80.9%	$5,001	-$22,106	-81.6%	$793	-$42,679	-98.2%	$11,775	-$118,944	-91.0%
Bait and Ice	$36,113	-$98,396	-73.2%	$33,901	-$81,538	-70.6%	$7,473	-$122,915	-94.3%	$80,965	-$336,436	-80.6%
Total	$152,794	-$659,471	-81.2%	$152,543	-$695,615	-82.0%	$28,944	-$1,609,258	-98.2%	$406,047	-$3,944,122	-90.7%
Net Impact**												
Transportation	$193,186	-$810,332	-17.6%	$98,222	-$674,238	-11.6%	$28,087	-$3,188,035	-72.7%	$39,600	-$1,364,732	-8.2%
Food	$388,169	-$1,089,063	-22.1%	$220,044	-$685,807	-12.5%	$50,454	-$1,793,294	-69.6%	$136,293	-$971,729	-6.1%
Lodging	$129,239	-$495,307	-36.3%	$73,321	-$400,917	-20.2%	$20,376	-$1,955,336	-77.0%	$58,077	-$620,628	-9.3%
Boat Fuel	$171,892	-$476,859	-17.5%	$91,486	-$280,693	-9.2%	$25,892	-$903,103	-62.0%	$44,611	-$315,343	-3.9%
Party/Charter Fees	$103,970	-$290,002	-32.9%	$56,104	-$171,103	-24.2%	$16,558	-$625,584	-91.3%	$34,724	-$145,982	-5.8%
ccess/Boat Launching	$0	-$27,665	-14.9%	$0	-$38,218	-9.4%	$0	-$244,486	-63.9%	$0	-$70,327	-6.2%
Equipment Rental	$47,528	-$134,026	-20.3%	$27,632	-$87,925	-12.8%	$6,402	-$229,549	-78.0%	$11,775	-$118,944	-6.1%
Bait and Ice	$396,649	-$971,600	-15.8%	$196,363	-$439,764	-7.1%	$63,457	-$987,059	-44.3%	$80,965	-$336,436	-2.2%
Total	$1,430,633	-$4,294,853	-20.0%	$763,171	-$2,778,665	-11.4%	$211,227	-$9,926,446	-68.2%	$406,047	-$3,944,122	-5.8%

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** For Puget Sound regions, the net impact represents effects caused by changes in non-local and non-resident spending relative to baseline spending.
For Washington, the net impact represents effects caused by changes in non-resident spending relative to baseline spending.
The baseline includes local, non-local, and non-resident spending effects.

Table D-28. Total changes in personal income (in 2002 dollars) caused by changes in sport fishing trips under the project alternatives.
Scenario B: 2003 Abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 3 - Escapement Goal Management at the Population Level/Terminal Fisheries Only											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Angler Group/Sector	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number		Change from Baseline (%)	Number	Change from Baseline	% Change
Local Residents												
Transportation	$430,246	-$3,171,026	-88.1%	$891,399	-$4,133,630	-82.3%	$12,600	-$1,157,653	-98.9%	$1,398,065	-$9,187,607	-86.8%
Food	$474,769	-$2,977,028	-86.2%	$1,035,108	-$3,551,370	-77.4%	$12,197	-$721,099	-98.3%	$1,685,674	-$8,501,788	-83.5%
Lodging	$22,758	-$717,047	-96.9%	$46,914	-$1,459,608	-96.9%	$696	-$564,027	-99.9%	$73,754	-$2,958,189	-97.6%
Boat Fuel	$282,076	-$1,790,747	-86.4%	$591,214	-$2,078,977	-77.9%	$8,464	-$520,059	-98.4%	$927,754	-$4,779,699	-83.7%
Party/Charter Fees	$83,817	-$402,801	-82.8%	$170,041	-$310,193	-64.6%	$2,618	-$40,563	-93.9%	$269,358	-$810,304	-75.1%
cess/Boat Launching	$0	-$157,525	-100.0%	$0	-$367,628	-100.0%	$0	-$138,158	-100.0%	$0	-$732,568	-100.0%
Equipment Rental	$77,000	-$400,332	-83.9%	$176,052	-$397,127	-69.3%	$2,065	-$56,193	-96.5%	$273,424	-$971,994	-78.0%
Bait and Ice	$674,349	-$4,104,993	-85.9%	$1,319,175	-$4,261,018	-76.4%	$21,515	-$1,154,634	-98.2%	$2,077,942	-$9,951,478	-82.7%
Total	$2,045,016	-$13,721,500	-87.0%	$4,229,903	-$16,559,549	-79.7%	$60,154	-$4,352,386	-98.6%	$6,705,972	-$37,893,626	-85.0%
Non-Local Residents												
Transportation	$102,848	-$726,926	-87.6%	$86,635	-$472,380	-84.5%	$10,323	-$2,550,696	-99.6%	$215,781	-$4,508,141	-95.4%
Food	$193,780	-$1,069,070	-84.7%	$171,774	-$509,956	-74.8%	$17,063	-$1,516,064	-98.9%	$444,229	-$4,225,248	-90.5%
Lodging	$60,057	-$436,735	-87.9%	$50,335	-$290,899	-85.2%	$6,292	-$1,685,606	-99.6%	$125,665	-$2,813,584	-95.7%
Boat Fuel	$88,181	-$485,288	-84.6%	$75,145	-$221,451	-74.7%	$9,069	-$793,205	-98.9%	$187,262	-$1,762,429	-90.4%
Party/Charter Fees	$50,491	-$287,985	-85.1%	$41,646	-$136,085	-76.6%	$5,406	-$583,291	-99.1%	$104,764	-$1,139,989	-91.6%
cess/Boat Launching	$0	-$20,381	-100.0%	$0	-$28,234	-100.0%	$0	-$209,849	-100.0%	$0	-$323,180	-100.0%
Equipment Rental	$24,345	-$133,394	-84.6%	$22,631	-$65,819	-74.4%	$2,238	-$190,241	-98.8%	$55,817	-$515,456	-90.2%
Bait and Ice	$204,263	-$1,029,477	-83.4%	$162,462	-$358,226	-68.8%	$22,337	-$897,791	-97.6%	$406,392	-$2,443,086	-85.7%
Total	$723,965	-$4,189,255	-85.3%	$610,628	-$2,083,050	-77.3%	$72,728	-$8,426,744	-99.1%	$1,539,908	-$17,731,113	-92.0%
Non-residents of the State												
Transportation	$6,603	-$167,141	-96.2%	$11,586	-$201,858	-94.6%	$882	-$654,221	-99.9%	$29,049	-$1,375,284	-97.9%
Food	$26,141	-$188,242	-87.8%	$48,271	-$175,852	-78.5%	$3,064	-$307,557	-99.0%	$99,977	-$1,008,045	-91.0%
Lodging	$13,165	-$114,589	-89.7%	$22,986	-$110,017	-82.7%	$1,836	-$281,978	-99.4%	$42,602	-$636,103	-93.7%
Boat Fuel	$9,205	-$66,076	-87.8%	$16,341	-$59,242	-78.4%	$1,260	-$125,461	-99.0%	$32,725	-$327,230	-90.9%
Party/Charter Fees	$8,414	-$47,082	-84.8%	$14,458	-$35,018	-70.8%	$1,199	-$52,245	-97.8%	$25,472	-$155,234	-85.9%
cess/Boat Launching	$0	-$7,283	-100.0%	$0	-$9,984	-100.0%	$0	-$34,637	-100.0%	$0	-$70,327	-100.0%
Equipment Rental	$2,582	-$21,233	-89.2%	$5,001	-$22,106	-81.6%	$316	-$43,156	-99.3%	$8,638	-$122,082	-93.4%
Bait and Ice	$20,461	-$114,048	-84.8%	$33,901	-$81,538	-70.6%	$2,979	-$127,409	-97.7%	$59,392	-$358,009	-85.8%
Total	$86,571	-$725,694	-89.3%	$152,543	-$695,615	-82.0%	$11,537	-$1,626,664	-99.3%	$297,855	-$4,052,314	-93.2%
Net Impact**												
Transportation	$109,451	-$894,067	-19.4%	$98,222	-$674,238	-11.6%	$11,206	-$3,204,917	-73.1%	$29,049	-$1,375,284	-8.2%
Food	$219,921	-$1,257,312	-25.5%	$220,044	-$685,807	-12.5%	$20,127	-$1,823,621	-70.8%	$99,977	-$1,008,045	-6.3%
Lodging	$73,222	-$551,324	-40.4%	$73,321	-$400,917	-20.2%	$8,128	-$1,967,584	-77.5%	$42,602	-$636,103	-9.6%
Boat Fuel	$97,387	-$551,364	-20.3%	$91,486	-$280,693	-9.2%	$10,329	-$918,666	-63.0%	$32,725	-$327,230	-4.1%
Party/Charter Fees	$58,905	-$335,067	-38.1%	$56,104	-$171,103	-24.2%	$6,605	-$635,537	-92.7%	$25,472	-$155,234	-6.2%
cess/Boat Launching	$0	-$27,665	-14.9%	$0	-$38,218	-9.4%	$0	-$244,486	-63.9%	$0	-$70,327	-6.2%
Equipment Rental	$26,928	-$154,626	-23.5%	$27,632	-$87,925	-12.8%	$2,554	-$233,397	-79.3%	$8,638	-$122,082	-6.3%
Bait and Ice	$224,724	-$1,143,524	-18.6%	$196,363	-$439,764	-7.1%	$25,316	-$1,025,200	-46.0%	$59,392	-$358,009	-2.3%
Total	$810,537	-$4,914,949	-22.9%	$763,171	-$2,778,665	-11.4%	$84,266	-$10,053,407	-69.1%	$297,855	-$4,052,314	-5.9%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.
** For Puget Sound regions, the net impact represents effects caused by changes in non-local and non-resident spending relative to baseline spending.
For Washington, the net impact represents effects caused by changes in non-resident spending relative to baseline spending.
The baseline includes local, non-local, and non-resident spending effects.

Table D-28. Total changes in personal income (in 2002 dollars) caused by changes in sport fishing trips under the project alternatives.
Scenario B: 2003 Abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries, continued.

	Alternative 4 - No Fishing											
	North Puget Sound			SPS/SHC*			SJF/NHC*			State		
Angler Group/Sector	Number	Change from Baseline	% Change	Number	Change from Baseline	% Change	Number		Change from Baseline (%)	Number	Change from Baseline	% Change
Local Residents												
Transportation	$13,760	-$3,587,513	-99.6%	$18,649	-$5,006,380	-99.6%	$489	-$1,169,763	-100.0%	$34,869	-$10,550,803	-99.7%
Food	$15,184	-$3,436,613	-99.6%	$21,655	-$4,564,822	-99.5%	$473	-$732,823	-99.9%	$42,042	-$10,145,421	-99.6%
Lodging	$728	-$739,077	-99.9%	$981	-$1,505,540	-99.9%	$27	-$564,695	-100.0%	$1,839	-$3,030,104	-99.9%
Boat Fuel	$9,021	-$2,063,802	-99.6%	$12,369	-$2,657,822	-99.5%	$329	-$528,194	-99.9%	$23,139	-$5,684,314	-99.6%
Party/Charter Fees	$2,681	-$483,937	-99.4%	$3,557	-$476,677	-99.3%	$102	-$43,079	-99.8%	$6,718	-$1,072,944	-99.4%
ccess/Boat Launching	$0	-$157,525	-100.0%	$0	-$367,628	-100.0%	$0	-$138,158	-100.0%	$0	-$732,568	-100.0%
Equipment Rental	$2,463	-$474,870	-99.5%	$3,683	-$569,495	-99.4%	$80	-$58,178	-99.9%	$6,819	-$1,238,599	-99.5%
Bait and Ice	$21,567	-$4,757,776	-99.5%	$27,598	-$5,552,595	-99.5%	$835	-$1,175,313	-99.9%	$51,825	-$11,977,595	-99.6%
Total	$65,402	-$15,701,114	-99.6%	$88,494	-$20,700,959	-99.6%	$2,335	-$4,410,204	-99.9%	$167,251	-$44,432,347	-99.6%
Non-Local Residents												
Transportation	$3,292	-$826,481	-99.6%	$1,811	-$557,205	-99.7%	$399	-$2,560,620	-100.0%	$6,023	-$4,717,899	-99.9%
Food	$6,203	-$1,256,647	-99.5%	$3,590	-$678,139	-99.5%	$660	-$1,532,467	-100.0%	$12,399	-$4,657,077	-99.7%
Lodging	$1,923	-$494,869	-99.6%	$1,052	-$340,182	-99.7%	$243	-$1,691,654	-100.0%	$3,508	-$2,935,741	-99.9%
Boat Fuel	$2,823	-$570,646	-99.5%	$1,571	-$295,025	-99.5%	$351	-$801,923	-100.0%	$5,227	-$1,944,464	-99.7%
Party/Charter Fees	$1,616	-$336,859	-99.5%	$870	-$176,861	-99.5%	$209	-$588,488	-100.0%	$2,924	-$1,241,829	-99.8%
ccess/Boat Launching	$0	-$20,381	-100.0%	$0	-$28,234	-100.0%	$0	-$209,849	-100.0%	$0	-$323,180	-100.0%
Equipment Rental	$779	-$156,960	-99.5%	$473	-$87,977	-99.5%	$87	-$192,392	-100.0%	$1,558	-$569,715	-99.7%
Bait and Ice	$6,539	-$1,227,201	-99.5%	$3,395	-$517,292	-99.3%	$864	-$919,264	-99.9%	$11,343	-$2,838,134	-99.6%
Total	$23,176	-$4,890,045	-99.5%	$12,762	-$2,680,915	-99.5%	$2,814	-$8,496,658	-100.0%	$42,982	-$19,228,039	-99.8%
Non-residents of the State												
Transportation	$213	-$173,531	-99.9%	$244	-$213,200	-99.9%	$34	-$655,070	-100.0%	$758	-$1,403,575	-99.9%
Food	$843	-$213,540	-99.6%	$1,017	-$223,106	-99.5%	$117	-$310,504	-100.0%	$2,609	-$1,105,414	-99.8%
Lodging	$424	-$127,329	-99.7%	$484	-$132,519	-99.6%	$70	-$283,745	-100.0%	$1,112	-$677,593	-99.8%
Boat Fuel	$297	-$74,985	-99.6%	$344	-$75,239	-99.5%	$48	-$126,673	-100.0%	$854	-$359,100	-99.8%
Party/Charter Fees	$271	-$55,225	-99.5%	$305	-$49,171	-99.4%	$46	-$53,399	-99.9%	$665	-$180,041	-99.6%
ccess/Boat Launching	$0	-$7,283	-100.0%	$0	-$9,984	-100.0%	$0	-$34,637	-100.0%	$0	-$70,327	-100.0%
Equipment Rental	$83	-$23,732	-99.7%	$105	-$27,002	-99.6%	$12	-$43,460	-100.0%	$225	-$130,494	-99.8%
Bait and Ice	$660	-$133,849	-99.5%	$714	-$114,725	-99.4%	$113	-$130,275	-99.9%	$1,550	-$415,851	-99.6%
Total	$2,791	-$809,474	-99.7%	$3,214	-$844,945	-99.6%	$439	-$1,637,762	-100.0%	$7,773	-$4,342,396	-99.8%
Net Impact**												
Transportation	$3,505	-$1,000,012	-21.7%	$2,055	-$770,405	-13.3%	$433	-$3,215,690	-73.3%	$758	-$1,403,575	-8.4%
Food	$7,046	-$1,470,186	-29.8%	$4,607	-$901,245	-16.4%	$777	-$1,842,971	-71.5%	$2,609	-$1,105,414	-6.9%
Lodging	$2,347	-$622,199	-45.6%	$1,536	-$472,701	-23.9%	$313	-$1,975,399	-77.8%	$1,112	-$677,593	-10.2%
Boat Fuel	$3,120	-$645,631	-23.7%	$1,915	-$370,265	-12.2%	$399	-$928,596	-63.7%	$854	-$359,100	-4.5%
Party/Charter Fees	$1,888	-$392,084	-44.5%	$1,175	-$226,032	-32.0%	$255	-$641,887	-93.7%	$665	-$180,041	-7.2%
ccess/Boat Launching	$0	-$27,665	-14.9%	$0	-$38,218	-9.4%	$0	-$244,486	-63.9%	$0	-$70,327	-6.2%
Equipment Rental	$863	-$180,691	-27.4%	$578	-$114,978	-16.7%	$99	-$235,853	-80.2%	$225	-$130,494	-6.7%
Bait and Ice	$7,199	-$1,361,050	-22.1%	$4,110	-$632,017	-10.2%	$978	-$1,049,538	-47.1%	$1,550	-$415,851	-2.7%
Total	$25,967	-$5,699,519	-26.5%	$15,976	-$3,525,860	-14.5%	$3,253	-$10,134,420	-69.7%	$7,773	-$4,342,396	-6.4%

* SPS/SHC = South Puget Sound/South Hood Canal; SJF/NHC = Strait of Juan de Fuca/North Hood Canal.
** For Puget Sound regions, the net impact represents effects caused by changes in non-local and non-resident spending relative to baseline spending.
For Washington, the net impact represents effects caused by changes in non-resident spending relative to baseline spending.
The baseline includes local, non-local, and non-resident spending effects.

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ATTACHMENT A

Background Data for the Affected Environment

Table D.A-1. Ex-vessel value of salmon landed in Puget Sound ports between 1991 and 1998 (in thousands of nominal dollars).

Major Port/County	1991	1992	1993	1994	1995	1996	1997	1998	Annual Average
Blaine	$2,382	$2,021	$2,898	$4,637	$960	$725	$1,595	$1,036	$2,031
Bellingham	$8,668	$4,148	$7,507	$8,051	$2,805	$1,626	$5,417	$2,811	$5,129
Whatcom County	$11,050	$6,647	$10,924	$13,192	$3,862	$2,351	$7,011	$3,847	$7,360
Friday Harbor	$260	$369	$691	$146	$35	--[1]	$3	$4	$215
San Juan County	$260	$369	$691	$146	$35	--[1]	$6	$6	$216
Anacortes	$674	$281	$1,480	$891	$662	$236	$336	$25	$573
LaConner	$3,298	$1,535	$1,251	$720	$84	$169	$361	$264	$960
Skagit County	$3,972	$1,816	$2,730	$1,611	$746	$405	$697	$290	$1,533
Everett	$1,206	$1,312	$2,100	$3,301	$708	$533	$1,670	$933	$1,470
Snohomish County	$1,206	$1,312	$2,100	$3,301	$708	$533	$1,670	$933	$1,470
Seattle	$4,657	$3,466	$2,195	$1,726	$1,186	$855	$1,136	$716	$1,992
King County	$4,657	$3,466	$2,195	$1,726	$1,186	$855	$1,136	$716	$1,992
Tacoma	$275	$946	$432	$689	$538	$409	$210	$516	$501
Pierce County	$275	$946	$432	$689	$538	$409	$210	$516	$501
Olympia	$208	$115	$118	$212	$114	$86	$26	$45	$115
Thurston County	$208	$115	$118	$212	$114	$86	$26	$45	$115
Shelton	$373	$297	$335	$602	$670	$579	$421	$828	$513
Mason County	$373	$297	$335	$602	$670	$579	$421	$828	$513
Port Townsend	$88	$73	$211	$112	$51	$84	$202	$179	$125
Jefferson County	$346	$299	$413	$898	$190	$84	$202	$586	$377
Poulsbo	$12	$24	$82	$22	$17	$43	$22	$36	$32
Bremerton	$230	--[1]	--[1]	--[1]	--[1]	--[1]	$4	--[1]	$167
Kitsap County	$241	$282	$248	$281	$113	$146	$26	$36	$171
Port Angeles	$1,233	$535	$1,209	$1,631	$636	$332	$218	$572	$795
Neah Bay	$1,592	$1,524	$1,196	$285	$418	$673	--[1]	$468	$468
Clallam County	$3,767	$2,982	$2,687	$2,053	$1,194	$1,129	$598	$1,131	$1,942
REGIONAL TOTAL	$26,355	$18,531	$22,873	$24,711	$9,356	$6,577	$12,003	$8,934	$16,190

Source: Pacific Fisheries Management Council, Community Descriptions (1999).

Not reported for confidentiality reasons (fewer than 3 buyers).

Table D.A-2. Annual average catch (pounds landed) and ex-vessel value of salmon harvested in Puget Sound from 1991 through 2000 (in thousands of pounds or thousands of nominal dollars).

Year	Species										Total Pounds Landed	Total Ex-Vessel Value
	Chinook		Chum		Coho		Pink		Sockeye			
	Pounds Landed	Ex-Vessel Value	Pounds Landed	Ex-Vessel Value	Pounds Landed	Ex-Vessel Value	Pounds Landed	Ex-Vessel Value	Pounds Landed	Ex-Vessel Value		
1991	2,008.3	$2,375.1	8,845.4	$4,776.6	3,446.8	$2,447.2	12,035.8	$2,407.2	10,248.1	$12,400.1	36,584.5	$24,406.2
1992	1,646.0	$1,700.8	12,247.8	$5,634.0	2,197.7	$1,890.1	0.7	$0.2	3,410.4	$6,411.6	19,502.7	$15,636.6
1993	1,145.7	$996.4	10,059.4	$6,236.8	1,057.4	$676.7	7,437.6	$1,190.0	15,099.2	$13,589.2	34,799.2	$22,689.2
1994	1,118.9	$991.7	11,818.1	$3,190.9	2,131.9	$1,449.7	0.9	$0.2	10,317.6	$15,889.1	25,387.4	$21,521.6
1995	923.4	$572.1	6,556.8	$1,901.5	1,340.5	$630.0	9,477.2	$1,611.1	2,323.6	$2,672.0	20,621.4	$7,386.8
1996	963.2	$484.2	7,073.9	$1,202.6	760.4	$235.7	0.2	$0.0	1,887.8	$2,831.7	10,685.5	$4,754.3
1997	1,049.3	$540.8	3,684.4	$1,215.9	793.6	$428.6	7,032.2	$1,265.8	7,674.1	$8,211.3	20,233.7	$11,662.3
1998	692.2	$357.1	7,467.5	$1,120.1	778.7	$303.7	3.3	$2.2	3,014.9	$4,401.8	11,956.6	$6,184.8
1999	1,121.8	$617.6	2,017.5	$605.2	505.4	$227.4	169.3	$25.4	114.9	$141.3	3,928.9	$1,617.0
2000	980.5	$684.6	2,454.5	$883.6	1,699.7	$730.9	1.3	$1.2	3,052.8	$3,571.7	8,188.8	$5,872.0
Annual Average	1,164.9	$932.0	7,222.5	$2,676.7	1,471.2	$902.0	3,615.9	$650.3	5,714.3	$7,012.0	19,188.9	$12,173.1

Source: Washington Department of Fish and Wildlife, License, and Fish Ticket database (personal communication with Doug McNair, The William Douglas Company, December 20, 2002).

Table D.A-3. Annual average commercial (tribal and non-tribal) harvest (pounds landed)[1] of salmon in marine waters of Puget Sound, by marine catch area and species (1991 through 2000).

Marine Catch Areas	Chinook		Chum		Coho		Pink		Sockeye		All Species	
	Average Annual Catch	% of Total Species Catch	Average Annual Catch	% of Total Species Catch	Average Annual Catch	% of Total Species Catch	Average Annual Catch	% of Total Species Catch	Average Annual Catch	% of Total Species Catch	Average Annual Catch	% of Total Species Catch
Area 4	31,545	3%	509	0%	23,544	2%	3,565	0%	6,693	0%	65,856	0%
Area 5	114,607	10%	298,755	4%	52,591	4%	36,360	1%	258,621	5%	760,934	4%
Area 6	33,315	3%	18,312	0%	22,146	2%	3,077	0%	19,725	0%	96,575	0%
Area 7	499,652	44%	831,927	12%	316,168	21%	3,343,213	93%	5,585,956	94%	10,576,916	55%
Area 8	128,526	11%	986,886	14%	330,982	22%	225,246	6%	213	0%	1,671,853	9%
Area 9	451	0%	12,990	0%	41,820	3%	208	0%	11	0%	55,480	0%
Area 10	175,390	16%	1,170,576	16%	232,265	16%	1,179	0%	69,900	1%	1,649,310	9%
Area 11	4,446	0%	594.769	8%	49,090	3%	38	0%	0	0%	648,343	3%
Area 12	42,063	4%	3,124,520	44%	45,415	3%	367	0%	0	0%	3,212,365	17%
Area 13	98,867	9%	142,251	2%	357,652	24%	106	0%	0	0%	598,876	3%
All Marine	1,128,862	100%	7,181,495	100%	1,471,673	100%	3,613,359	100%	5,941,119	100%	19,336,508	100%

Source: Washington Department of Fish and Wildlife, License, and Fish Ticket database (personal communication with Doug McNair, The William Douglas Company, December 20, 2002).

Note: Conversion from number of fish to pound landed is based on average weight over the period of 1996 through 2000.

Table D.A-4. Average annual commercial (tribal and non-tribal) harvest (pounds landed) of salmon in freshwater areas of Puget Sound, by catch area and species (1991 through 2000).

Freshwater Catch Areas	Chinook		Chum		Coho		Pink		Sockeye		All Species	
	Average Annual Catch	% of Total Species Catch	Average Annual Catch	% of Total Species Catch	Average Annual Catch	% of Total Species Catch	Average Annual Catch	% of Total Species Catch	Average Annual Catch	% of Total Species Catch	Average Annual Catch	% of Total Species Catch
Nooksack-Samish	27,823	10%	103,416	16%	89,360	20%	3,152	2%	300	31%	224,051	14%
Skagit	19,888	7%	216,547	34%	35,496	8%	174,540	96%	645	66%	447,116	29%
Stillaguamish	139	0%	34,582	5%	3,120	1%	2,220	1%	-	0%	40,061	2%
Snohomish	17	0%	11	0%	192	0%	-	0%	-	0%	220	0%
Lk. Washington	0	0%	-	0%	56	0%	-	0%	-	0%	56	0%
Green-Duwamish	45,431	16%	31,597	5%	136,880	30%	32	0%	10	1%	213,950	14%
Puyallup	47,195	15%	11,631	2%	157,888	35%	2,448	1%	5	1%	214,167	14%
Nisqually	94,047	33%	140,010	22%	11,632	3%	40	0%	5	1%	245,734	16%
S. Puget Sound	37,716	13%	14,841	2%	1,320	0%	12	0%	-	0%	53,879	3%
Mid-Hood Canal	-	0%	64	0%	1,248	0%	-	0%	-	0%	1,312	0%
Skokomish	17,191	6%	91,057	14%	2,632	1%	4	0%	0	0%	110,884	7%
JDF Strait	1,096	0%	161	0%	9,672	2%	0	0%	0	0%	10,929	1%
All Freshwater	285,533	100%	643,917	100%	449,496	100%	182,448	100%	965	100%	1,562,359	100%

Source: Washington Department of Fish and Wildlife, License and Fish Ticket database (personal communication with Doug McNair, The William Douglas Company, December 20, 2002.

Note: Conversion from number of fish to pound landed is based on average weight over the period of 1996 through 2000.

Table D.A-5. Number of licenses issued for commercial salmon fishing in Puget Sound between 1991 and 2000. [1]

Year	Residents	Non-Residents	Total Issued[2]
1991	1,423	123	1,512
1992	1,400	114	1,495
1993	1,363	110	1,451
1994	1,318	91	1,398
1995	1,240	74	1,312
1996	1,177	58	1,233
1997	1,161	98	1,215
1998	1,093	186	1,147
1999	946	41	987
2000	946	42	987
Annual Average	1,207	94	1,274

Source: Washington Department of Fish and Wildlife, License and Fish Ticket database (personal communication with Lee Hoines, WDFW, January 17, 2002).

[1] Excludes licenses issued for salmon charters and guides.

[2] Total number of licenses issued does not equal the sum of resident and non-resident licenses issued.

Table D.A-6. Distribution of 2001 commercial non-tribal harvest (pounds landed) of salmon by marine catch area and commercial fishing permit holder region of residence.

Catch Area	Region where commercial fishing license holder resides				TOTAL
	North Puget Sound	South Puget Sound/Hood Canal	Strait of Juan de Fuca/North Hood Canal	Other Washington	
Marine Catch Area 4	0		0	0	0
Marine Catch Area 5	0	0	0	0	0
Marine Catch Area 6	5,709	7,002	25,573	0	38,284
Marine Catch Area 7	2,259,518	484,058	5,381	12,633	2,761,590
Marine Catch Area 8	744,015	555,855	3,802	5,186	1,308,858
Marine Catch Area 9	0	1,992	13,895	0	15,887
Marine Catch Area 10	980,048	758,828	88,457	33,299	1,860,632
Marine Catch Area 11	370,964	1,411,350	0	16,826	1,799,140
Marine Catch Area 12	1,168,448	540,255	289,705	125,042	2,123,450
Marine Catch Area 13	0	0	0	0	0
TOTAL	5,528,702	3,759,340	426,813	192,986	9,907,841

Source: Washington Department of Fish and Wildlife, License and Fish Ticket database (personal communication with Lee Hoines, WDFW, December 18, 2002).

Table D.A-7. Distribution of 2001 commercial non-tribal harvest (pounds landed) of salmon by marine catch area and type of gear used.

Catch Area	Pounds Landed by Gear Type			Total Pounds Landed
	Gillnet	Purse Seine	Reef Net	
Marine Catch Area 4	0	0	0	0
Marine Catch Area 5	0	0	0	0
Marine Catch Area 6	38,889	0	0	38,889
Marine Catch Area 7	928,955	1,723,564	123,921	2,776,440
Marine Catch Area 8	71,362	1,237,496	0	1,308,858
Marine Catch Area 9	15,887	0	0	15,887
Marine Catch Area 10	247,676	1,612,928	0	1,860,604
Marine Catch Area 11	42,307	1,880,291	0	1,922,598
Marine Catch Area 12	136,551	1,866,949	0	2,003,500
Marine Catch Area 13	0	0	0	0
TOTAL	1,481,627	8,321,228	123,921	9,926,776

Source: Washington Department of Fish and Wildlife, License and Fish Ticket database (personal communication with Lee Hoines, WDFW, December 18, 2002).

Table D.A-8. Annual average catch (in thousands of pounds landed) and ex-vessel value (in thousands of nominal dollars) of salmon harvested by tribes in Puget Sound (1991 through 2000).

Year	Species												Total Pounds Landed	Total Ex-Vessel Value
	Chinook		Chum		Coho		Pink		Sockeye		Steelhead			
	Pounds Landed	Ex-Vessel Value	Pounds Landed	Ex-Vessel Value	Pounds Landed	Ex-Vessel Value	Pounds Landed	Ex-Vessel Value	Pounds Landed	Ex-Vessel Value	Pounds Landed	Ex-Vessel Value		
1991	1277.0	$1,545.2	5103.2	$2,398.5	2271.5	$1,771.8	6940.8	$1,527.0	4516.1	$5,238.7	63.4	$67.2	20,172.0	$12,548.3
1992	904.8	$1,122.0	7395.4	$3,327.9	1445.2	$1,300.7	0.388	$0.1	1651.7	$3,138.2	87.4	$83.9	11,484.9	$8,972.8
1993	687.9	$763.6	4424.1	$2,300.5	682.3	$484.4	4297.7	$644.7	6990.6	$6,291.5	32.5	$30.6	17,115.1	$10,515.3
1994	765.1	$749.8	7340.3	$1,908.5	2246.8	$1,572.8	0.776	$0.2	5062.7	$7,492.8	36.47	$29.2	15,452.1	$11,753.2
1995	759.2	$675.7	3291.1	$888.6	1498.3	$824.1	3744.8	$636.6	1347.2	$741.0	39.1	$32.5	10,679.7	$3,798.4
1996	759.1	$736.3	1826.2	$383.5	729.7	$357.6	0.125	$0.0	1641.2	$787.8	27.2	$20.1	4,983.5	$2,285.3
1997	740.1	$577.3	1789.1	$518.8	591.6	$349.0	3484.4	$522.7	3475.2	$3,683.7	13.9	$10.0	10,094.3	$5,661.5
1998	511.7	$378.7	1283.9	$256.8	826.9	$430.0	2.1	$0.5	1769.4	$2,601.0	34.6	$25.6	4,428.6	$3,692.5
1999	847.6	$712.0	1022.1	$327.1	550.5	$346.8	187.1	$29.9	119.8	$146.2	13.3	$10.1	2,740.4	$1,572.1
2000	762.1	$632.5	937.8	$384.5	2097.4	$1,027.7	1.76	$0.4	1732.1	$2,026.6	17.7	$14.9	5,548.9	$4,086.6
Annual Average	801.5	$789.3	3,441.3	$1,269.5	1,294.0	$846.5	1,866.0	$336.2	2,830.6	$3,214.7	36.6	$32.4	10,270.0	$6,488.6

Source: Northwest Indian Fisheries Commission, license and fish ticket database (personal communication with Phil Meyer, Meyer Resources, Inc., December 17, 2002).

Table D.A-9. Distribution of tribal commercial harvest (pounds landed) of salmon by marine catch area in 2001.

Catch Area	Tribal Location			TOTAL
	North Puget Sound	South Puget Sound/Hood Canal	Strait of Juan de Fuca/ North Hood Canal	
Marine Catch Area 4	0	0	212,548	212,548
Marine Catch Area 5	0	14,784	277,847	292,631
Marine Catch Area 6	0	0	3,460	3,460
Marine Catch Area 7	2,134,075	31,826	674	2,166,575
Marine Catch Area 8	2,911,493	0	0	2,911,493
Marine Catch Area 9	0	12,476	0	12,476
Marine Catch Area 10	166,161	745,233	0	911,394
Marine Catch Area 11	0	25,327	0	25,327
Marine Catch Area 12	0	3,017,884	617	3,018,501
Marine Catch Area 13	0	742,427	0	742,427
Freshwater	598,815	2,245,648	74,152	2,918,615
TOTAL	5,810,544	6,835,605	569,298	13,215,447

Source: Washington Department of Fish and Wildlife, License and Fish Ticket database (personal communication with Lee Hoines, WDFW, December 18, 2002).

Table D.A-10. Number of sport fishing trips for salmon and steelhead in Puget Sound, by marine catch area (1991 through 2000).

Marine Catch Area	Year										Annual Average
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	
5	225,086	153,398	161,808	1,216	46,277	39,769	62,683	34,000	31,840	30,925	78,700
6	80,696	76,981	75,615	3,926	29,251	18,294	30,845	16,399	10,581	26,891	36,948
7	73,349	48,798	75,544	45,992	51,699	52,908	58,323	22,523	18,549	25,595	47,328
8	97,415	75,462	92,593	32,246	91,763	55,899	84,507	35,920	35,423	35,506	63,673
9	116,212	127,481	114,749	34,385	66,141	65,156	56,643	60,746	45,414	41,826	72,875
10	142,247	100,573	108,221	68,516	89,599	68,279	61,714	37,684	21,296	44,916	74,305
11	134,642	93,282	93,015	97,688	101,049	106,928	79,305	78,302	70,197	69,347	92,376
12	9,681	17,571	14,253	18,476	10,884	9,032	22,154	18,937	17,672	16,591	15,525
13	44,341	32,550	72,778	50,976	36,724	36,678	32,462	45,434	26,730	27,649	40,632
Grand Total	923,669	726,096	808,576	353,421	523,387	452,943	488,636	349,945	277,702	319,246	522,362

Source: Washington Department of Fish and Wildlife, Sport Fish database (personal communication with Terrie Manning, WDFW, December 17, 2002).

Table D.A-11. Annual sport catch of salmon by species in marine and freshwater areas of the Puget Sound (1991 through 2000).

Year	Chinook		Coho		Chum		Pink		Sockeye		Total Marine	Total Freshwater
	Marine	Freshwater	Marine	Freshwater	Marine	Freshwater	Marine	Freshwater	Marine	Freshwater		
1991	90,566	2,693	252,361	5,942	3,646	5,937	217	18,142	217	37	347,077	32,751
1992	97,733	3,292	189,372	14,256	8,712	6,747	193	12	193	40	296,203	24,347
1993	80,166	11,076	135,974	22,736	5,846	4,933	1,043	69,132	1,043	40	224,072	107,917
1994	48,286	3,351	31,801	10,319	9,936	N/A	41	10	41	13	90,105	13,693
1995	91,799	6,045	78,675	11,256	6,717	5,294	165	112,926	165	0	177,521	135,521
1996	91,799	3,968	78,675	11,756	6,717	12,488	165	0	60	69,988	177,416	98,200
1997	72,069	4,045	85,139	14,358	12,394	5,799	60	16,603	262	32	169,924	40,837
1998	60,425	9,505	138,571	15,304	5,836	10,025	262	0	90	20	205,184	25,854
1999	37,598	8,161	34,781	11,475	7,302	4,505	35,067	11,287	54	27	114,802	35,455
2000	29,893	5,740	71,965	21,847	3,689	3,708	59	79	100	28,597	105,706	59,971
Average	70,033	5,787	109,731	13,925	7,080	6,604	3,727	22,819	223	9,879	109,794	59,014

Source: Washington Department of Fish and Wildlife, Sport Fish database (personal communication with Terrie Manning, WDFW, December 17, 2002).

Table D.A-12. Proportion of 2001 sport catch of salmon in Puget Sound marine waters by angler county of origin.

Region/County	Marine Catch Areas									
	05	06	07	08	09	10	11	12	13	Grand Total
North Puget Sound										
Whatcom	1.11%	0.23%	35.16%	1.69%	1.46%	0.64%	0.12%	0.00%	0.00%	3.21%
Skagit	0.74%	2.47%	24.68%	3.97%	0.81%	0.20%	0.02%	0.07%	0.00%	2.68%
Snohomish	7.04%	1.93%	8.49%	68.62%	36.26%	17.54%	1.34%	3.05%	1.39%	19.98%
Island	0.49%	5.95%	2.72%	6.03%	16.60%	0.25%	0.10%	0.00%	0.00%	3.91%
San Juan	0.00%	0.00%	7.82%	0.05%	0.00%	0.00%	0.00%	0.22%	0.00%	0.56%
Subtotal	*9.38%*	*10.58%*	*78.87%*	*80.36%*	*55.13%*	*18.63%*	*1.59%*	*3.35%*	*1.39%*	30.35%
South Puget Sound/South Hood Canal										
King	20.08%	5.02%	5.88%	12.25%	19.92%	47.76%	37.13%	18.59%	5.99%	22.77%
Pierce	14.65%	2.70%	2.27%	1.07%	2.58%	3.13%	52.15%	16.58%	36.14%	14.98%
Thurston	5.93%	1.16%	0.78%	0.78%	0.42%	0.14%	1.02%	13.68%	39.07%	4.47%
Mason	2.65%	0.93%	0.33%	0.16%	0.37%	0.31%	0.15%	12.12%	8.15%	1.80%
Kitsap	8.04%	2.78%	0.44%	0.35%	8.72%	24.12%	4.29%	19.41%	1.39%	8.10%
Subtotal	*51.34%*	*12.59%*	*9.71%*	*14.60%*	*32.00%*	*75.46%*	*94.74%*	*80.37%*	*51.34%*	52.11%
Strait of Juan de Fuca/North Hood Canal										
Clallam	14.61%	59.15%	1.05%	0.32%	1.02%	0.20%	0.17%	0.74%	0.21%	6.16%
Jefferson	2.16%	8.49%	0.17%	0.03%	7.80%	0.08%	0.12%	5.06%	0.00%	2.29%
Subtotal	*16.77%*	*67.64%*	*1.22%*	*0.35%*	*8.82%*	*0.28%*	*0.30%*	*5.80%*	*0.21%*	8.46%
Other Washington	12.84%	3.71%	4.83%	1.82%	1.54%	2.43%	1.69%	6.99%	5.92%	4.80%
Outside Washington	9.67%	5.48%	5.38%	2.87%	2.51%	3.19%	1.69%	3.49%	1.74%	4.28%
TOTAL	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Source: Washington Department of Fish and Wildlife, Sport Fish database (personal communication with Doug McNair, The William Douglas Company, December 16, 2002).

ATTACHMENT B

Economic Factors for Commercial Salmon Fishing

Developed by The Research Group

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MEMORANDUM

To: Tom Wegge
From: Hans Radtke and Shannon Davis
Date: September 18, 2003
Re: Economic Analysis Results for the Puget Sound Chinook Salmon Fishery Management Plan, Pertaining to Commercial Fisheries

This memorandum describes our updated commercial fishing economic analysis results for the referenced project. Below, we provide definitions, explain data sources, and give details about modeling methods. The model has been specified and calibrated to a Year 2002 one-year time period. The model has also been applied to all salmon species harvested in the management plan catch area during that one year time period. We have tried to anticipate the intermediate economic factors necessary to apply to management plan fisheries response effects. Please let us know if the form and format is convenient and sufficient for its application.

There are several tables attached to this memorandum. These tables and others are also contained in a computer file accompanying this memorandum. The printed tables are:

Table 1: Puget Sound Salmon Fisheries Volume by Gear and Disposition in 2002
Table 2: Average and Marginal Economic Impact Factors for Composite Product Forms by Species and Industry Component
Table 3: Economic Impact Factors by Product Forms and Industry Component
Table 4: Economic Contributions From Salmon Fisheries for Economic Regions and for the State
Table 5: Revenue Distributions for Non-Tribal Vessels That Harvest and Processors That Purchase Puget Sound Salmon in 2002
Figure 1: Landing Volume and Prices by Salmon Species for Puget Sound Salmon Fisheries in 1981 to 2002
Figure 2: Economic Contribution From Puget Sound Commercial Salmon Fisheries in 1981 to 2002

An appendix to this memorandum contains detailed information about landing and catch area assignments

Economic Impact Factors

The derived regional and state economic impact factors (coefficients and multipliers) are provided for making average and marginal impact calculations. The factors are used to calculate impacts measured by personal income, output,[1] and employment.[2] We have used the factors and 2002 landing data (Table 1) as an example to show our modeling results. The factors (for example average economic impacts per landed round pound) would only apply to other historical landing periods if adjustments are made for real dollars and species ex-vessel value. The ex-vessel value would both depend on converting to a real dollar year using an index such as the GDP Implicit Price Deflator, and also for the changing real value received for the salmon species. For example, there has been a lot of volatility for egg prices in recent years. Egg prices for the catch area salmon have gone from $7.26 in 2000, to $4.35 in 2001, and $3.33 in 2002 averaged over all species. There has been similar volatility in whole fish. It would have to be a stated assumption that the economic factors that are from a model calibrated to Year 2002 applies to future years.

The economic factors are provided for each salmon species and for sub-state economic regions for composite product forms (i.e. averaged over all product forms) and for special market product forms. For showing changes to the chinook and coho salmon fisheries, the factors are also provided for gear groups. The other salmon species from this catch area are landed with nets. The salmon fisheries singular product forms (Table 3) are: carcass sold fresh or frozen (approximately 94 percent of Puget Sound chinook catch area harvests are used for this product form), cured eggs for export (approximately 4 percent product form), and canned or smoked products (2 percent product form). The other species have different distribution. Unless there is specific reason to show economic impacts for different product forms, the composite factors in Table 2 should be used.

Factors are expressed for direct, indirect, and induced effects. The definition we are using for direct effect is payments for vessel crews, processing workers, net income to vessel owners/operators, and net income to processor owners. The definition for indirect effects has two sources. The first source (called indirect labor) is payments from first round spending by vessel provisioners, processor suppliers, etc. to labor. The second source (called indirect

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1. Output impacts are sometimes of interest, but for policy decision making purposes, personal income and employment impacts are the more appropriate comparative statistics.
2. Employment is calculated as a full/part time equivalent (FTE). Employment can include the relationship between license permit holders plus anticipated crew members. However, permit holders should be viewed as potential participants, not actual participants. Some permit holders may only make a few landings per year. This participation can be viewed as social interest but it does not provide calculations of actual annual jobs that may be generated. For example, in Oregon there are presently 1,200 troll permit holders. Of these, only about 370 make any landings at all. And of those that make any landings, only about half of these generate more than about $30,000 per year in ex-vessel landings. Erroneously, we could describe the Oregon troll fishery as generating about 2,400 direct jobs (skipper and crew) with an additional amount for the "multiplier" effects. The social description is useful, but should not take the place of an economic description.

provisioners) is payments from second round spending for labor. The induced effects are payments from all other rounds of spending.

Chinook Salmon Fisheries User Groups

We did not find significant differences between non-treaty and treaty fisheries to justify user group specific factors. We reached this conclusion by reviewing ex-vessel prices paid to the user groups, reviewing vessel budgets with key representatives from tribal fishing groups, and talking to processor representatives. Prices averaged over seasons are about the same between the two user groups. Tribes have some early fishing seasons which fetched higher prices. However, lower prices received by tribal fisherman in later seasons tended to balance the effect. The tribal fishing group representatives agreed that the budgets generally patterned the harvesters that catch most of the tribal allocations. Processor representatives told us that salmon from the two user groups enter the same markets and have the same value added at the primary processing level.

Sub-State Catch Areas and Economic Regions

The mapping of Puget Sound management plan catch areas and the ports where the catch is landed is shown in an attached appendix. The ports are grouped into three sub-state regions: Northern Puget Sound, Southern Puget Sound, and Coastal Washington North. The regions' geographic boundaries in relation to city and county boundaries are also shown in the appendix. The boundaries were chosen in consideration of fishing industry labor markets, location of ports where deliveries are received and primary processing occurs, ports where there is a likeness in fleet and vessel profiles, and other considerations. Nearly all of the landings from the Puget Sound management plan catch areas are accounted for in the selected regions. However, some are delivered elsewhere in the State. For this reason, the sum of the economic impacts from the regions will not equal the economic impacts to the State. There is a net import of salmon to the selected regions. The plan's catch area harvests only represented about a third of the chinook salmon delivered in the region. Other harvest areas include the Pacific Ocean, deliveries hauled from the Columbia River, etc.

Harvest Data

Data for the analysis is from the WDFW fish ticket system and salmon buyers and processors personal interviews. Fish tickets issued for salmon harvests have a declaration for disposition of the salmon. Most are declared for commercial purposes, but a large portion from treaty fisheries are declared "take-home." According to WDFW data managers, most net caught, treaty salmon sold for their eggs are claimed as take-home for their final disposition. Take-home fish are assumed to provide the same impact as commercially sold fish. It is assumed that they are a substitute for other protein. The consumption of fish at home frees up funds to spend on other similar items. Ceremonial and subsistence, illegally caught fish, etc. are disregarded in our economic impact modeling results. It was necessary to interview the primary processors to determine the market product forms for the catch area salmon.

Salmon landings are sometimes made head-on, gutted, and gilled, sometimes head-off and gutted, and other times in the whole (termed round). Salmon are generally delivered dressed in troll gear fisheries and in the round in net gear fisheries. Adjustments have been made in the modeling factors to always approximate the weight of fish in the round. Care needs to be used in making sure weight units for fish to be modeled are also in round pounds. The average weights per fish by species and the conversion factor between landed pounds and round pounds is shown in a table included in the computer file.

Modeling factors are also expressed in terms of finish product pounds. Finish pounds are the product weight after processing. For example, a fillet, skin-on product is about 55 percent recovery from net caught chinook salmon round pounds. Salmon generating eggs has about a seven to eight percent recovery weight on females. Assuming half the fish are males, the recovery is four percent. The amount of recovery in percent is referenced in tables as “yield.”[3]

Ex-Vessel Prices

Example statewide landed prices for the catch area’s harvests are $0.70 per round pound for net caught chinook and $1.02 for troll caught chinook. A processor uses both the fish flesh and its eggs. The price for a fish’s weight assumes the egg value. The egg credit is generally $0.18 per round pound. This means that a fish round weight price is $0.52, plus the egg credit of $0.18, equals $0.70. As previously mentioned about a salmon’s declared disposition, sometimes a buyer only purchases the eggs and the carcass remains with the seller. In this case, an example price for net caught chinook eggs is about $1.89 per egg pound. There is some variation in prices seasonally and for different ports. It was assumed the annual, statewide prices applied to all regions for showing modeling results.

Regional Economic Impact Modeling Methods

The 2000 IMPLAN database (latest version available) was used to construct a Fisheries Economic Assessment Model (FEAM) for the four geographic areas. The FEAM uses basic input/output relationships from IMPLAN. Custom fishing industry sectors are comprised of aggregated and disaggregated IMPLAN sectors. The input/output relationships for the custom sectors are then applied to spending patterns from the harvesting and processing components of

3. South Puget Sound eggs exceed the backward calculations of delivered carcasses at an 8% yield for 50% females [(304,134 + 384,961 + 15,907) * 0.08 * 0.50 = 28,200]. A total of 40,926 pounds of eggs were landed, therefore it would be expected at least 1.02 million round pounds of carcasses would be landed. There was no attempt to resolve this data discrepancy.

the fishing industry to show direct, indirect, and induced effects to local economies and the State. The FEAM has inputs of species landing weight, prices, product forms, and budgets for fishing industry businesses. Coefficients and multiplier factors based on landed weight were derived from FEAM outputs. The FEAM will generate total economic impact results, but the coefficients and multiplier factors can also be applied outside of the model for calculating economic impacts.

The factors can be used outside of the FEAM for calculating the regional economic impacts for the different management plans' harvest alternatives. Care must be taken to use average per unit impact factors to calculate total economic contribution and marginal per unit impact factors to calculate changes to fisheries. The ratio of the former to the latter is about 0.89 for income, employment, and output.

Modeling Results

Puget Sound catch area landings have decreased dramatically from the middle 1980's (Figure 1). Recent higher landings in 2001 and 2002 for chum salmon have reversed the total salmon volume declining trends. The other salmon species have stayed at lower levels. Ex-vessel prices have also declined during this period, due to large supplies of salmon in the marketplace. Significant proportions of these supplies are from farm origin.

Harvest data is available by vessel for non-Indian harvesters (Table 4). The revenue distribution shows 77 percent of these vessels sell less than $30,000 in harvested fish. The proportion of the revenue from Puget Sound salmon fisheries is greater than 80 percent for these vessels. While most of the vessels are in the lower revenue categories, they only harvest 22 percent of fish resources taken by all vessels that participate in the Puget Sound salmon fisheries. The lower revenue vessel categories harvest 44 percent of the Puget Sound salmon. Processors that purchase Puget Sound salmon from non-treaty and/or treaty fisheries have a similarly skewed distribution (Table 4).[4] Sixty-nine percent of the processors have total purchases less than $100,000, while they are only utilizing five percent of total purchases. The lower purchase category processors buy 12 percent of the Puget Sound salmon.

The regional and statewide economic impacts for Year 2002 salmon fisheries catch area harvests are shown in Table 5 and Figure 2. The Puget Sound management plan catch area’s chinook fisheries at the state level contributed $2.4 million in personal income, $3.2 million in output, and about 83 jobs (FTE). Economic contributions from all salmon fisheries in 2002 were $25.9 million in personal income, $35.2 million in output, and 760 jobs (FTE). About 44 percent was in the south Puget Sound region, 43 percent in north Puget Sound, and 13 percent in coastal Washington north.

4. Processor codes that show purchases from only one vessel are excluded from the analysis. These processor codes represent "across the dock" sales from vessels directly to the public.

Appendix
Landing and Catch Area Assignments

The data analysis included aggregating ports-of-delivery to economic regions (port groups). The following table shows how individual ports were assigned:

Economic Regions (Port Groups)	Counties	Landing Locations	Nearby Harvest Data Statistical Area
Northern Puget Sound	Island, San Juan, Skagit, Snohomish, Whatcom	Anacortes, Bellingham Bay, Blaine, Deer Harbor, Friday Harbor, La Conner, Marietta, Point Roberts	WDFW 7, 8
Southern Puget Sound	King, Kitsap, Mason, Pierce, Thurston	Bremerton, Brinnon, Coupeville, Everett, Olympia, Poulsbo, Quilcene, Seattle, Shelton, Stanwood, Tacoma, Whidby Island	WDFW 9, 10, 11, 12, 13
Coastal Washington North	Clallam, Jefferson	Bay City, Copalis Beach, Hoh, Lapush, Moclips, Neah Bay, Port Angeles, Port Townsend, Queets, Sequim, Taholah	WDFW 4B, 5, 6

Landings from the following catch areas were used in the analysis. Only statistical areas with landings in 2002 are shown.

Nearby Economic Region	Statistical Area	Area Name	2002 Chinook Landings (round_pounds)
Coastal Washington North	4B	TATOOSH - SAIL ROCK	15,965
Coastal Washington North	5	CLALLAM BAY	18,087
Northern Puget Sound	7	SAN JAUN ISLANDS	6,295
Northern Puget Sound	77B	LOWER NOOKSACK RIVER	6,027
Northern Puget Sound	78C	LOWER SKAGIT RIVER	4,512
Northern Puget Sound	78D	UPPER SKAGIT RIVER	774
Northern Puget Sound	7A	POINT ROBERTS	28,729
Northern Puget Sound	7B	BELLINGHAM BAY	496,010
Northern Puget Sound	7C	SAMISH BAY	122,298
Northern Puget Sound	7D	LUMMI BAY	53
Northern Puget Sound	8	SKAGIT BAY	25
Northern Puget Sound	8A	PORT SUSAN - PORT GARDNER	825
Northern Puget Sound	8D	TULALIP BAY	68,352
Northern Puget Sound	9A	PORT GAMBLE	18
Southern Puget Sound	10	SEATTLE	381
Southern Puget Sound	10A	ELLIOTT BAY	24,104
Southern Puget Sound	10E	EAST KITSAP	61,600
Southern Puget Sound	10F	LAKE WASHINGTON SHIP CANAL	1,560
Southern Puget Sound	12A	QUILCENE - DABOB BAY	54
Southern Puget Sound	12B	CENTRAL HOOD CANAL	1,128
Southern Puget Sound	12C	LOWER HOOD CANAL	272,053
Southern Puget Sound	13	FOX ISLAND	2,064
Southern Puget Sound	13A	CARR INLET	13,324
Southern Puget Sound	13C	CHAMBERS CREEK ESTUARY	7,384
Southern Puget Sound	13D	CASE INLET - SQUAXIN ISLAND	44
Southern Puget Sound	13F	BUDD INLET	415
Southern Puget Sound	80B	GREEN - DUWAMISH	136,420
Southern Puget Sound	81B	PUYALLUP RIVER	72,928
Southern Puget Sound	82G	SKOKOMISH RIVER	34,783
Southern Puget Sound	83C	MINTER CREEK	560
Southern Puget Sound	83D	NISQUALLY RIVER	95,644
Southern Puget Sound	83F	MCALISTER CREEK	4,335
Total			1,496,751

The landings in the economic regions from the selected catch areas are as follows:

Economic Region	Port Codes	Port Name	2002 Chinook Volume (round_pounds)
Northern Puget Sound	105	ANACORTES	6,238
Northern Puget Sound	110	BELLINGHAM BAY	591,393
Northern Puget Sound	115	BLAINE	13,808
Northern Puget Sound	135	FRIDAY HARBOR	15,412
Northern Puget Sound	140	LA CONNER	18,388
Southern Puget Sound	125	COUPEVILLE	3,110
Southern Puget Sound	130	EVERETT	52,034
Southern Puget Sound	143	WHIDBY ISLAND	1,639
Southern Puget Sound	155	OLYMPIA	7,440
Southern Puget Sound	169	POULSBO	13,373
Southern Puget Sound	170	SEATTLE	159,584
Southern Puget Sound	180	SHELTON	301,244
Southern Puget Sound	190	TACOMA	259,010
Coastal Washington North	150	NEAH BAY	14,488
Coastal Washington North	160	PORT ANGELES	9,886
Coastal Washington North	165	PORT TOWNSEND	7,444
Coastal Washington North	230	COPALIS BEACH	123
Other			22,137
Total			1,496,751

The chinook volume by catch area and the economic regions in which they were landed is as follows:

	Landing Area				
Catch Area (Nearby Economic Region)	Coastal Washington North	Southern Puget Sound	Northern Puget Sound	Other	Total
Coastal Washington North	24,338	408		9,306	34,052
Southern Puget Sound	3,167	78,777	645,239	6,735	733,918
Northern Puget Sound	4,436	718,249		6,096	728,781
Total	31,941	797,434	645,239	22,137	1,496,751

The statistical areas are shown on the following map:

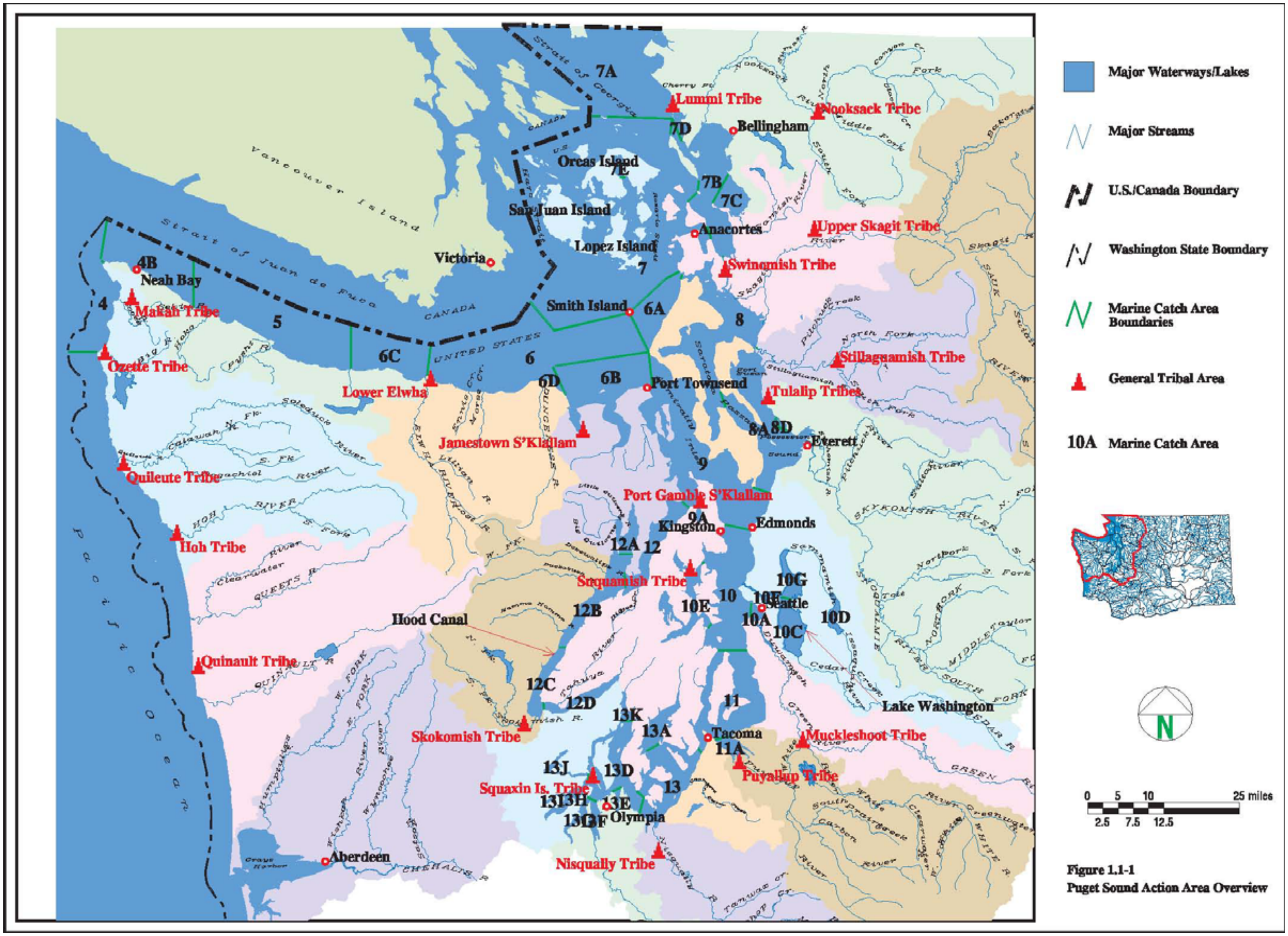


Figure 1.1-1
Puget Sound Action Area Overview

Project: NWIFC Puget Sound Chinook Management EIS
Statement: Puget Sound Salmon Fisheries Volume by Gear and Disposition in 2002
Date: September 18, 2003
Report Table: 1

Landing Area	Non-Treaty		Treaty				
(Economic Region)	Volume	Eggs	Commercial	Take-Home	Eggs	C&S/Other	Total
CHINOOK							
Net							
North Puget Sound	258,414	78	359,892	15,800	1,070	5,552	382,314
South Puget Sound	20,967	68	304,134	384,961	40,926	15,907	745,928
Coastal Washington North	3,131	-	11,888	20	-	123	12,031
Regional Total	282,512	146	675,914	400,781	41,996	21,582	1,140,273
Statewide	284,022	146	683,012	400,781	41,996	21,582	1,147,371
Troll							
North Puget Sound	-	-	-	-	-	-	-
South Puget Sound	-	-	-	357	47	-	404
Coastal Washington North	-	-	16,625	141	-	-	16,766
Regional Total	-	-	16,625	498	47	-	17,170
Statewide	-	-	25,779	498	47	-	26,324
All Gears							
North Puget Sound	258,414	78	364,325	15,800	1,070	5,552	386,747
South Puget Sound	20,967	68	316,434	402,535	40,973	16,457	776,399
Coastal Washington North	3,131	-	28,526	161	-	123	28,810
Regional Total	282,512	146	709,285	418,496	42,043	22,132	1,191,956
Statewide	284,022	146	729,912	418,496	42,043	22,132	1,212,583
COHO							
Net							
North Puget Sound	102,694	-	525,205	107,395	10,819	10,941	654,360
South Puget Sound	18,499	-	690,439	118,801	11,637	21,888	842,765
Coastal Washington North	27,012	80	76,406	4,387	1,877	1,080	83,750
Regional Total	148,205	80	1,292,050	230,583	24,333	33,909	1,580,875
Statewide	148,205	80	1,292,737	230,583	24,333	33,909	1,581,562
Troll							
North Puget Sound	-	-	-	-	-	-	-
South Puget Sound	-	-	-	-	-	-	-
Coastal Washington North	-	-	-	-	-	-	-
Regional Total	-	-	-	-	-	-	-
Statewide	-	-	600	-	-	-	600
All Gears							
North Puget Sound	102,694	-	550,809	113,736	12,373	11,142	688,060
South Puget Sound	18,499	-	690,439	119,726	11,637	21,888	843,690
Coastal Washington North	27,012	80	76,409	4,387	1,877	1,080	83,753
Regional Total	148,205	80	1,317,657	237,849	25,887	34,110	1,615,503
Statewide	148,205	80	1,293,337	230,583	24,333	33,909	1,582,162
CHUM							
Net							
North Puget Sound	3,315,789	1,302	1,322,109	1,538,917	127,050	42,273	3,030,349
South Puget Sound	3,436,990	67	662,049	4,008,194	375,330	27,364	5,072,937
Coastal Washington North	2,906,175	-	11,571	100	-	76,767	88,438
Regional Total	9,658,954	1,369	1,995,729	5,547,211	502,380	146,404	8,191,724
Statewide	9,777,947	1,369	1,995,729	5,547,211	502,380	146,404	8,191,724

Landing Area	Non-Treaty		Treaty				
(Economic Region)	Volume	Eggs	Commercial	Take-Home	Eggs	C&S/Other	Total
PINK							
Net							
North Puget Sound	21	-	14	3	-	160	177
South Puget Sound	-	-	345	60	-	12	417
Coastal Washington North	-	-	696	-	-	-	696
Regional Total	21	-	1,055	63	-	172	1,290
Statewide	21	-	1,055	63	-	172	1,290
SOCKEYE							
Net							
North Puget Sound	708,420	-	1,189,387	11,296	-	11,713	1,212,396
South Puget Sound	70,961	-	402,325	13,830	30	35,846	452,031
Coastal Washington North	8,507	-	383,872	3,239	-	319	387,430
Regional Total	787,888	-	1,975,584	28,365	30	47,878	2,051,857
Statewide	793,104	-	1,980,970	28,365	30	47,878	2,057,243
STEELHEAD							
Net							
North Puget Sound	-	-	-	1,068	-	152	1,220
South Puget Sound	-	-	1,405	745	2	288	2,440
Coastal Washington North	-	-	2,195	811	29	-	3,035
Regional Total	-	-	3,600	2,624	31	440	6,695
Statewide	-	-	3,600	2,624	31	440	6,695

Notes: 1. Volume in round pound equivalents.
2. There was no attempt to resolve inconsistency for egg production. For example, it can be assumed that the general egg take yield is 7% to 8% for females. If 40,926 pounds of eggs are being reported as taken by chinook treaty net fisheries in southern Puget Sound, this would mean 1.02 million pounds of treaty salmon carcasses should be reported as landed rather than the 0.69 million pounds.
3. Statewide landings will be more than the sum of the three regions because some landings are delivered outside the regions.

Source: WDFW fish tickets database; extraction provided by NWIFC May 2003.

Project: NWIFC Puget Sound Chinook Management EIS
Statement: Average and Marginal Economic Impact Factors for Composite Product Forms by Species and Industry Component
Date: September 18, 2003
Report Table: 2

	Chinook						Coho																	
	Net			Troll			Net			Troll			Chum Net			Pink Net			Sockeye Net			Steelhead Net		
Margins	Processor	Harvester	Total	Processor	Harvester	Total	Processor	Harvester	Total	Processor	Harvester	Total	Processor	Harvester	Total	Processor	Harvester	Total	Processor	Harvester	Total	Processor	Harvester	Total
Washington 2002																								
Ex-vessel price (per round pound)			$0.70			$1.02			$0.37			$0.41			$0.16			$0.48			$0.85			$0.48
Yield			80%			87%			80%			87%			80%			80%			80%			80%
Ex-processor price (per finish pound)			$1.68			$1.91			$1.26			$1.17			$0.97			$1.38			$1.87			$1.38
Ex-processor price (per round pound)			$1.34			$1.66			$1.01			$1.02			$0.78			$1.10			$1.49			$1.10
Processor margin (per round pound)			$0.64			$0.64			$0.64			$0.61			$0.62			$0.62			$0.64			$0.62
Personal income per pound																								
Marginal state level	$0.90	$1.01	$1.91	$0.87	$1.44	$2.31	$0.91	$0.49	$1.40	$0.85	$0.48	$1.33	$0.88	$0.16	$1.04	$0.90	$0.66	$1.56	$0.90	$1.25	$2.15	$0.90	$0.66	$1.56
Average state level	$0.80	$0.90	$1.70	$0.77	$1.28	$2.06	$0.81	$0.43	$1.24	$0.76	$0.42	$1.18	$0.78	$0.15	$0.93	$0.80	$0.58	$1.38	$0.80	$1.12	$1.92	$0.80	$0.58	$1.38
Direct			44.9%			44.9%			44.9%			44.9%			44.9%			44.9%			44.9%			44.9%
Indirect			24.9%			24.9%			24.9%			24.9%			24.9%			24.9%			24.9%			24.9%
Labor			20.5%			20.5%			20.5%			20.5%			20.5%			20.5%			20.5%			20.5%
Provisioners, suppliers, etc.			4.4%			4.4%			4.4%			4.4%			4.4%			4.4%			4.4%			4.4%
Induced			30.2%			30.2%			30.2%			30.2%			30.2%			30.2%			30.2%			30.2%
Employment per million round pounds																								
Marginal state level	25.8	29.1	54.9	25.0	41.5	66.4	26.1	14.0	40.2	24.4	13.7	38.2	25.2	4.7	30.0	25.8	18.9	44.7	25.8	36.1	62.0	25.8	18.9	44.7
Average state level	23.0	25.9	48.9	22.2	36.9	59.1	23.2	12.5	35.8	21.7	12.2	34.0	22.5	4.2	26.7	23.0	16.8	39.8	23.0	32.2	55.1	23.0	16.8	39.8
Direct			61.4%			61.4%			61.4%			61.4%			61.4%			61.4%			61.4%			61.4%
Indirect			16.3%			16.3%			16.3%			16.3%			16.3%			16.3%			16.3%			16.3%
Labor			13.5%			13.5%			13.5%			13.5%			13.5%			13.5%			13.5%			13.5%
Provisioners, suppliers, etc.			2.7%			2.7%			2.7%			2.7%			2.7%			2.7%			2.7%			2.7%
Induced			22.4%			22.4%			22.4%			22.4%			22.4%			22.4%			22.4%			22.4%
Output per round pounds																								
Marginal state level	$1.20	$1.36	$2.56	$1.18	$1.96	$3.14	$1.21	$0.69	$1.90	$1.15	$0.72	$1.87	$1.18	$0.27	$1.45	$1.19	$0.90	$2.09	$1.21	$1.67	$2.88	$1.19	$0.90	$2.09
Average state level	$1.07	$1.21	$2.28	$1.05	$1.74	$2.79	$1.08	$0.61	$1.69	$1.02	$0.64	$1.66	$1.05	$0.24	$1.29	$1.06	$0.80	$1.86	$1.08	$1.48	$2.56	$1.06	$0.80	$1.86
Direct			30.8%			30.8%			30.8%			30.8%			30.8%			30.8%			30.8%			30.8%
Indirect			32.2%			32.2%			32.2%			32.2%			32.2%			32.2%			32.2%			32.2%
Labor			26.1%			26.1%			26.1%			26.1%			26.1%			26.1%			26.1%			26.1%
Provisioners, suppliers, etc.			6.1%			6.1%			6.1%			6.1%			6.1%			6.1%			6.1%			6.1%
Induced			37.0%			37.0%			37.0%			37.0%			37.0%			37.0%			37.0%			37.0%

Project: NWIFC Puget Sound Chinook Management EIS
Statement: Economic Impact Factors For Net Caught Salmon By Product Forms And Industry Component
Date: September 11, 2003
Report Table: 3

	Chinook Product Form								
	Whole w/o Eggs			Eggs			Specialty Product		
	Processor	Harvester	Total	Processor	Harvester	Total	Processor	Harvester	Total
Washington 2002									
Ex-vessel price (per round pound)			$0.52			$1.85			$0.52
Yield			76%			90%			45%
Ex-processor price (per finish pound)			$1.48			$4.20			$3.67
Ex-processor price (per round pound)			$1.13			$3.78			$1.65
Processor margin (per round pound)			$0.61			$1.93			$1.13
Personal income per round pounds									
Marginal state level	$0.86	$0.54	$1.40	$2.72	$2.79	$5.51	$1.38	$0.53	$1.91
Average state level			$1.25			$4.90			$1.70
Direct			44.9%			44.9%			44.9%
Indirect			24.9%			24.9%			24.9%
Labor			20.5%			20.5%			20.5%
Provisioners, suppliers, etc.			4.4%			4.4%			4.4%
Induced			30.2%			30.2%			30.2%
Employment per million round pounds									
Marginal state level	24.7	15.6	40.3	78.0	80.4	158.4	39.6	15.4	55.1
Average state level	22.0	13.9	35.9	69.5	71.5	141.0	35.2	13.7	49.0
Direct			61.4%			61.4%			61.4%
Indirect			16.3%			16.3%			16.3%
Labor			13.5%			13.5%			13.5%
Provisioners, suppliers, etc.			2.7%			2.7%			2.7%
Induced			22.4%			22.4%			22.4%
Output per round pounds									
Marginal state level	$1.15	$0.73	$1.88	$3.63	$3.70	$7.33	$1.85	$0.72	$2.57
Average state level	$1.02	$0.65	$1.67	$3.23	$3.29	$6.52	$1.64	$0.64	$2.28
Direct			30.8%			30.8%			30.8%
Indirect			32.2%			32.2%			32.2%
Labor			26.1%			26.1%			26.1%
Provisioners, suppliers, etc.			6.1%			6.1%			6.1%
Induced			37.0%			37.0%			37.0%

Project: NWIFC Puget Sound Chinook Management EIS
Statement: Puget Sound Salmon Vessel and Processor Profiles in 2002
Date: September 18, 2003
Report Table: 4

Revenue Distribution for Non-Tribal Vessels That Harvested Puget Sound Salmon in 2002

Vessel's Total Revenue	Count of Vessels	Count %	Total Revenue	Total Revenue %	Average Revenue	Puget Sound Salmon Revenue % of Vessel	% of Total	Average	Median
$0 to $500	18	7%	4,148	0.1%	230	99.8%	0.1%	230	216
$501 to $5,000	87	35%	212,020	3.1%	2,437	98.5%	7.1%	2,401	2,208
$5,001 to $30,000	88	35%	1,312,477	19.3%	14,915	81.8%	36.7%	12,201	9,246
$30,001 to $50,000	26	10%	988,393	14.5%	38,015	78.1%	26.3%	29,675	34,479
$50,001 to $100,000	19	8%	1,193,252	17.6%	62,803	32.9%	13.4%	20,636	15,701
Over $100,000	14	6%	3,083,211	45.4%	220,229	15.5%	16.3%	34,187	31,309
All vessels	252	100%	6,793,501	100.0%	26,958	43.1%	100.0%	11,623	5,199

Notes: 1. Revenue is ex-vessel value received for selling harvests to processors or the public.
Source: PacFIN July 2003 extraction.

Purchase Distribution for Processors that Purchase Puget Sound Salmon in 2002

Processor's Total Purchases	Count of Processors	Count %	Total Purchases	Total Purchases %	Average Purchases	Puget Sound Salmon Purchases % of Processor	% of Total	Average	Median
$0 to $5,000	21	22%	52,170	0.2%	2,484	56.4%	0.4%	1,402	1,115
$5,001 to $30,000	27	28%	338,326	1.1%	12,531	67.8%	3.2%	8,492	6,778
$30,001 to $100,000	19	20%	1,101,685	3.4%	57,983	54.9%	8.4%	31,849	22,228
$100,001 to $1,000,000	22	23%	9,365,309	29.1%	425,696	47.6%	61.9%	202,714	204,396
Over $1,000,000	8	8%	21,276,573	66.2%	2,659,572	8.8%	26.1%	234,842	27,437
All processors	97	100%	32,134,063	100.0%	331,279	22.4%	100.0%	74,251	7,407

Notes: 1. Purchases are ex-vessel value.
2. Excludes 38 processor codes that are vessels selling fish to the public.
Source: PacFIN July 2003 extraction.

Project: NWIFC Puget Sound Chinook Management EIS
Statement: Economic Contributions From Salmon Fisheries For Economic Regions And For State
Date: September 18, 2003
Report Table: 5

	Chinook						
		Treaty					
		Net					
	Non-Treaty	Commercial				Troll	
	Net	Whole w/eggs	Specialty	Take-Home	Eggs	Commercial	Total
North Puget Sound							
Pounds landed	258,414	349,095	10,797	15,800	1,070	-	
Average impacts							
Income	420,879	568,571	16,427	17,604	4,684	-	1,028,165
Employment (FTE)	13.2	17.8	0.5	0.6	0.2	-	32.2
Output	448,477	605,855	22,425	24,028	6,350	-	1,107,134
South Puget Sound							
Pounds landed	20,967	295,010	9,124	384,961	40,926	-	
Average impacts							
Income	36,015	506,739	15,459	477,665	199,536	-	1,235,414
Employment (FTE)	1.0	14.0	0.4	12.5	5.2	-	33.1
Output	47,025	661,648	20,135	622,017	258,057	-	1,608,882
Coastal Washington North							
Pounds landed	3,131	11,531	357	20	-	16,625	
Average impacts							
Income	4,849	17,857	501	21	-	31,072	54,300
Employment (FTE)	0.2	0.6	0.0	0.0	-	1.1	1.8
Output	5,685	20,936	670	28	-	36,991	64,309
Regional Total							
Pounds landed	282,512	655,637	20,277	400,781	41,996	16,625	
Average impacts							
Income	461,743	1,093,168	32,387	495,290	204,220	31,072	2,317,879
Employment (FTE)	14.3	32.4	1.0	13.1	5.4	1.1	67.2
Output	501,187	1,288,440	43,230	646,072	264,407	36,991	2,780,326
State							
Pounds landed	284,022	662,522	20,490	400,781	41,996	25,779	
Average impacts							
Income	482,809	1,126,221	34,920	500,188	205,944	52,999	2,403,081
Employment (FTE)	13.9	32.4	1.0	14.4	5.9	15.2	82.8
Output	647,116	1,509,489	46,783	669,993	273,969	72,042	3,219,392

Notes:
1. Treaty commercial net and troll harvests include effects from 98% of fish with product form whole, fresh. About 2% is lower grade and purchased for a product going to specialty markets. About 75% of net fish provide a marketable egg product during a fishing season. Because there is generally no differentiation in ex-vessel price, commercial net fisheries uses a with eggs economic impact factor.
2. Take-home assumes commercial use without eggs.
3. A small amount of eggs landed in the non-treaty net fishery, and a small amount of take-homes and eggs in the treaty troll fishery is not included in the analysis. It is assumed C&S, and seizures do not have commercial value.
4. Eggs are delivered with most carcasses declared take-homes. There is an unresolved discrepancy between assumed egg yield and carcass pounds.
5. Region economic analysis totals will not equal state because of "trade leakage" from economies. Also, there are some harvests in the management plan regions, but landed in areas outside of the region. These landings are included at the state level calculations.

	Coho						
		Treaty					
		Net					
	Non-Treaty	Commercial				Troll	
	Net	Whole w/eggs	Specialty	Take-Home	Eggs	Commercial	Total
<u>North Puget Sound</u>							
Pounds landed	102,694	528,777	22,032	113,736	12,373	-	
Average impacts							
Income	122,473	630,619	16,507	62,037	53,185	-	884,821
Employment (FTE)	3.8	19.7	0.5	2.0	1.7	-	27.8
Output	132,527	682,386	22,533	84,664	72,126	-	994,236
<u>South Puget Sound</u>							
Pounds landed	18,499	662,821	27,618	119,726	11,637	-	
Average impacts							
Income	23,214	831,775	23,044	72,726	55,707	-	1,006,466
Employment (FTE)	0.6	23.0	0.6	1.9	1.5	-	27.6
Output	30,788	1,103,134	30,011	94,694	72,075	-	1,330,701
<u>Coastal Washington North</u>							
Pounds landed	27,012	73,353	3,056	4,387	1,877	-	
Average impacts							
Income	30,291	82,258	2,114	2,209	7,448	-	124,320
Employment (FTE)	1.0	2.8	0.1	0.1	0.3	-	4.2
Output	35,821	97,273	2,829	2,955	9,901	-	148,778
<u>Regional Total</u>							
Pounds landed	148,205	1,264,951	52,706	237,849	25,887	-	
Average impacts							
Income	175,979	1,544,651	41,665	136,972	116,340	-	2,015,607
Employment (FTE)	5.5	45.5	1.2	4.0	3.5	-	59.7
Output	199,135	1,882,793	55,372	182,313	154,102	-	2,473,715
<u>State</u>							
Pounds landed	148,205	1,241,604	51,733	230,583	24,333	600	
Average impacts							
Income	184,290	1,543,910	43,417	140,880	117,161	709	2,030,366
Employment (FTE)	5.3	44.4	1.2	4.1	3.4	0.2	58.6
Output	250,089	2,095,146	58,162	188,685	155,926	996	2,749,004

	Chum						
		Treaty					
		Net					
	Non-Treaty	Commercial				Troll	
	Net	Whole w/eggs	Specialty	Take-Home	Eggs	Commercial	Total
North Puget Sound							
Pounds landed	3,315,789	1,295,667	26,442	1,538,917	127,050		
Average impacts							
Income	2,980,563	1,164,675	9,309	397,155	828,775		5,380,477
Employment (FTE)	93.1	36.4	0.3	12.9	27.0		169.7
Output	3,246,157	1,268,458	12,708	542,086	1,112,970		6,182,379
South Puget Sound							
Pounds landed	3,436,990	648,808	13,241	4,008,194	375,330		
Average impacts							
Income	3,273,046	617,860	5,191	1,151,981	2,726,633		7,774,710
Employment (FTE)	90.5	17.1	0.1	30.2	71.4		209.3
Output	4,343,668	819,964	6,761	1,500,143	3,493,437		10,163,973
Coastal Washington North							
Pounds landed	2,906,175	11,340	231	100	-		
Average impacts							
Income	2,405,441	9,386	75	24	-		2,414,926
Employment (FTE)	81.3	0.3	0.0	0.0	-		81.6
Output	2,896,875	11,303	101	32	-		2,908,311
Regional Total							
Pounds landed	9,658,954	1,955,814	39,915	5,547,211	502,380		
Average impacts							
Income	8,659,049	1,791,921	14,575	1,549,160	3,555,408		15,570,113
Employment (FTE)	264.9	53.8	0.4	43.1	98.4		460.6
Output	10,486,701	2,099,725	19,570	2,042,261	4,606,407		19,254,663
State							
Pounds landed	9,777,947	1,955,814	39,915	5,547,211	502,380		
Average impacts							
Income	9,084,240	1,817,057	15,740	1,603,581	3,670,840		16,191,459
Employment (FTE)	261.2	52.3	0.5	46.1	105.6		465.6
Output	12,586,297	2,517,549	21,087	2,148,009	4,837,819		22,110,762

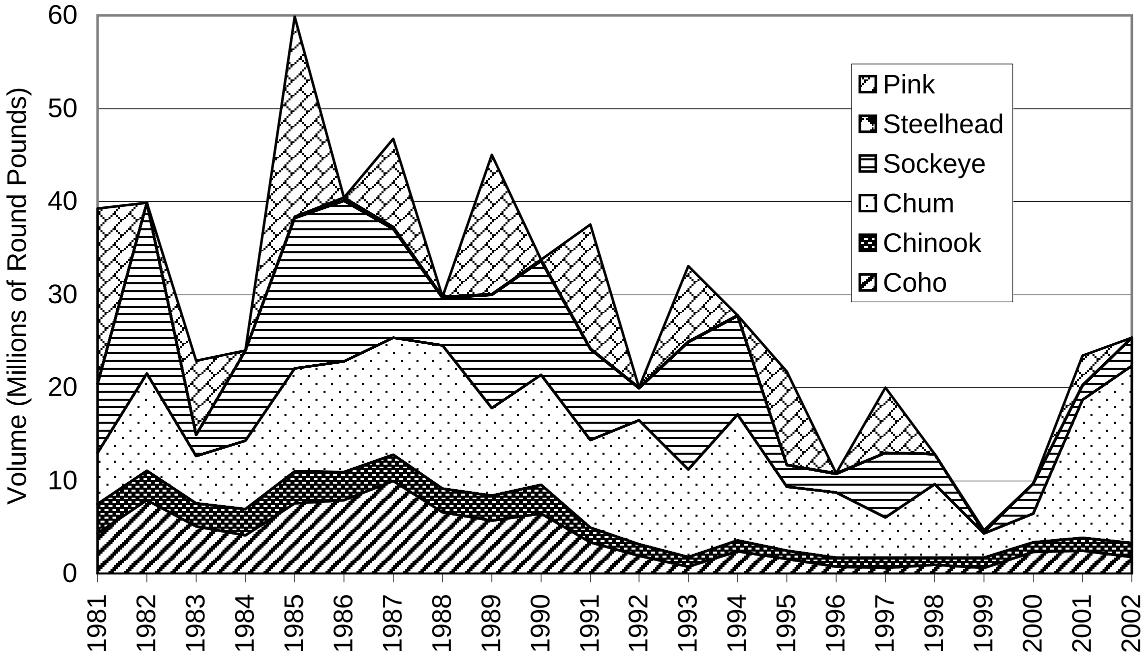
	Pink						
		Treaty					
		Net					
	Non-Treaty	Commercial				Troll	
	Net	Whole w/eggs	Specialty	Take-Home	Eggs	Commercial	Total
North Puget Sound							
Pounds landed	21	14	0	3	-		
Average impacts							
Income	27	18	0	-	-		46
Employment (FTE)	0.0	0.0	0.0	-	-		0.0
Output	30	19	0	-	-		50
South Puget Sound							
Pounds landed	-	338	7	60	-		
Average impacts							
Income	-	466	8	-	-		475
Employment (FTE)	-	0.0	0.0	-	-		0.0
Output	-	617	11	-	-		628
Coastal Washington North							
Pounds landed	-	682	14	-	-		
Average impacts							
Income	-	856	14	-	-		870
Employment (FTE)	-	0.0	0.0	-	-		0.0
Output	-	1,008	19	-	-		1,027
Regional Total							
Pounds landed	21	1,034	21	63	-		
Average impacts							
Income	27	1,340	23	-	-		1,391
Employment (FTE)	0.0	0.0	0.0	-	-		0.0
Output	30	1,644	31	-	-		1,704
State							
Pounds landed	21	1,034	21	63	-		
Average impacts							
Income	29	1,431	26	-	-		1,486
Employment (FTE)	0.0	0.0	0.0	-	-		0.0
Output	39	1,926	35	-	-		2,001

	Sockeye						
		Treaty					
		Net					
	Non-Treaty	Commercial				Troll	
	Net	Whole w/eggs	Specialty	Take-Home	Eggs	Commercial	Total
North Puget Sound							
Pounds landed	708,420	1,165,599	23,788	11,296	-		
Average impacts							
Income	1,311,427	2,157,757	34,798	-	-		3,503,982
Employment (FTE)	41.0	67.4	1.1	-	-		109.5
Output	1,380,781	2,271,870	47,373	-	-		3,700,024
South Puget Sound							
Pounds landed	70,961	394,279	8,047	13,830	30		
Average impacts							
Income	138,310	768,488	13,109	-	-		919,907
Employment (FTE)	3.8	21.2	0.3	-	-		25.4
Output	178,729	993,069	17,026	-	-		1,188,825
Coastal Washington North							
Pounds landed	8,507	376,195	7,677	3,239	-		
Average impacts							
Income	14,915	659,582	10,368	-	-		684,865
Employment (FTE)	0.5	22.3	0.4	-	-		23.2
Output	17,338	766,722	13,836	-	-		797,896
Regional Total							
Pounds landed	787,888	1,936,072	39,512	28,365	30		
Average impacts							
Income	1,464,653	3,585,827	58,274	-	-		5,108,754
Employment (FTE)	45.3	111.0	1.9	-	-		158.1
Output	1,576,849	4,031,661	78,235	-	-		5,686,745
State							
Pounds landed	793,104	1,941,351	39,619	28,365	30		
Average impacts							
Income	1,520,991	3,723,063	64,919	-	-		5,308,973
Employment (FTE)	43.7	107.1	1.9	-	-		152.7
Output	2,030,322	4,969,799	86,735	-	-		7,086,856

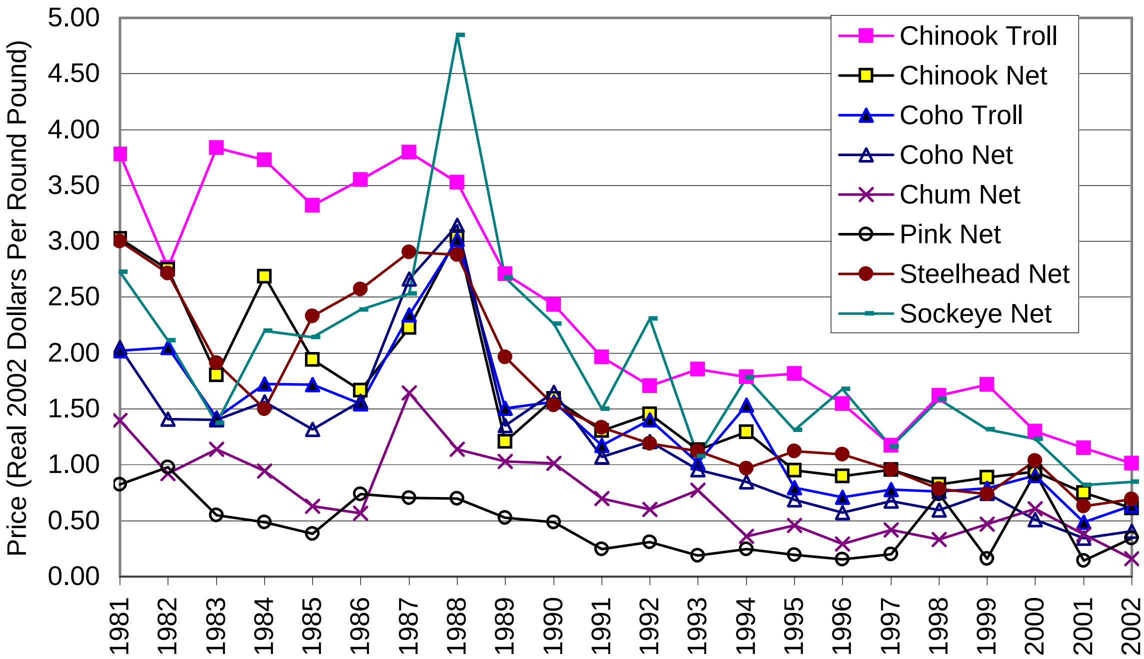
	Steelhead						
		Treaty					
		Net					
	Non-Treaty	Commercial				Troll	
	Net	Whole w/eggs	Specialty	Take-Home	Eggs	Commercial	Total
North Puget Sound							
Pounds landed	-	-	-	1,068	-		
Average impacts							
Income	-	-	-	-	-		-
Employment (FTE)	-	-	-	-	-		-
Output	-	-	-	-	-		-
South Puget Sound							
Pounds landed	-	1,377	28	745	2		
Average impacts							
Income	-	1,899	35	-	-		1,934
Employment (FTE)	-	0.1	0.0	-	-		0.1
Output	-	2,512	45	-	-		2,557
Coastal Washington North							
Pounds landed	-	2,151	44	811	29		
Average impacts							
Income	-	2,699	45	-	-		2,744
Employment (FTE)	-	0.1	0.0	-	-		0.1
Output	-	3,178	60	-	-		3,238
Regional Total							
Pounds landed	-	3,528	72	2,624	31		
Average impacts							
Income	-	4,599	79	-	-		4,678
Employment (FTE)	-	0.1	0.0	-	-		0.1
Output	-	5,690	105	-	-		5,795
State							
Pounds landed	-	3,528	72	2,624	31		
Average impacts							
Income	-	4,884	89	-	-		4,973
Employment (FTE)	-	0.1	0.0	-	-		0.1
Output	-	6,574	120	-	-		6,693

Project: NWIFC Puget Sound Chinook Management EIS
Statement: Statewide Historical Landings From Puget Sound
Date: September 18, 2003
Report Figure: 1

Landing Volume From Puget Sound Commercial Salmon Fisheries in 1981 to 2002



Price of Salmon From Puget Sound Commercial Fisheries in 1981 to 2002

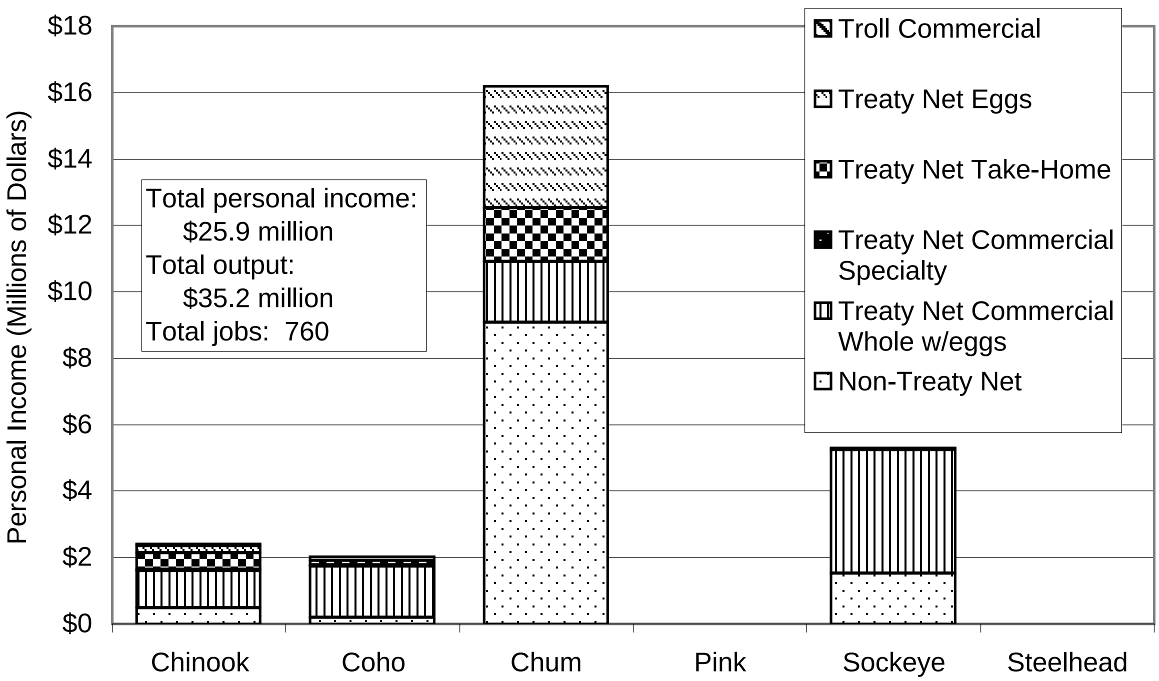


Notes: 1. Price adjusted to 2002 dollars using the GDP implicit price deflator developed by the U.S. Bureau of Economic Analysis.

Source: PacFIN January and July 2003 extractions.

Project: NWIFC Puget Sound Chinook Management EIS
Statement: Economic Contributions From Salmon Fisheries For State
Date: September 18, 2003
Report Figure: 2

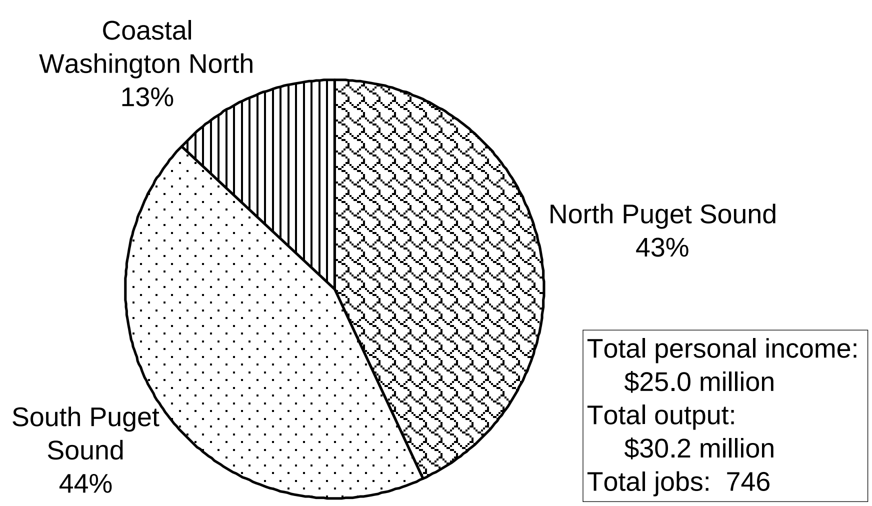
Economic Contribution From Puget Sound Commercial Salmon Fishing to Washington State's Economy in 2002



Notes: 1. Economic contribution measured by personal income adjusted to 2002 dollars using the GDP implicit price deflator developed by the U.S. Bureau of Economic Analysis. Economic contribution is at the state level.

2. Economic contribution includes direct, indirect, and induced impacts (multiplier effect) on the economy.

Economic Contribution From Puget Sound Commercial Salmon Fishing to the Puget Sound Economy in 2002



Notes: 1. Economic contribution measured by personal income adjusted to 2002 dollars using the GDP implicit price deflator developed by the U.S. Bureau of Economic Analysis. Economic contribution is at the local level economy.

2. Economic contribution includes direct, indirect, and induced impacts (multiplier effect) on the economy.

ATTACHMENT C

Net Economic Value Factors for Commercial Fishing

Developed by Meyer Resources, Inc.

Net Economic Value for Commercial Salmon Fishing in Puget Sound and the Strait of Juan de Fuca

I. Background and Available Method.

Economists paid particular attention to requisite procedures for net economic valuation of commercial salmon fishing in the Pacific Northwest – and more generally – from the late 1960's and early 1970's[1] through the early 1980's – where procedural consensus was summed up in the U.S. Water Resources Council's Principles and Guidelines (hereafter P&G)[2]. The principles established over this period have been generally followed in applied economic analysis of impacts from federal projects to the present day. These principles are:

- Net economic value is the appropriate measure of economic impact from a national accounting perspective. Net economic impact for commercial fishing is to be determined by the change in ex-vessel value of harvest under each project alternative, minus the associated change in cost[3]. This principal also holds for fish processing.

- Excess fleet capacity may have an important effect on estimating actual changes in costs associated with alternative fishing plans.

  > The excess capacity that will normally exist will make it difficult to obtain a proper estimate of changes in cost associated with changes in harvests. In some instances, idle boats will be available and the only additional costs will be operating costs. In other instances, vessels that are operating will be able to harvest the extra catch without significant change in variable costs.[4]

- Any employment of otherwise unemployed labor resources is to be treated as a net economic benefit, not a cost, in net economic impact accounting.

  > Conceptually, any employment, anywhere in the Nation, of otherwise unemployed or underemployed resources that results from a project represents a valid NED (net economic development) benefit.[5]

  In applied terms, this requirement instructs that costs associated with labor, taken from a labor pool that is otherwise substantially and persistently unemployed, should not be deducted from net economic value.

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[1] i.e. Idaho Cooperative Fishery Unit, **A Report to the National Marine Fisheries Service, on Workshops in Fishery Economics at Moscow, Idaho, and Madison, Wisconsin,** University of Idaho, 1973.
[2] U.S. Water Resources Council, 1983. **Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies.** Washington, D.C., U.S. Superintendent of Documents.
[3] **Supra** at 90.
[4] **Supra.**
[5] **Supra** at 93.

Net economic value associated with producers' and consumers' surplus can also be calculated at retail levels. However, no contemporary region-specific data is available to support such assessment. Meyer Resources, Inc. and Biosystems Analysis, Inc. used earlier national data to develop estimates of retailer producer surplus[6] along the Pacific Coast. In 1976, Brown, Douglas, Johnston and Wahle estimated consumer surplus at retail for Columbia River Salmon[7]. The present analysis does not incorporate such retail-level estimates. This convention reduces the absolute net economic estimate for each Alternative considered, but does not alter the comparative ranking of the Alternatives.

II. Comparing Net Economic Value from Impacts of Change with Status Quo Circumstances.

The framework of Alternatives considered by this EA/EIS incorporates one choice – Alternative 1 – based on estimates of "no change in present fishery management planning", essentially a theoretical representation of status quo. Since methods discussed in the preceding section measure the net economic impacts from <u>change</u>, they cannot be directly used for Alternative 1 – but must be adjusted to consider status quo.

The central issue concerning net economic evaluation of the present circumstances of salmon harvesters stems from the common property characteristics of the salmon fishery[8]. As early as 1955, it was noted that where access of harvesters to fisheries was unrestrained, the fishing fleet would tend to expand as long as some fishers made profits – driving net economic returns for the fleet as a whole toward zero[9].

Economic dialogue on this issue in the 1960's and 70's focussed on the extent to which fishery planning was "intentionally inefficient"[10] in order to meet social objectives – such as well-being of fishing communities - as well as economic efficiency goals. But economists cautioned that if benefits associated with social goals were to be included in economic calculus, there would need to be a system regulating the number of salmon harvesters in place – where, at least in a general sense, tradeoffs between economic and social objectives actually occurred. A gathering of fishery economic specialists, brought

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[6] i.e. Meyer Resources, Inc., 1985. **The Economic Value of Striped Bass, <u>Morone saxatilis</u>, Chinook Salmon, <u>Oncorhynchus tshawytscha</u>, and Steelhead Trout, <u>Salmon gairdneri</u>, of the Sacramento and San Joaquin River Systems.** Sacramento: California Department of Fish and Game Administrative Report 85-03. Biosystems Analysis, Inc., 1988. **A Bioeconomic Model for Evaluation of Flow Changes Affecting Chinook Salmon, Agriculture and Power: Economic Sub-Model.** Sausalito, CA: A Report to the National Marine Fisheries Service. Meyer Resources, Inc., 1997. **Northwest Tribal Values on the Land.** 1997. Davis, CA: A Report to the Northwest Indian Fisheries Commission.

[7] Brown, William G., D.M. Larson, R.S. Johnston and R.J. Wahle, 1976. **Improved Economic Evaluation of Commercially and Sport-Caught Salmon and Steelhead of the Columbia River.** Corvallis: University of Oregon State Agricultural Experiment Station Special Report 463.

[8] A common property resource is a resource held by public trustees, as opposed to private owners.

[9] H. Scott Gordon, 1955. "The Economic Theory of a Common Property Resource; The Fishery", in, **Journal of Political Economy**, LXIII, Apr.

[10] Defined in the salmon context as "too many vessels harvesting too few fish" to achieve maximum economic returns per vessel.

together by NMFS, identified this framework during review of U.S. Water Resources Council Guidelines in 1973.

> It might be argued that the cost of the inefficiencies associated with the current over-capitalization of the (fishing) industry is a choice by society, and that if society were to choose, there could be substantial net economic rent generated. However, there is still no possibility that anyone can capture this potential net economic rent until institutional changes in the market system are made. If these institutional changes are made, there will be important regional effects and "social effects" (i.e. displacement of families, change in the nature of fishing ports, etc.). Since these changes have not been made, one might assume that the value of these "social effects" is at least equal to the net economic rent that could be generated from the fishery.[11]

Crutchfield (1962) had already recommended that net benefits associated with salmon harvesting be calculated as the maximum net economic rent attainable if the fishery were operated by a non-discriminating sole owner[12]. But explicit access management plans to govern salmon fleet size only began in 1969, in British Columbia – and did not follow in the United States for another decade or more.

Crutchfield's 1962 recommendation may have been prescient. It is clear today that determination of the number of vessels that are allowed access to commercial harvest openings in waters off the State of Washington receive continuing attention by salmon management authorities. It is equally clear that dialogue concerning access to salmon fisheries considers trade-offs between economic efficiency and the well being of fishing families, communities and ports on an ongoing basis.

Consequently, assessment of net economic value associated with the Alternative 1 management status quo in this EA/EIS will consider two indicators of net economic status: i) present-day average *net economic returns* evident in the salmon fishery – without consideration of benefit trade-offs with family and/or community goals; ii) net economic returns from present fishing activities plus "potential economic rent" forgone to achieve family, community or fishing port objectives. We will term the first indicator *net economic efficiency returns,* and the second indicator *net socio-economic returns.*

III. Empirical Evidence

1. Salmon Fishing

In order to implement net economic value analyses at the salmon fishing level, it is necessary to obtain relevant data with respect to levels of salmon harvest, revenue associated with stipulated harvest levels, associated fishing costs and the characteristics of employment/ unemployment in the labor pool from which fishers are drawn.

[11] Idaho Cooperative Fishery Unit, **Supra** at 10.
[12] Crutchfield, James. 1962. "Valuation of Fishery Resources", in, **Land Economics**, 38: 145-154.

For this EIS, estimates of salmon harvest under each alternative were provided by the fishery modeling group – and converted to weight of harvest in pounds using data from the Washington Department of Fish and Wildlife's LIFT database. Harvest poundage was then converted to dollars of revenue, using average prices from the LIFT database.

Empirical information with respect to changes in salmon net economic value, as harvest levels change is less systematically available. Major empirical enquiries were conducted by Barclay and Morley (1977)[13], Oregon State University (1978)[14], Petry (1979)[15] and Jear (1980)[16]. More recent studies concerning net economic changes in fishery harvest values have essentially summarized earlier studies, and made "expert recommendations" based on those data – but have introduced little further contemporary empirical evidence[17].

Cost and earnings analyses of Pacific Northwest fisheries have been conducted over the years. Canada Fisheries and Oceans periodically release financial data for the adjacent Canadian salmon fleet – with data from 1994 the most recent[18]. A more recent data release from *Fisheries Economic Assessment Model* (FEAM) by the Pacific Fisheries Management Council is currently pending[19]. Such cost and earnings information will be utilized in this report to provide *net economic efficiency returns* for Alternative 1, status quo. These data are also of assistance in developing net economic impact estimates for Alternatives 2 through 4 – although they do not address net economic impacts from changed salmon harvest levels directly. Characteristics of the salmon fleet of Washington State and British Columbia are similar. We will utilize the Canada Fisheries and Oceans data for this analysis – and update it as feasible when FEAM data becomes fully available.

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[13] Barclay, J.C. and R.W. Morley, 1977. **Estimation of Commercial Fishery Benefits and Costs for the National Income Account**. Vancouver: Department of Fisheries and Oceans.

[14] Oregon State University, 1978, **Socio-Economics of the Idaho, Washington, Oregon and California Coho and Chinook Salmon Industry**, 2 Vols. Corvallis: A Report to the Pacific Fishery Management Council.

[15] Petry, G.H., 1979. **Pacific Northwest Salmon and Steelhead Fishery Report—The Economic Status of the Oregon and Washington Non-Indian Salmon Gillnet and Troll Fishery, 2 Vols**. Pullman: Washington State University.

[16] Jear, L. 1980. **Second Draft of Commercial Fishery Benefits and Costs Data (1976-1978)**. Vancouver: Department of Fisheries and Oceans.

[17] i.e. Meyer, Philip A., 1982. **Net Economic Values for Salmon and Steelhead from the Columbia River System**. Portland: National Marine Fisheries Service, NOAA Technical Memorandum NMFS F/NWR – 3; Rettig, Bruce and B. McCarl, 1984, "Potential and Actual Benefits from Commercial Fishing Activities" in, **NMFS Workshop**. Seattle: National Marine Fisheries Service, NOAA Technical Memorandum F/FWR-8; Biosystems Analysis, Inc. 1988. **Supra**: Radke, Hans D., S.W. Davis and R.L. Johnson, 1999. **Anadromous Fish Economic Analysis: Lower Snake River Juvenile Migration Feasibility Study**. Corvallis: Prepared for Foster Wheeler Environmental Corporation and the U.S. Army Corps of Engineers.

[18] Gislason, Gordon. 1997. **The BC Fishing Fleet: Financial Returns for 1991 and 1994.** Vancouver: Canada Fisheries and Oceans.

[19] Pacific Fisheries Management Council, 2003. **Fisheries Economic Assessment Model**. Portland: forthcoming.

2. Salmon Processing

Empirical information from which to calculate net economic impacts on salmon processors from altered salmon harvests is less available than for fishermen. Few economists have asked questions concerning whether processor infrastructure changes at all – and if so, by what proportion – as the amount of salmon landed changes. Rather, economists have tended to use FEAM-type average data, or other specific survey-based findings to estimate *value added by processing* and associated status quo *net economic efficiency returns* for processors. Principal among these studies are: Oregon State University (1978), Petry (1979), Penn (1980)[20], Clarkson Gordon, (1983)[21], Biosystems Analysis (1988), Kearney/Centaur (1988)[22] and Pacific Fisheries Management Council (2003).

These studies, and associated data, will be employed in the present EIS to estimate net economic returns to salmon processors under each alternative.

IV. A Framework for Net Economic Valuation of Impacts in the Present EIS.

1. The Magnitude of Change in Harvest

As noted, the magnitude of change in harvest is an important determinant of associated change in harvest costs. For small adjustments in harvest, associated fishing costs may change little, if at all. For more substantial adjustments, capital may remain fixed, but variable costs associated with harvesting can be expected to rise (for harvest increases) or fall (for harvest decreases). As harvest increases/decreases further, fishing capital may be expected to increase (for gains) or decline (for losses).

Alternative 2 (Escapement Goal Management) and Alternative 3 (No Action/No Authorized Take) forecast non-tribal salmon harvest levels declining to near zero. On this basis, impact on non-tribal fishers will be estimated at the *net economic efficiency* level and the *net socio-economic returns* level.

Alternatives 2 and 3 reduce tribal harvests substantially, but do not eliminate them. Given the material and cultural importance of salmon fishing to the tribes, this assessment of net economic returns to tribal fishers will assume that the fishing power of tribal vessels and set nets remains near present levels – and that variable cost changes with reduction in harvest.

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[20] Penn, E. 1980. **Cost Analysis of Fish Price Margins, 1972-1977, at Different Production and Distribution Levels.** Washington, D.C.: National Marine Fisheries Service.

[21] Clarkson Gordon, 1983. **Summary of the British Columbia Fish Processing Industry.** Vancouver: A Report to the Department of Fisheries and Oceans.

[22] Kearney/Centaur, 1988. **Development of Value Added, Margin and Expenditures for Marine Fishery Products.** Washington, D.C.: A Report for the National Marine Fisheries Service.

2. Characteristics of the Labor Pool for Fishers.

The US Water Resources Council's P&G (1983) established criteria to decide whether or not payments to labor should be treated as a benefit in net benefit estimation.

> Benefits from use of otherwise unemployed or underemployed labor resources may be recognized as a project benefit if the area has substantial and persistent unemployment… . Substantial and persistent unemployment exists in an area when:
>
> (1) the current rate of unemployment, as determined by appropriate annual statistics for the most recent 12 consecutive months, is 6 percent or more and has averaged at least 6 percent for the qualifying time periods specified in paragraph (2) and
>
> (2) the annual average rate of unemployment has been at least: (i) 50 percent above the national average for three of the preceding four calendar years, or (ii) 75 percent above the national average for one of the preceding two calendar years. [23]

The P&G further identifies that such unemployed labor must be available to fishing, and specific to the area in question[24].

Data concerning unemployment for the ten counties constituting the area of impact for this EA/EIS fall within the range of U.S. unemployment[25]. They do not rise to the standard required by the P&G for crediting of labor costs as benefits. Consequently, estimates of *net economic efficiency* and *net socio-economic returns* for non-tribal fishers will treat payments to labor as costs.

Unemployment rates for affected tribes are much higher – ranging from a 2001 low of 26 percent (Lummi) to a high of 78 percent (Sauk-Suiattle)[26]. These levels exceed the standard for *substantial and persistent unemployment* establish by the U.S. Water Resources Council. Consequently, payments to tribal fishers will be excluded from variable costs in tribal net economic benefit calculations.

3. Selection of Net Economic Value Coefficients for the Present Analysis.

Fishing level coefficients utilize 1994 cost and earnings data for salmon gill-netters and trollers from Gislason, 1997 (Table 1).

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[23] U.S. Water Resources Council. **Supra** at 93.
[24] **Supra**.
[25] i.e. U.S. Bureau of the Census, 2003. **Census 2000.** Summary File 3, Table P43.
[26] U.S. Bureau of Indian Affairs, 2003. **Indian Population and Labor Force Report: 2001**. pp. 9 & 18. Also see same publication for preceding years.

Table 1

Estimated Average Annual Revenue and Costs For Salmon Gill-netters and Trollers

Revenue/Cost Element	Revenue/Cost ($)	Percent of Total Revenue
Annual Revenue Per Vessel	51,460	100%
Fixed Cost	10,460	20
Capital Cost	6,060	12
Variable Cost:	24,520	48
• Crew & Skipper	o 19,240	o 38
• Fuel/Food/Other	o 5,280	o 10
Net Return to Investment	10,420	20%

Source: Gislason, 1997. Exhibit B3.

Selection of *non-tribal fishing coefficients for Alternative 1* (No Change) follow discussion from prior sections - and employs the Gislason data to estimate for *net economic efficiency* - and the 90 percent "maximum net economic rent" recommendation from Crutchfield, Krol and Phinney (1965)[27] and Richards (1968)[28] to estimate for *net socio-economic return*.

Selection of *non-tribal fishing level coefficients for Alternatives 2 and 3* use the same as for Alternative 1[29].

Tribal net economic efficiency for Alternative 1 is determined as the sum of net fishing return (20% of gross fishing revenue in Table 1) plus the labor share of fishing costs (38% of gross fishing revenue), previously termed the *substantial and persistent unemployment credit.* This results in a 58 percent *net economic efficiency* coefficient for tribal fishers under Alternative 1.

Radke et al. (1999) suggest *net economic impacts* from declines in harvests for surviving commercial fisheries be valued at 90 percent of ex-vessel value[30]. Determination of *fishing level coefficients for surviving tribal fisheries under Alternatives 2 and 3* adjust the Radke et al. (1999) 90 percent number by the *substantial and persistent unemployment credit* discussed in prior Section IV.2. To obtain this estimate, we again note from Table 1 that the labor component of fishing cost is 38% - and credit the

[27] Crutchfield, J.A., K.B. Krol and L.A. Phinney, 1995. **On Economic Evaluation of Washington State Department of Fisheries Controlled Natural-Rearing Program for Coho Salmon.** U.S. Fish and Wildlife Service Contract No. 14-17-007-246.

[28] Richards, Jack A., 1968. **An Economic Evaluation of Columbia River Anadromous Programs**. PhD. Thesis. Corvallis: Oregon State University.

[29] Recalling earlier discussion, our *net economic efficiency* convention is based on the premise that non-tribal commercial harvests are almost entirely lost under A2 and A3. Should fishery experts conclude otherwise, a higher 90 percent net economic impact coefficient, recommended by Radke et al. (1999), would be appropriate.

[30] Radke et al. **Supra** at IV-17.

suggested 90 percent *marginal cost* component from Radke et al. accordingly, to obtain an adjusted net economic coefficient for tribal fishers of 94 percent[31].

Processing coefficients were developed in two steps. First, Oregon State University (1978) identified value mark-ups from salmon fishing to processing levels for Puget Sound of between 84 percent and 113 percent, depending on assumptions used. We employ a mark-up of 100 percent here. Second, Penn (1980) estimated variable processing costs at 48 to 50 percent of processing value added. We assume no reduction in processor fixed cost – and utilize a processor net value coefficient of 50% of value added.

Compounding assumed value mark-up and net value percentage, the net economic value coefficient is calculated as a percentage of gross landed value. It is additive to estimates of net economic value at the fishing level.

Resultant fishing and processing level net economic value coefficients are displayed in Table 2.

Table 2

Net Economic Value Coefficients* – Puget Sound Chinook Salmon EIS

Alternative	Measure	Non-Tribal	Tribal
Fishing: A1	**:** *net economic efficiency* **:** *net socio-economic return*	20% 90%	58% 94%
Fishing: A2 & A3	**:** *net economic value*	20% and 90%	94%
Fish Processing – All Alternatives	**:** *net economic value*	50%	50%

* Coefficients are expressed as a percent of gross landed value of salmon.

[31] Tribal fishing net economic return = 1 – [marginal cost] + labour credit] = 1 – .10 + (.10)(.38) = 94%.

ATTACHMENT D

Net Economic Value Factors for Commercial Salmon Fishing

Developed by The Research Group

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MEMORANDUM

To: Tom Wegge, TCW Economics
From: Hans Radtke and Shannon Davis
Date: October 21, 2003
Re: Puget Sound Chinook Resource Harvest Management Plan EIS - Issues/Questions Concerning Net Economic Values for Commercial Fishing

You asked us about using net economic value (NEV) in the evaluation of harvest management alternatives for the Puget Sound Chinook Resource Harvest Management EIS. Phil Meyer recently prepared a document (report titled "Net Economic Value for Commercial Salmon Fishing in Puget Sound and the Strait of Juan de Fuca," received October 16, 2003) that addresses this topic. Because Phil cited our work on the Snake River (The Research Group, Anadromous Fish Economic Analysis, prepared for the U.S. Army Corps of Engineers Walla Walla District for use in the Lower Snake River Juvenile Salmon Migration Feasibility Study, June 1999) as a key information source, you requested our thoughts on several issues. More specifically, you asked us to address four questions based on consideration of the following.

A. Review of Phil's most recent version of his NEV write-up.

We reviewed Phil Meyer's report and found his discussion very thorough and informative.[1] There are three key points in his report that we would like to address: size of consumer surplus, labor market considerations, and components of producer surplus.

Because of the variety of substitutes available and the price leadership that aquaculture has taken, we expect, as was pointed out by Phil, no calculable net value due to consumers' willingness to pay higher prices. Only in very rare niche market cases, such as customer loyalty for Indian caught salmon products, may a case for consumer surplus be made.

The argument that because unemployment rates in tribal areas are high, crew share (or labor costs) should be counted as a benefit, is reasonable and in line with recommendations made by the Water Resources Council.

Phil reiterates our argument for using 50 percent of the ex-vessel value primary processor margin as an indication of the processing component for producer surplus.[2] We have argued in the past that primary processing should be included because of several factors. Primary processing usually takes place in proximity to harvesting. Also, trolling includes partial processing, while most net fishing lands the catch in the round, and includes tendering. It is for these reasons that the use of a comparable product is reasonable in calculating NEV.

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1. One exception is that Phil should spell Hans Radtke's name correctly.
2. Phil should qualify his writing that the primary processing component is 50 percent of the processor margin and not 50 percent of the ex-vessel value.

We argue that primary processing will only take place if processors cover their variable costs plus a "contribution margin" that includes plant overhead and profits. We argue that 50 percent of this "contribution margin" of $0.40 per finished pound is a reasonable estimate. This is based on a finished product weight. The finished product weight, compared to landed weight, will vary according to yields for various products from the purchased fish.

B. The expected changes in the commercial harvest of salmon and steelhead by tribal and non-tribal fishers.

We separated management actions into harvest incremental changes where fleet overcapacity probably exists and large harvest changes where capital costs for gear etc. would have to be incurred (or lost). The incremental changes would not include changes in fixed costs, whereas the large harvest changes would include increases (decreases) in investments.

C. Our understanding of commercial fishing operations in Puget Sound.

We have been involved in modeling fisheries in Washington (and throughout the Pacific Ocean rim) for over 20 years. The original version of the Fisheries Economic Assessment Model included a major input from William Jensen, part of the family that owned and operated Washington Crab Producers. More recently, The Research Group completed a study, "Tribal Salmon Fisheries Marketing Opportunities" for the Northwest Indian Fisheries Commission, dated June 2003. As part of this study, we interviewed several key members of Northwest tribal fisheries on harvesting, processing, and marketing of tribal harvested salmon. As part of this study, we concluded, based on discussions with key members, that the harvesting and processing of tribal and non-tribal caught fish are basically similar. The only difference may be the make-up of the fleet. Tribal harvesting includes more small operations.

Fish ticket data sources can be used to differentiate vessel types for non-treaty fisheries. However, tickets issued within treaty fisheries do not identify unique vessels. We have relied on a fish ticket database to explain vessel types for non-treaty fisheries and the before mentioned study to estimate the fleet mix for treaty harvesters. The following table shows our estimates. The cost-earnings budgets for these vessel types are from the FEAM developed for the current study.

	Vessel Mix	
Vessel Type	Treaty	Non-Treaty
Salmon Troller-Crabber	10%	15%
Part-time Salmon Troller	10%	20%
Salmon Netter	35%	30%
Small General Fisher	45%	35%

We have assumed Year 2002 salmon species prices as shown in the following table.

	Salmon Species/Gears						
	Troll Coho	Troll Chinook	Net Coho	Net Chinook	Net Chum	Net Pink/ Steelhead	Net Sockeye
Ex-vessel price	$0.41	$1.02	$0.37	$0.70	$0.16	$0.48	$0.85

D. Our experience with calculating NEV for commercial salmon fishing with production from the Columbia River and elsewhere.

Most of our original work on commercial fishing was in building regional economic impact models for fisheries along the West Coast and in Alaska. Because those models included budgets for harvesters and processors, we have also been asked to develop NEV estimates for several studies. Some examples:

- In the 1990's, we were asked by the Pacific Salmon Commission to develop comparable NEV estimates between species and geographic areas.[1] Our method for estimating was reviewed by Jim Critchfield (University of Washington) and James Wilen (University of California, Davis), who found the methodology reasonable. The results were never published because negotiations between Canada and the U.S. are always ongoing.

- We have prepared NEV estimates for the Pacific Fishery Management Council (PFMC) for recreational and commercial fishing. We have concluded that, in very general terms across many vessel types, a 0.7 rate (inclusive of a 0.5 harvest and 0.2 primary processing rate) of ex-vessel value is a reasonable NEV estimate. Our methods were reviewed by the PFMC Science and Statistical Committee.

- Our NEV analysis for the Lower Snake River Juvenile Migration Feasibility Study was reviewed by the Northwest Power and Conservation Council, Independent Economic Analysis Board (IEAB).

Based on the above background, we addressed the following questions and calculated NEV on a per round pound basis at single year annual prices for salmon species harvested in the Puget Sound catch areas. Our estimates are shown in the enclosed tables. The ratio of NEV to ex-vessel value would change if there were a different fleet mix or different prices are assumed.

(1) Given the estimated changes in the commercial harvest of salmon and steelhead, what factors would you recommend using for estimating the NEV change in the management alternatives? Please explain your rationale, including the effect (if any) that the redistribution of harvest has on your recommendation.

Harvest capacity is over subscribed for current salmon fisheries. Small incremental changes to fisheries will not result in additional capital costs to ramp up or down for the small changes. Therefore, we recommend a ratio estimate excluding fixed costs for management alternatives that have incremental harvest changes. In situations where there might be under capacity, we recommend that half of a vessel's fixed cost share of annual revenues be included in the calculation of NEV. Where management actions cause large decreases in harvests, the same fixed costs can be considered as investment losses.

1. We worked with Gary Morishima on this project.

(2) Do you recommend using different factors for estimating changes in tribal and non-tribal fisheries? Please explain your rationale.

Based on Phil Meyer's paper in which he argues that tribal unemployment is much higher than in the general economy, and in line with the Water Resources Council recommendation that in areas of high unemployment labor costs should be included as a benefit, in these cases we have added harvest labor cost as part of the NEV estimate.

(3) Do the factors recommended above include NEV for processing? If so, please indicate how you accounted for this component. If not, what do you recommend for estimating NEV for processing?

The factors include estimates of NEV for primary processing. As stated above, it is primary processing that supplies a marketable and comparable product. The gutting, skinning, icing, and boxing are required to move the product from the harvesting area. This component of the NEV is listed under the processor line of the enclosed tables. It includes half of the contribution margin, which covers general plant overhead and profits. Because processor workers are less skilled and are drawn from larger labor market areas, we do not recommend the labor costs from this component of producer surplus be credited back as a benefit.

(4) Do the NEV factors that you recommend take into account potential losses in capital investments (e.g., boats and equipment) associated with reductions in harvest, especially under the no fishing alternative? Please explain.

In both cases of large changes to harvests, we would expect investments in capital equipment to change. We would not expect there are alternative fisheries for existing boats and equipment in a period of declining harvest opportunities.

<u>Summary</u>

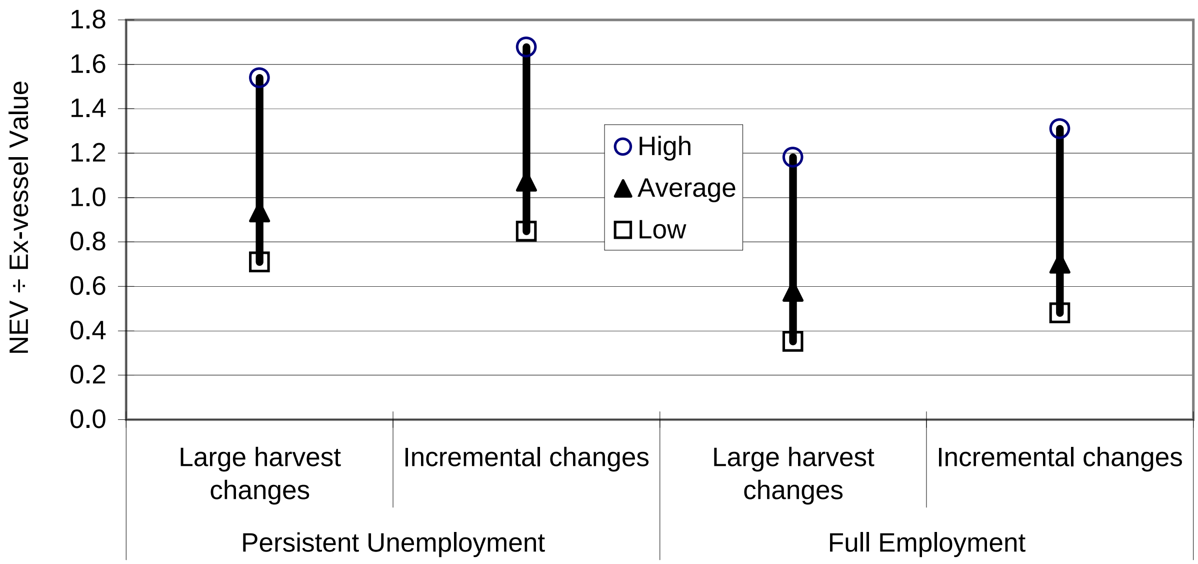
The range of NEV to ex-vessel value ratios is shown on the following figure. The ratios are specific to the fleet mix and ex-vessel prices. Because of this, the recommended ratios are somewhat different from the very general 0.7 rate of ex-vessel value that was used in the Snake River feasibility study. Those rules were developed based on a different set of harvesters and ex-vessel prices.

The fleet mix changes NEV because different vessel types have different variable and fixed costs. Prices change NEV because the primary processing "contribution margin" tends to stay fairly constant at the $0.40 rate. As the ex-vessel price decreases, the NEV to ex-vessel value ratio will increase.

While we bring more detail to our estimates, we would conclude that our recommendations for NEV factors are generally consistent with the estimates described by Phil Meyer.

Project: NWIFC Puget Sound Chinook Management EIS
Statement: NEV to ex-vessel value ratio
Date: October 22, 2003

Range of NEV to Ex-Vessel Value Ratio



Notes: 1. The range is across landed species and vessel types.
2. The ratio will be different for other assumptions of fleet mix and ex-vessel salmon prices.

Project: NWIFC Puget Sound Chinook Management EIS
Statement: NEV by species/gear for treaty and non-treaty
Filter: Treaty Vessel Mix
Date: October 22, 2003

Vessel Type	Vessel Mix	Share of Revenue Variable Costs: Labor	Other	Total	Fixed Costs Share	Net Income Share
Salmon Troller-Crabber	10%	39.0%	28.9%	67.9%	12.0%	20.1%
Part-time Salmon Troller	10%	39.0%	12.6%	51.6%	20.4%	27.9%
Salmon Netter	35%	39.0%	49.1%	88.1%	19.4%	-7.5%
Small General Fisher	45%	39.0%	24.3%	63.3%	39.3%	-2.6%
Weighted Total	100%	39.0%	32.3%	71.3%	27.7%	1.0%

Species	Reveue (Ex-vessel price)	Variable Cost Share	Variable Portion	Labor Cost Share	Labor Portion	Fixed Cost Share	Fixed Cost Portion	Net Income Share	Net Income Portion
Troll coho	$0.41	71.3%	$0.29	39.0%	$0.16	27.7%	$0.11	1.0%	$0.00
Troll chinook	$1.02	71.3%	$0.73	39.0%	$0.40	27.7%	$0.28	1.0%	$0.01
Net coho	$0.37	71.3%	$0.26	39.0%	$0.14	27.7%	$0.10	1.0%	$0.00
Net chinook	$0.70	71.3%	$0.50	39.0%	$0.27	27.7%	$0.19	1.0%	$0.01
Net chum	$0.16	71.3%	$0.11	39.0%	$0.06	27.7%	$0.04	1.0%	$0.00
Net pink/steelhead	$0.48	71.3%	$0.34	39.0%	$0.19	27.7%	$0.13	1.0%	$0.00
Net sockeye	$0.85	71.3%	$0.61	39.0%	$0.33	27.7%	$0.24	1.0%	$0.01

Vessel	Troll coho	Troll chinook	Net coho	Net chinook	Net chum	Net pink/ steelhead	Net sockeye	
Revenue (ex-vessel price)	$0.41	$1.02	$0.37	$0.70	$0.16	$0.48	$0.85	
Variable	$0.29	$0.73	$0.26	$0.50	$0.11	34.2%	$0.61	
Labor costs	$0.16	$0.40	$0.14	$0.27	$0.06	$0.19	$0.33	
1/2 fixed costs	$0.06	$0.14	$0.05	$0.10	$0.02	$0.07	$0.12	
Net income	$0.00	$0.01	$0.00	$0.01	$0.00	$0.00	$0.01	
Processor								
Yield	0.87	0.87	0.80	0.80	0.80	0.80	0.80	
Contribution margin (finish)	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	
Contribution margin (round)	$0.35	$0.35	$0.32	$0.32	$0.32	$0.32	$0.32	
1/2 margin is net income	$0.17	$0.17	$0.16	$0.16	$0.16	$0.16	$0.16	Full employment, over capacity
NEV								
NEV w/o labor, w/o fixed	$0.29	$0.47	$0.27	$0.36	$0.21	$0.30	$0.40	Full employment, over capacity
NEV w/o labor, w fixed	$0.23	$0.33	$0.21	$0.26	$0.18	$0.23	$0.29	Full employment, under capacity
NEV w labor, w/o fixed	$0.45	$0.86	$0.41	$0.63	$0.27	$0.49	$0.74	Persistent unemployment, over capacity
NEV w labor, w fixed	$0.39	$0.72	$0.36	$0.54	$0.25	$0.42	$0.62	Persistent unemployment, under capacity

Ex-vessel price ratio	Troll coho	Troll chinook	Net coho	Net chinook	Net chum	Net pink/ steelhead	Net sockeye
Large harvest changes	1.0	0.7	1.0	0.8	1.5	0.9	0.7
Incremental changes	1.1	0.8	1.1	0.9	1.7	1.0	0.9

Project: NWIFC Puget Sound Chinook Management EIS
Statement: NEV by species/gear for treaty and non-treaty
Filter: Non-treaty Vessel Mix
Date: October 22, 2003

Vessel Type	Vessel Mix	Share of Revenue Variable Costs: Labor	Other	Total	Fixed Costs Share	Net Income Share
Salmon Troller-Crabber	15%	39.0%	28.9%	67.9%	12.0%	20.1%
Part-time Salmon Troller	20%	39.0%	12.6%	51.6%	20.4%	27.9%
Salmon Netter	30%	39.0%	49.1%	88.1%	19.4%	-7.5%
Small General Fisher	35%	39.0%	24.3%	63.3%	39.3%	-2.6%
Weighted Total	100%	39.0%	30.1%	69.1%	25.5%	5.4%

Species	Reveue (Ex-vessel price)	Variable Cost Share	Variable Portion	Labor Cost Share	Labor Portion	1/2 Fixed Cost Share	Fixed Cost Portion	Net Income Share	Net Income Portion
Troll coho	$0.41	69.1%	$0.28	39.0%	$0.16	12.7%	$0.05	5.4%	$0.02
Troll chinook	$1.02	69.1%	$0.70	39.0%	$0.40	12.7%	$0.13	5.4%	$0.06
Net coho	$0.37	69.1%	$0.26	39.0%	$0.14	12.7%	$0.05	5.4%	$0.02
Net chinook	$0.70	69.1%	$0.48	39.0%	$0.27	12.7%	$0.09	5.4%	$0.04
Net chum	$0.16	69.1%	$0.11	39.0%	$0.06	12.7%	$0.02	5.4%	$0.01
Net pink/steelhead	$0.48	69.1%	$0.33	39.0%	$0.19	12.7%	$0.06	5.4%	$0.03
Net sockeye	$0.85	69.1%	$0.59	39.0%	$0.33	12.7%	$0.11	5.4%	$0.05

Vessel	Troll coho	Troll chinook	Net coho	Net chinook	Net chum	Net pink/ steelhead	Net sockeye	
Revenue (ex-vessel price)	$0.41	$1.02	$0.37	$0.70	$0.16	$0.48	$0.85	
Variable	$0.28	$0.70	$0.26	$0.48	$0.11	33.2%	$0.59	
Labor costs	$0.16	$0.40	$0.14	$0.27	$0.06	$0.19	$0.33	
1/2 fixed costs	$0.05	$0.13	$0.05	$0.09	$0.02	$0.06	$0.11	
Net income	$0.02	$0.06	$0.02	$0.04	$0.01	$0.03	$0.05	
Processor								
Yield	0.87	0.87	0.80	0.80	0.80	0.80	0.80	
Contribution margin (finish)	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	
Contribution margin (round)	$0.35	$0.35	$0.32	$0.32	$0.32	$0.32	$0.32	
1/2 margin is net income	$0.17	$0.17	$0.16	$0.16	$0.16	$0.16	$0.16	Full employment, over capacity
NEV								
NEV w/o labor, w/o fixed	$0.30	$0.49	$0.27	$0.38	$0.21	$0.31	$0.42	Full employment, over capacity
NEV w/o labor, w fixed	$0.25	$0.36	$0.23	$0.29	$0.19	$0.25	$0.31	Full employment, under capacity
NEV w labor, w/o fixed	$0.46	$0.89	$0.42	$0.65	$0.27	$0.50	$0.75	Persistent unemployment, over capacity
NEV w labor, w fixed	$0.41	$0.76	$0.37	$0.56	$0.25	$0.43	$0.65	Persistent unemployment, under capacity

Ex-vessel value ratio	Troll coho	Troll chinook	Net coho	Net chinook	Net chum	Net pink/ steelhead	Net sockeye
Large harvest changes	0.6	0.4	0.6	0.4	1.2	0.5	0.4
Incremental changes	0.7	0.5	0.7	0.5	1.3	0.6	0.5

ATTACHMENT E

Economic Factors for Salmon Sport Fishing

Developed by The Research Group

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MEMORANDUM

To: Tom Wegge
From: Hans Radtke and Shannon Davis
Date: September 18, 2003
Re: Economic Analysis Results for the Puget Sound Chinook Salmon Fishery Management Plan, Pertaining to Recreational Fisheries

This memorandum describes our recreational economic analysis results for the referenced project. They are contained in an attached Excel workbook. In regards to methods, recreational models are pretty straightforward: trips * spending per trip * multipliers = economic contribution. The hard part, of course, is acquiring data for each of these terms. We have discussed the IMPLAN and FEAM approach for getting multipliers in another memorandum to you, so we will not duplicate that discussion here.

We have used Gentner (2001) numbers for trips and spending per trip in the model. Gentner's publication describes a MRFSS economic add-on survey's results. The survey was administered in Year 2000. Gentner's trips are for saltwater fisheries at the statewide level when trip purposes include salmon and all other species. Gentner also reports trips by whether the angler's residence is within or outside Washington. We have adjusted the statewide numbers to regions using angler trips from RecFIN, which are available at the county level. RecFIN does not provide trips by residency, so we have kept Gentner's proportion of resident anglers. We assume NOAA Fisheries will supply the actual trips and angler counts by residency for the state and subregions, but we needed some numbers to test the model's application.

We have also used Gentner for calculating the economic effects from angler counts that generate the trips. It will not be necessary to use angler counts for small changes to trips, but it would be necessary if an EIS alternative calls for substantial reduction or increase in fisheries. Finding angler counts and their residence is more problematic because RecFIN does not provide these tallies directly. We can help suggest methods for finding these counts, such as maybe using some factor based on annual average effort per angler.

The recreation model uses statewide average spending per trip at the statewide level and sub-state regions. The multipliers are specific to the sub-state region. The multipliers and results are for three contribution measurements: personal income, output, and jobs (FTE). Notice we have also calculated jobs at the state level using BEA earnings per job to compare to jobs calculated from IMPLAN custom multipliers. They were within 10 percent, so we feel pretty good about using the IMPLAN custom multipliers.

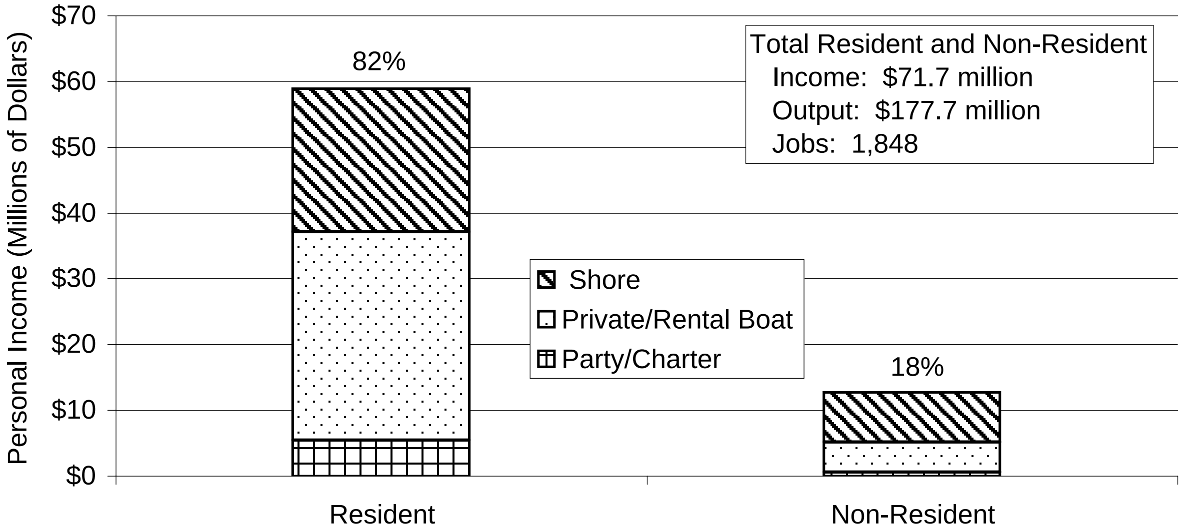
Total trip related NEV is calculated using benefit transfer approach. We have used Olsen (1990) ocean trip tables updated to current dollars, but can use other studies as necessary.

The results show there was $71.7 million (2002 dollars) in personal income contributed to the State's economy in 2000. The output and jobs (FTE) were $177.7 million and 1,848, respectively. About 82 percent was from resident anglers and 18 percent from non-resident anglers (Figure 1). Puget Sound fishing contributed $59.2 million personal income, $144.2 million output, and 1,570 jobs (FTE). The share of the economic contribution by sub-state regions was 58 percent south Puget Sound, 32 percent north Puget Sound, and 10 percent coastal Washington north.

Let me know if you have comments so I can incorporate them into the model for its easy application.

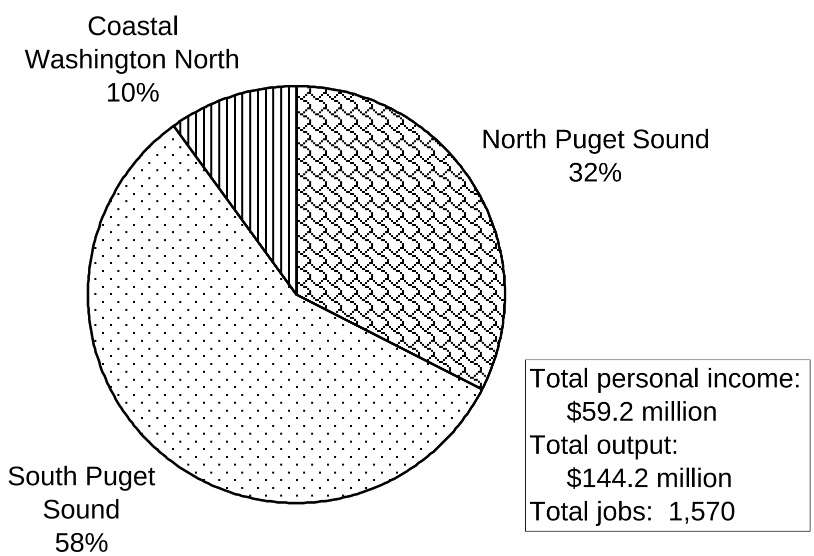
Project: NWIFC Puget Sound Chinook Management EIS
Statement: Recreational Model
Date: September 16, 2003
Report: Figure 1

Economic Contribution From Recreational Saltwater Fishing Effort to the Washington State Economy in 2000



Notes: 1. Economic contribution measured by personal income adjusted to 2002 dollars using the GDP implicit price deflator developed by the U.S. Bureau of Economic Analysis. Economic contribution is at the state level.
2. Economic contribution includes direct, indirect, and induced impacts (multiplier effect) on the economy.
3. Year 2000 effort and per trip spending from Gentner et al., <u>Marine Angler Expenditures in the Pacific Coast Region, 2000</u>, National Marine Fisheries Service, November 2001.

Economic Contribution From Recreational Saltwater Fishing Effort to the Puget Sound Economy in 2000



Notes: 1. Economic contribution measured by personal income adjusted to 2002 dollars using the GDP implicit price deflator developed by the U.S. Bureau of Economic Analysis. Economic contribution is at the local level economy.
2. Economic contribution includes direct, indirect, and induced impacts (multiplier effect) on the economy.
3. Year 2000 effort and per trip spending from Gentner et al., <u>Marine Angler Expenditures in the Pacific Coast Region, 2000</u>, National Marine Fisheries Service, November 2001, allocated to regions using Year 2000 trips from RecFIN.

APPENDIX E

Technical Methods - Environmental Justice

APPENDIX E – TECHNICAL METHODS: ENVIRONMENTAL JUSTICE

Data Sources and Calculations Associated with Section 4.7. Sources and calculations underlying data appearing in Section 4.7 are generally described here.

Data Sources:

Annual tribal data on number of fish harvested in the tribal commercial fishery within the action area, weight of that tribal catch and average price obtained by tribal fishermen – displayed in Table 4.7-1 by salmonid species – was obtained from the Northwest Indian Fisheries Commission database.

Data on average fish sizes and prices, 1996 through 2001, used for estimating revenue associated with each alternative, was provided by The William Douglas Company, based on information from the Washington Department of Fish and Wildlife.

Other data sources are as cited in appropriate tables.

Table 4.7-1 Tribal salmon fishing revenue for the action area – 17 fishing tribes.

Revenue estimates were obtained by multiplying the number of pounds of each species caught by the tribes by the appropriate average price per pound for each year – 1999 through 2001.

Table 4.7-2 Selected data for potentially affected tribes.

These data were extracted from the U.S. Bureau of the Census, Census 2000.

Table 4.7-3 Relative mortality for tribal peoples compared to residents of Washington State.

These data are extracted from a 1994 report of the Portland Area Indian Health Care Service.

Table 4.7-4 Estimated tribal salmon harvested annually under Alternative 1, Scenario B.

These data are taken from Tables C3-1 through C3-68 in Appendix C3, developed by the Biological Team.

Table 4.7-5 Estimated annual tribal salmon revenue, by species – Alternative 1, Scenario B.

Using 1996–2001 average prices and fish sizes from The William Douglas Company/Washington Department of Fish and Wildlife:

Step 1: Estimated numbers of each species of salmon harvested under Alternative 1 (Table 4.7-4) were multiplied by their average size to obtain estimated pounds of each species caught by the tribes under Alternative 1.

Step 2: Estimated pounds of each species caught under Alternative 1 (Step1) were then multiplied by average annual price per pound for each species to obtain estimated annual tribal salmon revenue, by species, under management Alternative 1.

Table 4.7-6 Predicted tribal harvests of chinook salmon under Alternative 1, Scenarios A, C, or D.

The same procedure was used as that used to develop Table 4.7-4.

Estimated impacts to tribal fishing revenue under Alternative 1 for Scenarios A, C, or D, reported in the Section 4.7.1 narrative, were developed using the procedure previously described for Table 4.7-5.

Table 4.7-7 Number of tribal salmon caught annually under Alternative 2, Scenario B.

The same procedure was used as that used to develop Table 4.7-4.

Estimated impacts to tribal fishing revenue under Alternative 2, reported in the Section 4.7.2 narrative, were developed using the procedure previously described for Table 4.7-5.

Table 4.7-8 Predicted tribal harvests of chinook salmon under Alternative 2, Scenarios A, C, or D.

The same procedure was used as that used to develop Table 4.7-4.

Estimated impacts to tribal fishing revenue under Alternative 2 for Scenarios A, C or D, reported in the Section 4.7.2 narrative, were developed using the procedure previously described for Table 4.7-5.

Table 4.7-9 Estimated tribal salmon numbers harvested annually under Alternative 3, Scenario B.

The same procedure was used as that used to develop Table 4.7-4.

Estimated impacts to tribal fishing revenue under Alternative 3, reported in the Section 4.7.3 narrative, were developed using the procedure described for Table 4.7-5.

Table 4.7-10 Predicted tribal harvests of chinook salmon under Alternative 3, Scenarios A, C, or D.

The same procedure was used as that used to develop Table 4.7-4.

Estimated impacts to tribal fishing revenue under Alternative 3 for Scenarios A, C or D, reported in the Section 4.7.3 narrative, were developed using the procedure previously described for Table 4.7-5.

Table 4.7-11 Estimated tribal salmon numbers harvested annually under Alternative 4, Scenario B.

The same procedure was used as that used to develop Table 4.7-4.

Estimated impacts to tribal fishing revenue under Alternative 4, reported in the Section 4.7.4 narrative, were developed using the procedure described for Table 4.7-5.

Table 4.7-12 Predicted tribal harvests of chinook salmon under Alternative 4, Scenarios A, C, or D.

The same procedure was used as that used to develop Table 4.7-4.

Estimated impacts to tribal fishing revenue under Alternative 4 for Scenarios A, C, or D, reported in the Section 4.7.3 narrative, were developed using the procedure previously described for Table 4.7-5.

APPENDIX F

Applicable Laws, Treaties, Licenses and Permits

APPENDIX F: APPLICABLE LAWS, TREATIES, LICENSES AND PERMITS

Federal Laws, Treaties, Licenses and Permits

Pacific Salmon Treaty

The Pacific Salmon Treaty was established March 17, 1985 between Canada and the United States to establish a framework for managing salmon populations either originating from one county and intercepted by the other, or affecting the management or the biology of the populations of the other country. The principles of the Treaty are to "1) prevent overfishing and to provide for optimum production, and 2) provide for each part to receive Benefits equivalent to the production of salmon originating in its waters." Fisheries are managed according to terms specified in the annexes to the Treaty to meet international conservation and allocation objectives agreed to by the two countries. In developing these objectives, the Treaty requires the two countries to take into account 1) ways to reduce interceptions; 2) avoiding, in most cases, the undue disruption of existing fisheries; and, 3) the annual variability in the abundances of the populations.

The Treaty called for the establishment of the Pacific Salmon Commission, comprised of representatives of both countries, which oversees implementation of the Treaty. The Pacific Salmon Commission does not regulate salmon fisheries, but provides regulatory and technical advice to the two countries. Regulation of the fisheries is the responsibility of the two countries.

Most relevant to this Environmental Assessment is the June 30, 1999, Agreement (Annex 4), which stipulates management goals and measures for important chinook and coho populations that are taken in Southeast Alaska and Canada and off the U.S. Pacific Coast. Included among these populations are several listed chinook Evolutionarily Significant Units. The new agreement establishes an abundance-based chinook management regime for the populations and fisheries subject to the Pacific Salmon Treaty. This regime will be in effect from 1999 through 2008.

Endangered Species Act

The Endangered Species Act of 1973, as amended, 16 U.S.C 1531 *et seq.* (ESA) provides broad protection for fish, wildlife, and plant species that are listed as threatened or endangered, and the conservation of the ecosystems on which they depend. Responsibility for implementing the ESA is shared by the U.S. Fish and Wildlife Service (USFWS)(for terrestrial and freshwater species) and NMFS (for most marine species and anadromous fish). The ESA provides for the conservation of species which have been so depleted in numbers that they are in danger of or threatened with extinction throughout all or a significant portion of their range. "Species" is defined the ESA as a species, a subspecies, or, or vertebrates only, a distinct population segment. NMFS has determined that a Pacific salmon stock will be considered a distinct population segment, and hence a "species" under the ESA, if it represents an evolutionarily significant unit (ESU) of the biological species.

Section 4 of the ESA prohibits the consideration of economic impacts in making species listing decisions. NMFS is required to make a listing decision based solely on the best scientific and commercial data available. However, under section 4, NMFS must consider economic impacts when designating critical habitat necessary for the continued survival of the species. After a species is listed, a recovery plan is prepared which identifies conservation measures to help the species recover.

Section 4(d) of the ESA requires the Secretary to adopt those regulations he deems necessary for the conservation of the species. The July 10, 2000 4(d) Rule for Puget Sound chinook under which the proposed action was provided to NMFS for consideration adopts those regulations necessary for the conservation of Puget Sound chinook. Fishing activities which are conducted in compliance with a resource management plans approved by NMFS are exempt from take prohibitions on listed Puget Sound chinook.

Section 7 of the ESA outlines the procedures for Federal interagency cooperation to conserve listed species and designated critical habitat, and requires all Federal agencies to consult with NMFS (or USFWS) concerning the potential effects of their actions on any listed species. Section 7(a)(1) requires federal agencies to conserve endangered and threatened species. Section 7(a)(2) requires federal agencies to ensure that any action authorized, funded, or carried out by such agencies is not likely to jeopardize endangered or threatened species, or result in the destruction or adverse modification of designated critical habitat. The determination that NMFS must make on the resource management plan constitutes a federal action and so requires consultation under section 7 of the Act.

If a proposed action is "likely to adversely affect" a listed species or its critical habitat, then formal consultation under section 7(a)(2) must be undertaken. Formal consultation concludes with NMFS' issuing a biological opinion. If the biological opinion concludes that the proposed action is likely to "jeopardize" the continued existence of the listed species or result in the destruction or adverse modification of designated critical habitat, then NMFS may develop reasonable and prudent alternatives in order to avoid these outcomes.

U.S. v. Washington

Five treaties ratified by the United States and various Washington Tribes between 1854 and 1856 guaranteed Tribes fishing rights in common with citizens of the Territory. These are the treaties of Medicine Creek, Quinault, Neah Bay, Point Elliott, and Point-No-Point. Findings of United States v. Washington, *see* 384 F. Supp. 312, commonly referred to as the Boldt Decision (United States District Court for the Western District of Washington, Tacoma District 1974) clarified these treaties with regard to allocation of salmon harvests between Tribal and non-Tribal fishers, holding that Tribes are entitled to a 50 percent share of the harvestable run of fish. Hoh v. Baldridge, 522 F. Supp. 683 (United States District Court for the Western District of Washington, Tacoma District 1981), established the principle that where annual fishery management plans might affect an individual Tribe, the plans must take into account returns to individual streams, thus establishing a key management principle of river-by-river or run-by-run management. The Puget Sound Salmon Management Plan, and the framework management plan adopted under Hoh v. Baldridge established principles governing the management of shared salmon resources and established the principle of co-management whereby Tribes are equal co-managers with the State and represent themselves in the regional and international management forums.

In general, the court held the following:

- The State must seek to regulate Tribes by the least restrictive means consistent with necessary conservation measures.
- The Tribes must be afforded a fair opportunity to take their fair portion of fish from each run by reasonable means.
- The States may regulate accustomed Tribal fishing stations only where the interests of conservation[i] are justified.

The Puget Sound treaty tribes co-manage Puget Sound fisheries with the state of Washington, and participate with tribes from California, Oregon and other Washington areas in managing fisheries under the jurisdiction of the Pacific Fisheries Management Council and the Pacific Salmon Treaty.

Executive Order ~~13084~~ 13175: Consultation and Coordination with Tribal Governments

This Executive Order was signed on ~~May 14, 1998~~ November 6, 2000, and published ~~May 19, 1998~~ November 9, 2000 (~~63~~ 65 FR ~~27655~~ 67249). Its purpose is to establish regular and meaningful consultation and collaboration with Indian Tribal governments in the development of federal regulatory practices that significantly or uniquely affect their communities; to reduce the imposition on unfunded mandates on Indian Tribal governments; and to streamline the application process for and increase the availability of waivers to Indian Tribal governments. This Executive Order requires federal agencies to have an effective process to involve and consult with representatives of Indian Tribal governments in developing regulatory policies and it prohibits regulations that impose substantial direct compliance costs on Indian Tribal communities.

Magnuson-Stevens Conservation and Management Act

The Magnuson-Stevens Act is the principal federal statute that provides for the management of U.S. marine fisheries. Originally enacted as the Fishery Conservation and Management Act in 1976 (Public Law 94-265), this law was arguably the most significant fisheries legislation in U.S. history. It has been amended periodically since 1976; most recently in 1996, by the Sustainable Fisheries Act (Public Law 104-297). The basic concepts of the Magnuson-Stevens Act have not changed and include the following:

- The biological conservation of a fishery resource has priority over its use.
- Conservation and management decision making must be based on the best available scientific information, which should include social, economic, and ecological factors along with biological factors.
- The needs of fishery resource users vary across the nation, and public participation in the policy making process should be maximized.

The Magnuson-Stevens Act (as amended in 1996) included the following policy statement regarding the nation's fisheries (16 U.S.C. 1801, Sec. 2[c]):

POLICY – It is further declared to be the policy of the Congress in this Act to:

1) Maintain without change the existing territorial or other ocean jurisdiction of the United States for all purposes other than the conservation and management of fishery resources, as provided for in this Act.

2) Authorize no impediment to, or interference with, recognized legitimate uses of the high seas, except as necessary for the conservation and management of fishery resources, as provided for in this Act.

3) Assure that the national fishery conservation and management program utilizes, and is based upon, the best scientific information available; involves, and is responsive to the needs of, interested and affected states and citizens; considers efficiency; draws upon federal, state, and academic capabilities in carrying out research, administration, management, and enforcement; considers the effects of fishing on immature fish and encourages development of practical

measures that minimize bycatch and avoid unnecessary waste of fish; and is workable and effective.

4) Permit foreign fishing consistent with the provisions of this Act.

5) Support and encourage active United States efforts to obtain internationally acceptable agreements which provide for effective conservation and management of fishery resources, and to secure agreements to regulate fishing by vessels or persons beyond the exclusive economic zones of any nation.

6) Foster and maintain the diversity of fisheries in the United States.

7) Ensure that the fishery resources adjacent to a Pacific Insular Area, including resident or migratory populations within the exclusive economic zone adjacent to such areas, be explored, developed, conserved, and managed for the benefit of the people of such area and of the United States.

The Magnuson-Stevens Act also established ten National Standards that serve as the overarching objectives for fishery conservation and management (16 U.S.C. 1851, Sec. 301[a].):

IN GENERAL – Any fishery management plan prepared, and any regulation promulgated to implement any such plan, pursuant to this title shall be consistent with the following national standards for fishery conservation and management:

1) Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry.

2) Conservation and management measures shall be based upon the best scientific information available.

3) To the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated populations of fish shall be managed as a unit or in close coordination.

4) Conservation and management measures shall not discriminate between residents of different states. If it becomes necessary to allocate or assign fishing privileges among various United States fishermen, such allocation shall be a) fair and equitable to all such fishermen; b) reasonably calculated to promote conservation; and c) carried out in such manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges.

5) Conservation and management measures shall, where practicable, consider efficiency in the utilization of fishery resources; except that no such measure shall have economic allocation as its sole purpose.

6) Conservation and management measures shall take into account and allow for variations among, and contingencies in, fisheries, fishery resources, and catches.

7) Conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication.

8) Conservation and management measures shall, consistent with the conservation requirements of this Act (including the prevention of overfishing and rebuilding of overfished populations), take into account the importance of fishery resources to fishing communities in order to a) provide for the sustained participation of such communities, and b) to the extent practicable, minimize adverse economic impacts on such communities.

9) Conservation and management measures shall, to the extent practicable, a) minimize bycatch and b) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch.

10) Conservation and management measures shall, to the extent practicable, promote the safety of human life at sea.

The Magnuson-Stevens Act also mandates the Secretary of Commerce to develop advisory guidelines to assist in fishery management plan development. These guidelines serve primarily to interpret and aid compliance with the national standards (codified at 50 CFR Part 600, and most recently revised on May 1, 1998 [63 FR 24212]).

Marine Mammal Protection Act

The Marine Mammal Protection Act of 1972 (16 U.S.C. 1361 *et se*q.), as amended through 1996, establishes a federal responsibility to conserve marine mammals; management responsibility for cetaceans (whales) and pinnipeds (seals) other than walrus is vested with NMFS. The U.S. Fish and Wildlife Service is responsible for all other marine mammals in Alaska including sea otter, walrus, and polar bear. Congress found that certain species and population populations of marine mammals are or may be in danger of extinction or depletion due to human activities. Congress also declared that marine mammals are resources of great international significance, and they should be protected and encouraged to develop to the greatest extent feasible commensurate with sound resource management policies.

The Marine Mammal Protection Act's primary management objective is to maintain the health and stability of the marine ecosystem, with a goal of obtaining an optimum sustainable population of marine mammals within the carrying capacity of the habitat. The Marine Mammal Protection Act is intended to work in concert with the provisions of the ESA. The Secretary of Commerce is required to give full consideration to all factors regarding regulations applicable to the "take" of marine mammals, including the conservation, development, and use of fishery resources, and the economic and technological feasibility of implementing the regulations. If a fishery affects a marine mammal population, then the potential effects of the fishery must be analyzed in the appropriate Environmental Assessment or Environmental Impact Statement, and the managing jurisdiction or NMFS may be requested to consider regulations to mitigate adverse effects.

The Puget Sound salmon fisheries are considered Category II or Category III fisheries depending on gear type. Puget Sound non-treaty salmon drift gillnet fisheries are classified as Category II fisheries, primarily for their interactions with Harbor porpoises, Harbor seals and Dall's porpoise. A Category II rating indicates an occasional likelihood of serious injuries or mortalities to marine mammals, according to the annual list of fisheries published in the Federal Register (67 FR 2410). Washington salmon troll, beach seine, purse seine, reef net and charter boat fisheries are classified as Category III, indicating a remote likelihood of or no known serious injuries or mortalities to marine mammals. Participants in Category II fisheries register with state or federal permit systems and NMFS is tasked with developing take reduction plans for Category 1 and II fisheries.

National Environmental Policy Act (NEPA)

The National Environmental Policy Act became law on January 1, 1970. It was designed to ensure that federal agencies made decisions fully informed about the impacts of their actions on the human and natural environment, to reduce those impacts where possible and to promote research and understanding of the environment. This Environmental Assessment is intended to meet the National Environmental Policy Act requirements that apply to the proposed action.

Migratory Bird Treaty Act

The Migratory Bird Treaty Act of 1918 was designed to end the commercial trade of migratory birds and their feathers that, by the early years of the 20th century, had diminished populations of many native bird species. The Act states that it is unlawful to take, kill, or possess migratory birds and their parts (including eggs, nests, and feathers) and is a shared agreement between the United States, Canada, Japan, Mexico, and Russia to protect a common migratory bird resource. The Migratory Bird Treaty Act prohibits the directed take of seabirds, but the incidental take of seabirds does occur.

Executive Order 12898: Environmental Justice

This Executive Order was signed February 11, 1994 (59 FR 7630). It requires Federal agencies to identify and address "as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low income populations…"(section 1-101). The Executive Order specifically requires the inclusion of Native American communities in the analysis of these effects. The Executive Order directs federal agencies to develop agency-specific environmental justice strategies that identify the types of actions that may or have raised environmental justice issues and possible approaches to address such concerns, as appropriate (section 1-103). These strategies should:

1) Promote enforcement of health and environmental laws in these communities.
2) Improve research, data collection and data analysis of environmental and human health risks, particularly with regard to exposure of these communities to environmental hazards (section 3-3), whenever practicable and appropriate.
3) Assess subsistence consumption of fish, vegetation, or wildlife whenever practicable and appropriate (section 4-401).
4) Effective public participation and access to information so that all sectors of the community have the opportunity and information to participate in the NEPA process in a meaningful way to the extent feasible (section 5-5).

Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act was signed March 10, 1934 and has been amended several times, the most recent of which was July 9, 1965. Its purpose is to provide assistance to, and cooperate with, federal, state, and public or private agencies and organizations in the development, protection, rearing, and stocking of all species of wildlife, resources thereof, and their habitat, in controlling losses of the same from disease or other causes, in minimizing damages from overabundant species, in

1. Providing public shooting and fishing areas, including easements across public lands for access thereto, and in carrying out other measures necessary to effectuate the purposes of said sections
2. Making surveys and investigations of the wildlife of the public domain, including lands and waters or interests therein acquired or controlled by any agency of the United States
3. Accepting donations of land and contributions of funds in furtherance of the purposes of said sections.

Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl, commonly referred to as the Northwest Forest Plan **(NFP)**

Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl is commonly referred to as the Northwest Forest Plan (NFP), adopted in 1994. The NFP is an integrated, comprehensive design for ecosystem management, inter-governmental and public collaboration, and rural community economic assistance for federal forests in western Oregon, Washington, and northern California. The management direction of the NFP consists of extensive standards and guidelines, including land allocations that comprise a comprehensive ecosystem management strategy. Aquatic conservation strategy objectives outlined in the NFP (Attachment A of the NFP) include, but are not limited to: "Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations and communities are uniquely adapted;" and, "Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities."

Executive Order 12962: Recreational Fisheries

This Executive Order was signed June 7, 1995, and published June 9, 1995 (Volume 60, Number 111). Its purpose is to conserve, restore, and enhance aquatic systems to provide for increased recreational fishing opportunities nationwide. It states the following:

- Federal agencies, in cooperation with States and Tribes, are to improve the quantity, function, sustainable productivity, and distribution of U.S. aquatic resources for increased recreational fishing opportunities.
- A National Recreational Fisheries Coordination Council is to be established.
- A comprehensive Recreational Fishery Resources Conservation Plan is to be developed.
- All Federal agencies are to work to identify and minimize conflicts between recreational fisheries and their respective responsibilities under the ESA. The U.S. Fish and Wildlife Service and NMFS will develop a joint agency policy to ensure consistency in the administration of the ESA between and within the two agencies, promote collaboration with other federal, state, and tribal fisheries managers, and to improve and increase efforts to inform nonfederal entities of the requirements of the ESA.
- The role of the Sport Fishing and Boating Partnership Council is to be expanded.

Clean Water Act

The Federal Water Pollution Control Act was originally enacted in 1972 and amended with major provisions by legislation in 1977, 1981, and 1987. It is commonly referred to as the Clean Water Act. The principal objective of the Act is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. The Clean Water Act also establishes a national policy on technology-based effluent standards and discharge water quality standards.

Coastal Zone Management Act

The Coastal Zone Management Act (16 U.S.C. 1451 *et seq.*) is designed to encourage and assist states in developing coastal management programs, to coordinate state activities, and to safeguard regional and national interests in the coastal zone. Section 307(c) of the Coastal Zone Management Act requires that any federal activity affecting the land or water uses or natural resources of a state's coastal zone be consistent with the state's approved coastal management program, to the maximum extent practicable.

A proposed fishery management action that requires a fishery management plan amendment or implementing regulations must be assessed to determine whether it directly affects the coastal zone of a state with an approved coastal zone management program. If so, NMFS must provide the state agency having coastal zone management responsibility with a consistency determination for review at least 90 days before final NMFS action.

National Marine Sanctuaries Act

The National Marine Sanctuaries Act, as amended by the Oceans Act of 1992 (Public Law 102-587) and the National Marine Sanctuaries Preservation Act of 1996 (Public Law 104- 283), requires the government identify and designate those marine areas determined to be "of special national significance"(16 U.S.C. 1431 ET.SEQ. as amended by Public Law 104-283). Management plans are developed for each marine sanctuary in consultation with affected governments, tribes, and the public. The plans are to provide for the conservation and management of the sanctuaries and include provisions for research, public education and compatible resource use.

Section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001

Section 515 directs the Office of Budget and Management to issue government-wide guidelines that "provide policy and procedural guidance to federal agencies for ensuring and maximizing the quality, objectivity, utility, and integrity of information (including statistical information) disseminated by federal agencies." The Office of Management and Budget in turn issued guidelines that required federal agencies to 1) develop their own guidelines; 2) provide a process for people to ask for and obtain corrected information that is found not to comply with section 515 or agency guidelines; and 3) keep track of the complaints about the accuracy of information and how they were handled.

Executive Order 12630: Governmental Actions and Interference with Civil Constitutionally Protected Property Rights

This Act requires each Federal agency to prepare a "takings" implication assessment for any action that may affect the use of any real or personal property. Prohibiting specific types of fishing gear could be considered a "taking" under this Executive Order.

State Laws, Treaties, Licenses and Permits

State of Washington, Chapter 36.70A RCW Growth Management – Planning by Selected Counties and Cities

State of Washington, Chapter 36.70A RCW Growth Management – Planning by Selected Counties and Cities, commonly referred to as the Growth Management Act (GMA), was adopted by the State of Washington in 1990. Under GMA, growth projected for the State by the Office of Fiscal Management is allocated to counties, which then develop plans to address the projected population increases and associated needs for services. Cities of a certain size and/or growth rate are required to prepare comprehensive land use plans under the GMA to guide both zoning and development within the jurisdictional boundaries of the plans. GMA provides a framework for regional coordination. Counties planning under the GMA are required to adopt county-wide planning policies and to establish urban growth areas (UGAs). Local comprehensive plans must include the following elements: land use; housing; capital facilities; utilities; transportation; and, for counties, a rural element. Shoreline master program policies are also an element of local comprehensive plans. GMA establishes the primacy of the comprehensive plan. The comprehensive plan is the starting point for any planning process and the centerpiece of local planning. Development regulations must be consistent with comprehensive plans. State agencies are required to comply with comprehensive plans and development regulations of jurisdictions planning under GMA.

Washington State Shoreline Management Act of 1971 (SMA)

The SMA was adopted in Washington in 1972 with the goal of "prevent[ing] the inherent harm in an uncoordinated and piecemeal development of the state's shorelines." The provisions of this law are designed to guide the development of the shoreline lands in a manner that will promote and enhance the public interest. The law expresses the public concern for protection against adverse effects to public health, the land and its vegetation and wildlife, and the aquatic life of the waters.

Washington Forest Practices Act, Chapter 76.09 of the Revised Code of Washington (RCW)

Washington Forest Practices Act, Chapter 76.09 of the Revised Code of Washington (RCW), was adopted by the state of Washington in 1974. The Washington Forest Practices Board was established in 1975 by the Legislature under the State Forest Practices Act. By law, the board is charged with establishing rules to protect the State's natural resources while maintaining a viable timber industry. Those rules, as embodied in the Washington Administrative Code (WAC), specifically consider the effects of various forest practices on fish, wildlife and water quality, as well as on capital improvements of the state or of its political subdivisions. A forest practice is defined as an activity carried out on forest land that relates to growing, harvesting or processing timber. Some examples include: logging, thinning, road construction, brush control, fertilization, and land conversions. Forest practice rules involving water quality protection must be approved by the Washington Department of Ecology.

Puget Sound Regional Council VISION 2020 Strategy

VISION 2020 is the long-range growth management, economic, and transportation strategy for the central Puget Sound region encompassing King, Kitsap, Pierce, and Snohomish counties. The strategy combines a public commitment to a growth management vision with the transportation investments and programs and economic strategy necessary to support that vision. VISION 2020 identifies the policies and key actions necessary to implement the overall strategy.

The vision is for "diverse, economically and environmentally healthy communities framed by open space and connected by a high-quality multimodal transportation system that provides effective mobility for people and goods." The VISION 2020 strategy for managing growth, the economy, and transportation contains the following eight parts: urban growth areas; contiguous and orderly development; regional capital facilities; housing; rural areas; open space, resource protection, and critical areas; economics; and transportation. Together, these eight parts constitute the Multi-county Policies for King, Kitsap, Pierce, and Snohomish counties and meet the multi-county planning requirements of Washington's Growth Management Act.

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[i] In this context, conservation is defined as those measures that are reasonable and necessary to the perpetuation of a particular run or species of fish.

APPENDIX G

Plant and Animal Database Searches

APPENDIX G – PLANT AND ANIMAL DATABASE SEARCHES

Appendix G lists the threatened or endangered plant and animal species likely to occur within the Puget Sound Action Area:

PLANTS

No threatened or endangered plant species were identified within the Puget Sound Action Area.

ANIMALS

Marine Mammals			
Humpback Whales[1]	(E)	*Megaptera novaeangliae*	NMFS
Steller Sea Lion[1]	(T)	*Eumetopias jubatus*	NMFS
Marine Turtles			
Leatherback Sea Turtle[1]	(E)	*Dermochalys coriacea*	NMFS
Birds			
Bald Eagle[2]	(T)	*Haliaeetus leucocephalus*	USFWS
Marbled Murrelet[2]	(T)	*Brachyramphus marmoratus*	USFWS
Brown Pelican[2]	(E)	*Pelecanus occidentalis*	USFWS
Fish			
Bull Trout[2]	(T)	*Salvelinus confluentus*	USFWS
Chinook Salmon		*Oncorhynchus tshawytscha*	
Puget Sound Chinook ESU[3]	(T)		
Lower Columbia River Chinook[3]	(T)		
Upper Willamette Spring-run Chinook[3]	(T)		
Snake River Fall-run Chinook[3]	(T)		
Chum Salmon		*Oncorhynchus keta*	NMFS
Hood Canal Summer-Run Chum[3]	(T)		
Columbia River Chum[3]	(T)		

[1] National Marine Fisheries Service. 2003. Endangered and threatened marine mammals and sea turtles under the jurisdiction of the National Marine Fisheries Service (NMFS) that may occur within Puget Sound. Internet-accessible species list, at http://www.nwr.noaa.gov/1seals/marmamlist.html. Web site accessed April 14, 2003.

[2] Berg, Ken. Manager, Western Washington Fish and Wildlife Office, U.S. Fish and Wildlife Service. September 24, 2002. Personal communication, letter to Species List Requester (W.L. Robinson, Assistant Regional Administrator, NMFS) in response to a request for a species list for those species listed by USFWS likely to occur within the Puget Sound Action Area.

[3] National Marine Fisheries Service. 2000. Endangered Species Act – Reinitiated Section 7 Consultation Biological Opinion Effects of Pacific Coast Ocean and Puget Sound Salmon Fisheries during the 200-2001 annual regulation cycle. April 28, 2000. 101 pages.

APPENDIX H

Consultation and Coordination

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Western Washington Fish and Wildlife Office
510 Desmond Dr. SE, Suite 102
Lacey, Washington 98503

In Reply Refer To:
1-3-04-F-0302

DEC 10 2004

William L. Robinson
Assistant Regional Administrator
NOAA Fisheries
7600 Sand Point Way N.E., Bldg. # 1
Seattle, Washington 98115-0070

Dear Mr. Robinson:

This is in response to your letter and Biological Assessment (BA) dated November 27, 2003, regarding the Puget Sound Comprehensive Chinook Management Plan (Plan). Your letter and BA were received in our office on December 11, 2003. The BA addresses effects to the marbled murrelet (*Brachyramphus marmoratus*), the bald eagle (*Haliaeetus leucocephalus*), the brown pelican (*Pelecanus occidentalis*), and the bull trout (*Salvelinus confluentus*). Your letter requests our concurrence with your finding that the project has "no effect" to the brown pelican, "may affect, but is not likely to adversely affect" the bald eagle, and is "likely to adversely affect, but is not likely to jeopardize" the marbled murrelet. Because you made a "no effect" determination for the brown pelican, there is no requirement for U.S. Fish and Wildlife Service concurrence. Your determination that this project will have no effect on the brown pelican rests with the action agency; therefore, consultation is not required. This consultation has been conducted in accordance with section 7(a)2 of the Endangered Species act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act).

Your letter did not request concurrence on effects to bull trout because the project is consistent with a special rule developed under the authority of section 4(d) of the Act, which considers the effects of activities such as the proposed action on bull trout. All effects of the proposed action that biologically conform to incidental take have been authorized under the special rule, which exempts take of bull trout for fishing activities authorized under State, National Park Service or Native American Tribal laws and regulations [64 FR 59910].

The Plan was developed jointly by the Puget Sound Treaty Tribes and Washington Department of Fish and Wildlife to provide a framework in which both entities manage all salmon and steelhead (*Oncorhynchus mykiss*) commercial and recreational fisheries that may impact Chinook salmon (*Oncorhynchus tschawytscha*) throughout Puget Sound and the Strait of Juan de Fuca in marine and freshwaters in U.S. territory.

The Plan will provide fisheries managers in Washington State with guidance concerning the amount of annual harvest of salmon and steelhead for the 2004 through 2009 management years. The intent of the Plan is to enable harvesting of strong productive stocks of salmon and steelhead (including Chinook salmon) while protecting weaker stocks of Chinook salmon.

We concur with your determination of "may affect, but is not likely to adversely affect" for the bald eagle. Impacts to bald eagles from the project activities are expected to be insignificant and discountable for the following reasons: (1) there are no records of salmon fisheries directly affecting bald eagles; (2) while salmon and steelhead fisheries may reduce the prey base for bald eagles, bald eagles have not been shown to be food-limited in the action area, and fish are not their only prey; and (3) salmon stocks are managed at sustainable projection levels, thereby maintaining available prey for bald eagles.

We also concur with your determination of "likely to adversely affect" the marbled murrelet. The effects of this action on the marbled murrelet have already been considered and analyzed in two Biological Opinions completed in this office. The first Biological Opinion (Reference # 1-3-01-F-1636) was completed in 2001 with the National Marine Fisheries Service (now NOAA Fisheries) and addressed effects to marbled murrelets from the Puget Sound Area Recreational and All Citizen Fisheries. This covered all non-treaty fisheries in the Puget Sound and Strait of Juan de Fuca in U.S. waters. The second Biological Opinion (Reference # 1-3-04-F-1049) was completed on December 10, 2004, with the Bureau of Indian Affairs, and addressed effects to marbled murrelets of treaty salmon fisheries in the Puget Sound and Strait of Juan de Fuca in U.S. waters. Because these two consultations have already addressed fishing activities described under the Plan, additional consultation is not needed for the Plan.

This concludes informal consultation pursuant to the regulations implementing the Endangered Species Act (50 CFR 402.13). This project should be re-analyzed if new information reveals effects of the action that may affect listed species or critical habitat in a manner, or to an extent, not considered in this consultation. The project should also be re-analyzed if the action is subsequently modified in a manner that causes an effect to a listed species or critical habitat that was not considered in this consultation, and/or a new species is listed or critical habitat is designated that may be affected by this project.

If you have any questions about this letter, please contact Yvonne Dettlaff at (360) 753-9582 or John Grettenberger at (360) 753-6044, of this office.

Sincerely,

John Grettenberger
for

Ken S. Berg, Manager
Western Washington Fish and Wildlife Office

cc:
BIA (Cook)
NWIFC (Seiders)

National Marine Fisheries Service
Endangered Species Act Section 7 Consultation
Biological Opinion and Magnuson-Stevens Act
Essential Fish Habitat Consultation

National Marine Fisheries Service
Endangered Species Act Section 7 Consultation
Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat Consultation

ACTION AGENCIES:	NOAA's National Marine Fisheries Service (NMFS) Bureau of Indian Affairs (BIA) US Fish and Wildlife Service (USFWS)
SPECIES/ESU AFFECTED:	Puget Sound Chinook Salmon
ACTIVITIES CONSIDERED:	The Endangered Species Act (ESA) Section 7 Consultation / Magnuson-Stevens Act Essential Fish Habitat (EFH) Consultation: Puget Sound Comprehensive Chinook Management Plan: Harvest Management Component - ESA section 4(d) Decision / Determination
CONSULTATION BY:	NMFS Northwest Region (NWR) Sustainable Fisheries Division (SFD) Consultation number: 2004/00731

This is NMFS' ESA section 7 consultation and EFH consultation on a proposed Federal action. The proposed Federal action has three components (sub-actions), which the action agencies have chosen to coordinate as a package for these consultations.

The primary Federal sub-action is:

(1) NMFS' proposed determination as to whether a resource management plan (the Puget Sound Comprehensive Chinook Management Plan: Harvest Management Component) adequately addresses the criteria in its salmon and steelhead ESA section 4(d) regulations (50 CFR 223.203) (hereafter referred to as the ESA 4(d) Rule).

Two other Federal sub-actions evaluated in these consultations include:

(2) The proposed BIA funding of Puget Sound tribes' management, enforcement, and monitoring projects in support of the resource management plan; and

(3) the proposed authorization of fisheries by the USFWS, as party to the Hood Canal Salmon Management Plan (Point No Point Treaty Council *et al.* 1986), that are consistent with the implementation of the resource management plan, as approved under the ESA 4(d) Rule.

This Biological Opinion has been prepared in accordance with section 7 of the Endangered Species Act (ESA) of 1973 as amended (16 U.S.C. 1531 *et seq.*) and in compliance with the Data Quality Act (§515 of PL 106-554). It is based on information provided in the resource management plan, NMFS' Evaluation and Recommended Determination document (ERD), comments from reviewers, and other sources representing the best available scientific information. These documents comprise the best available scientific information regarding the effects of the proposed Federal action. A complete administrative record for this consultation is on file with NMFS NWR in Seattle, Washington.

Approved by: D. Robert Lohn

D. Robert Lohn, Regional Administrator

Date: DEC 16 2004

Expiration Date: May 1, 2010

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1.0 ESA Section 7 Consultation - Biological Opinion

This document constitutes NMFS' biological opinion under section 7 of the ESA for the following sub-actions proposed by the NMFS, BIA and the USFWS:

(1) The proposed NMFS determination as to whether a resource management plan satisfies the criteria outlined in the ESA 4(d) Rule;

(2) The proposed BIA funding of Puget Sound tribes' management, enforcement, and monitoring projects in support of the resource management plan as approved under the ESA 4(d) Rule; and

(3) The proposed USFWS authorization of fisheries, as party to the Hood Canal Salmon Management Plan (Point No Point Treaty Council *et al.* 1986), that are consistent with the implementation of the resource management plan as approved under the ESA 4(d) Rule.

NMFS is grouping these three proposed Federal sub-actions in this consultation pursuant to 50 CFR 402.14 (b) because they are similar actions occurring within the same geographical area. The impacts associated the latter two Federal sub-actions are considered fully in the proposed NMFS determination. There would be no other environmental effects associated with the latter two Federal sub-actions that are not contemplated and evaluated in the proposed NMFS determination.

1.1 Introduction

This Biological Opinion considers impacts of the proposed action on Puget Sound chinook salmon listed under the ESA. Other species of listed anadromous salmonids occur in the Pacific Northwest, but for several reasons, summarized below, the proposed Federal actions are not expected to have an effect on these other species.

On March 24, 1999, NMFS listed the Puget Sound chinook salmon (*Oncorhynchus tshawytscha*) Evolutionarily Significant Unit[1] (ESU) as a threatened species under the ESA (64 FR 14308). The Puget Sound Chinook Salmon ESU includes all naturally spawned populations of chinook salmon from rivers and streams flowing into Puget Sound from the Elwha River, eastward. Major river systems within the ESU supporting chinook salmon populations include the Nooksack, Skagit, Stillaguamish, Snohomish, Cedar, Duwamish-Green, White, Puyallup, Nisqually, Skokomish, Mid-Hood Canal, Dungeness, and Elwha Rivers. Chinook salmon (and their progeny) from the following hatchery stocks are also currently listed under the ESA:

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1 An Evolutionarily Significant Unit or "ESU" is a collection of one or more Pacific salmon populations that share similar genetic, ecological, and life history traits but differ in important ways from salmon in other ESUs. Salmon ESUs are considered to be "distinct population segments" under the Federal Endangered Species Act (ESA).

Kendall Creek; North Fork Stillaguamish River; White River; Dungeness River; and Elwha River.

On July 10, 2000, NMFS issued the ESA 4(d) Rule establishing take prohibitions for 14 salmon and steelhead ESUs, including the Puget Sound Chinook Salmon ESU (50 CFR 223.203(b)(6); July 10, 2000, 65 FR 42422). The ESA 4(d) Rule provided limits on the application of the take prohibitions, i.e., take prohibitions would not apply to the plans and activities set out in the rule if those plans and activities met the rule's criteria. One of those limits (Limit 6) applies to joint tribal and state resource management plans.

On March 18, 2004, the Puget Sound Treaty Tribes (PSTT) and the Washington Department of Fish and Wildlife (WDFW) submitted a jointly developed resource management plan to NMFS, Northwest Regional Office. The resource management plan, titled the "Puget Sound Comprehensive Chinook Management Plan: Harvest Management Component," dated March 1, 2004 (hereafter referred to as the RMP), provides the framework within which the tribal and state jurisdictions would jointly manage all salmon and gillnet steelhead fisheries that might impact listed chinook salmon within the greater Puget Sound area. The PSTT and WDFW (jointly hereafter referred to as co-managers) propose that the RMP be in effect for six years, from May 1, 2004, through April 30, 2010.

NMFS published a notice in the *Federal Register* announcing the availability of its Proposed Evaluation and Pending Determination (PEPD) on the RMP for public review and comment on April 15, 2004 (69 FR 19975). The comment period closed on May 17, 2004. Several of the comments were addressed and reflected in NMFS' final Evaluation and Recommended Determination (ERD). The co-managers made no modifications to the RMP based on public comments received on NMFS' PEPD.

1.2 Consultation History

NMFS has considered the effects of Puget Sound salmon fisheries on listed Puget Sound chinook salmon in several other ESA section 7 consultations or ESA 4(d) Rule determinations completed in recent years. These consultations and determinations were:

(1) An April 28, 2000, biological opinion titled "Effects of Pacific Coast Ocean and Puget Sound Salmon Fisheries During the 2000-2001 Annual Regulatory Cycle" that was effective from May 1, 2000 through April 30, 2001.

(2) A biological opinion titled "Endangered Species Act - Reinitiated Section 7 Consultation-Biological Opinion - Approval of the Pacific Salmon Treaty by the U.S. Department of State and Management of the Southeast Alaska Salmon Fisheries Subject to the Pacific Salmon

Treaty." Completed November 18, 1999, this biological opinion is effective through December 31, 2010.

(3) A September 14, 2001, biological opinion titled "Programs Administered by the Bureau of Indian Affairs and Activities Authorized by the U.S. Fish and Wildlife Service Supporting Tribal Salmon Fisheries Affecting Listed Puget Sound chinook and Hood Canal summer-run chum salmon Evolutionarily Significant Units" was effective through April 30, 2003.

(4) The ESA 4(d) Rule determination completed on April 27, 2002, and titled "Joint State Tribal Resource Management Plan Provided by the Washington Department of Fish and Wildlife and the Puget Sound Tribes for Salmon Fisheries Affecting Puget Sound Chinook Salmon Under Limit 6 of the ESA 4(d) Rule - Determination Memorandum". NMFS' ESA 4(d) Rule determination for the subject plan was effective through April 30, 2003.

(5) The ESA 4(d) Rule determination completed on May 19, 2003, and titled "Joint Tribal and State Resource Management Plan (RMP) submitted under Limit 6 of the ESA 4(d) Rule by the Puget Sound Tribes and the Washington Department of Fish and Wildlife for salmon fisheries and steelhead net fisheries affecting Puget Sound chinook salmon - Determination Memorandum". NMFS' ESA 4(d) Rule determination for the subject plan was effective through April 30, 2004.

(6) An April 29, 2004, biological opinion titled "Effects of the Pacific Coast salmon harvest plan and U.S. Fraser Panel fisheries on the Puget Sound chinook and lower Columbia River Chinook Salmon Evolutionarily Significant Units" is effective until revoked.

(7) A June 10, 2004, biological opinion titled "Effects of Programs Administered by the Bureau of Indian Affairs supporting tribal salmon fisheries management in Puget Sound and Puget Sound salmon fishing activities authorized by the U.S. Fish and Wildlife Services during the 2004 fishing season" is effective through April 30, 2005.

On April 27, 2001, NMFS issued a Limit 6 determination under the ESA 4(d) Rule on a resource management plan considering fishery management activities impacting listed Hood Canal summer-run chum salmon, limiting the application of the ESA section 9 take prohibitions for those fisheries operating consistent with the resource management plan (June 12, 2001, 66 FR 31600).

The effects of Puget Sound salmon fisheries on the Snake River fall chinook salmon, Snake River spring/summer chinook salmon, and Snake River sockeye salmon, Sacramento River winter chinook salmon, Southern Oregon/Northern California Coastal coho salmon, Central California Coastal coho salmon, Oregon Coastal natural coho salmon, Central Valley spring-run chinook salmon, California coastal chinook salmon, lower Columbia River chinook salmon, upper Willamette River chinook salmon, upper Columbia River spring chinook salmon, Columbia River chum salmon, Hood Canal summer-run chum salmon, Ozette Lake sockeye salmon, and ten steelhead ESUs have been considered for ESA compliance through completion of other long-term biological opinions or the ESA 4(d) Rule evaluation and determination processes. These ESUs will therefore not be discussed further in this Biological Opinion.

1.3 Description of the Proposed Action

The primary Federal action is NMFS' proposal to issue a determination as to whether the RMP provided by the co-managers adequately addresses the requirements of Limit 6 under the ESA 4(d) Rule. NMFS is including two other proposed Federal actions as sub-actions in this consultation pursuant to 50 CFR 402.14 (b) because all are similar actions within a given geographical area. The duration of NMFS' determination for these Federal actions will extend through April 30, 2010, unless changed during any re-initiation (see Re-initiation of Consultation section, below). The following are the three proposed Federal actions that will be analyzed in this consultation:

(1) NMFS' ESA 4(d) Rule Determination Regarding the RMP:

NMFS proposes to issue a decision that the RMP adequately addresses the requirements of Limit 6 under the ESA 4(d) Rule. As mentioned earlier, a biological opinion issued by NMFS on June 10, 2004, titled "Effects of Programs Administered by the Bureau of Indian Affairs supporting tribal salmon fisheries management in Puget Sound and Puget Sound salmon fishing activities authorized by the U.S. Fish and Wildlife Services during the 2004 fishing season," is effective through April 30, 2005. Therefore, NMFS' evaluation and determination of the RMP under the ESA 4(d) Rule will address only from May 1, 2005 through April 30, 2010 of the proposed duration of the RMP.

The RMP does not include the specific details of the annual fishing regime, i.e., where and when fisheries occur; what gear will be used; or how harvest is allocated among gear, areas, or fishermen. However, the RMP does provide the management objectives against which the co-managers will develop their action-specific fishing regimes to protect listed Puget Sound chinook salmon. Therefore, NMFS anticipates evaluating each year's proposed fishery management for consistency with the RMP's objectives, after cooperative discussion with the co-managers.

Management objectives specified in the RMP account for fisheries-related mortality throughout the migratory range of Puget Sound chinook salmon, from Oregon to Southeast Alaska. The RMP implements limits to the cumulative directed and incidental fishery-related mortality to each population or management unit included within the listed Puget Sound Chinook Salmon ESU. The RMP's limits on the cumulative fishery-related mortality are expressed as: a rebuilding exploitation rate; an upper management threshold; a low abundance threshold; and a critical exploitation rate ceiling (see Table 2 in the ERD document). The following is a brief description of these RMP limits:

Rebuilding Exploitation Rate: The RMP's rebuilding exploitation rates are outlined in Table 2 in the ERD document. The co-managers define exploitation rate as the "[t]otal mortality in a fishery or aggregate of fisheries expressed as the proportion of the sum of total mortality plus escapement" (page 63 of the RMP). The co-managers propose that the RMP's rebuilding exploitation rate for the individual management units would improve the viability status of the population or populations within that management unit. The co-managers' intent is to manage fisheries such that harvest rates remain below each management unit's rebuilding exploitation rate (page 13 of the RMP). The co-managers used several methods to derive the RMP's rebuilding exploitation rates, which are explained in more detail within the RMP.

NMFS also established rebuilding exploitation rates for nine individual populations within the ESU and for the Nooksack Management Unit, which is discussed in more detail in the ERD. For individual populations, NMFS has determined that exploitation rates at or below NMFS-derived rebuilding exploitation rates will not appreciably reduce the likelihood of rebuilding that population, assuming current environmental conditions and based on specific risk criteria. The method used by NMFS to derive the rebuilding exploitation rates is described in a document titled "Viable Risk Assessment Procedure" (NMFS 2000a).

The NMFS-derived rebuilding exploitation rates are not the same as the RMP's rebuilding exploitation rates. The co-managers' rebuilding exploitation rates are management-unit-based. Some of the RMP's rebuilding exploitation rates are based on the same risk criteria as those used by NMFS, but other rebuilding exploitation rates proposed in the RMP are based on observed minimum exploitation rates or on harvest ceilings set by the Pacific Salmon Treaty. In addition, NMFS-derived rebuilding exploitation rates are designed to include all fishery-related mortality throughout the migratory range of Puget Sound chinook salmon. The RMP's rebuilding exploitation rates define allowable harvest rates for either total, southern United States (SUS) fisheries, or for pre-terminal southern United States (PT SUS) fisheries only. The RMP's rebuilding exploitation rates may therefore not be directly comparable to NMFS-derived rebuilding exploitation rates.

The SUS fishery is defined in the RMP as all fisheries occurring south of the border with Canada that may harvest listed Puget Sound chinook salmon. In addition to chinook salmon taken within the grater Puget Sound area, chinook salmon harvests encompassed within SUS fisheries would also include listed chinook salmon that may be taken in fisheries off the coast of Washington, Oregon, and northern California. The SUS fishery includes both pre-terminal and terminal area SUS fisheries. The co-managers define a pre-terminal fishery as a "fishery that harvests significant numbers of fish from more than one region of origin" (page 65 of the RMP). The co-managers define a terminal fishery as a "fishery, usually operating in an area adjacent to or in the mouth of a river, which harvests primarily fish from the local region of origin, but may include more than one management unit. Non-local stocks may be present, particularly in marine terminal areas" (page 65 of the RMP). The terminal SUS fisheries will vary by management unit and may occur in freshwater and marine areas.

Calculating a rebuilding exploitation rate ideally requires knowledge of a spawner-recruit relationship based on escapement, age composition, coded-wire tag distribution, environmental parameters, and an estimate of management error (N. Sands, NMFS, Northwest Fisheries Science Center (NWFSC), pers. com., to K. Schultz, NMFS, March 5, 2003). These types of data are available for several management units. The co-managers calculated rebuilding exploitation rates using this method for the Skagit Summer/Fall, Skagit Spring, Stillaguamish, and Snohomish chinook salmon Management Units.

The co-managers' expectations are that application of the RMP's rebuilding exploitation rates will: (1) result in escapement levels that are less than the point of instability[2] no more than five percent more often than if no harvest had occurred over 25 to 40 years[3]; *and* (2) lead to a high (at least 80 percent) probability that spawning escapements will increase in 25 or 40 years to a specified (upper) threshold, *or* that the percentage of escapements less than the RMP's low abundance threshold at the end of 25 or 40 years will differ from a no-harvest regime by less than 10 percent (pages 13 and 14 of the RMP). Appendix A: Management Unit Status Profiles of the RMP provides details on the methods the co-managers used to develop the RMP's rebuilding exploitation rates, which are based on a spawner-recruit relationship, where data were available.

The data required to calculate a spawner-recruit relationship is not yet available for most Puget Sound chinook salmon populations. For the Lake Washington, Skokomish, and Mid-Hood Canal Management Units, the co-managers generally established the RMP's rebuilding exploitation rate at the lowest level of exploitation rates observed in the late 1990s (approximately 15 percent pre-terminal SUS). Overall, implementation of these lower exploitation rate levels by the co-

2 The co-managers define the point of instability as "that level of population abundance (i.e., spawning escapement) that incurs substantial risk to genetic integrity, or exposes the stock to depensatory mortality factors" (page 65 of the RMP).

3 Based on co-manager's expertise and explained in more detail in Appendix A: Management Unit Status Profiles of the RMP. The RMP uses a 25-year projection for the Stillaguamish and Snohomish Management Units in development of the proposed rebuilding exploitation rate. The co-managers used a 40-year projection for the Skagit Summer/Fall and Skagit Spring Management Units.

managers has contributed to stable to increasing spawning escapement trends for populations within these management units.

Impacts associated with terminal fisheries would not be included in the pre-terminal SUS exploitation rate limits set for some Management Units. In response, and similar to recent years, the co-managers propose that terminal area fisheries in the Lake Washington and Mid-Hood Canal Management Units be limited by maximum allowable exploitation rates of less than 5 percent. Under the implementation of the RMP, the Skokomish chinook Management Unit's terminal area fisheries would be managed for an escapement objective. The achievement of the Skokomish Management Unit's chinook salmon escapement objective would dictate the maximum allowable terminal area exploitation rate in a given year.

Terminal area fishery impacts are very low or non-existent for the Dungeness, Elwha, and Western Strait of Juan de Fuca chinook Management Units. Under the proposed RMP, a rebuilding exploitation rate of 10 percent for SUS fisheries would be applied for these three management units. The SUS fisheries limited by the 10 percent rate would include both pre-terminal and terminal area SUS fisheries. Thus, impacts associated with Alaska or Canadian fisheries would not be included in this SUS fishery exploitation rate limitation.

Upper Management Threshold: Table 2 in the ERD document outlines the RMP's upper management thresholds. The co-managers define the upper management threshold as the "escapement level associated with optimum productivity (i.e. maximum sustainable harvest...)" (page 12 of the RMP). The co-managers calculated the RMP's upper management threshold assuming current habitat conditions (page 13 of the RMP). The upper management thresholds proposed in the RMP equate to upper escapement thresholds and defined as targets by the co-managers for each management unit.

The RMP's annual management strategy depends on whether a harvestable surplus is forecast. A management unit is considered to have a harvestable surplus if the spawning escapement is expected to exceed its upper management threshold (page 12 of the RMP). The RMP prohibits directed harvest on listed populations of Puget Sound chinook salmon unless they are shown to have a harvestable surplus. In other words, if a management unit does not have a harvestable surplus, then all harvest-related mortality on chinook salmon in SUS fisheries would be limited to incidental impacts only (page 32 of the RMP).

With an exception, the RMP states that the "projected exploitation rate for management units with no harvestable surplus [and above their lower abundance threshold] would not be allowed to exceed their rebuilding exploitation rate ceiling" (page 33 of the RMP). The exception to this limit is associated with the chinook salmon harvest in Canadian fisheries, which were approved under the Pacific Salmon Treaty. For those management units affected by Canadian fisheries, in some years the RMP's critical exploitation rate ceiling, rather than the rebuilding exploitation rate ceiling, may be applied as the restraining limit on Puget Sound fisheries. In such instances, the total exploitation rate in that year would exceed the RMP's rebuilding exploitation rate (see discussion of the RMP's critical exploitation rate ceiling below).

The technical basis for the RMP's establishment of upper management thresholds varies among management units (see footnotes on Table 12, page 43 of the RMP). For populations with sufficient information, the co-managers derived upper management thresholds using such methods as standard spawner-recruit calculations (Ricker 1975), empirical observations of relative escapement levels and catches, or Monte Carlo simulations that buffer for error and variability (Hayman 2003). The methods selected for use in deriving thresholds for each management unit are described in Appendix A: Management Unit Status Profiles of the RMP.

Low Abundance Threshold: Table 2 in the ERD document presents the RMP's proposed low abundance thresholds. The co-managers define the low abundance threshold as a "spawning escapement level, set intentionally above the point of biological instability, which triggers extraordinary fisheries conservation measures to minimize fishery related impacts and increase spawning escapement" (page 63 of the RMP).

For specific application in managing fisheries affecting each management unit, the co-managers further defined the low abundance threshold as either: (1) the lowest escapement with a greater than one return per spawner ratio; (2) the forecasted escapement for which there is an "acceptably low" probability that the observed escapement will be below the point of instability (page 15 of the RMP); or (3) in cases where specific data were lacking, the co-managers "derived the RMP's low abundance threshold "in accordance with scientific literature [such as the generic guidelines found in the Viable Salmonid Populations (VSP) paper (NMFS 2000b) or more subjectively, at an annual escapement of 200 to 1,000 fish" (page 15 in the RMP). The method chosen by the co-managers depended on the quality and quantity of population-specific data available (see Appendix A: Management Unit Status Profiles of the RMP).

Critical Exploitation Rate Ceiling: The co-managers established a critical exploitation rate ceiling for all management units with a low abundance threshold (see Table 2 in the ERD document). For most management units, the RMP's critical exploitation rate ceiling imposes an upper limit on SUS exploitation rates when spawning escapement for a management unit is projected to fall below its low abundance threshold, *or* if impacts in Canadian fisheries make it difficult or impossible to achieve the RMP's rebuilding exploitation rate. The RMP's rebuilding exploitation rate, the upper management threshold, and the low abundance threshold discussed above are primarily biologically-driven objectives. The RMP's proposed critical exploitation rate ceilings are primarily driven by policy considerations.

The co-managers propose that the critical exploitation rate ceiling, when imposed on SUS fisheries, would result "in a significant reduction in incidental impacts on listed chinook salmon," while providing "minimally acceptable access" to non-listed salmon species, including non-listed hatchery chinook salmon, for which harvestable surpluses have been identified (page 15 of the RMP). A general description of these minimal fisheries, as proposed by the co-managers, is outlined in Appendix C: Minimum Fisheries Regime of the RMP.

For the majority of the management units, the RMP's critical exploitation rate ceilings are defined as an exploitation rate ceiling for the all SUS fisheries. For the Lake Washington, Green, Puyallup, Nisqually, Mid-Hood Canal and Skokomish Management Units, the RMP's critical exploitation rate ceiling applies only to pre-terminal area SUS fisheries. For these units, the co-managers outline additional terminal area fishery management conservation measures that may be considered (Appendix A: Management Unit Status Profiles and Appendix C: Minimum Fisheries Regime of the RMP).

The RMP's critical exploitation rate ceilings were established by the co-managers after policy consideration of "recent fisheries regimes that responded to critical status for some management units" (page 17 of the RMP). The co-managers' position is that if further resource protection is necessary, it must be found by reducing exploitation rates in mixed-stock fisheries in Alaska and Canada, improving habitat conditions, and/or providing hatchery supplementation where necessary and appropriate (page 16 of the RMP). However, where analysis can demonstrate that additional conservation measures in fisheries would contribute substantially to recovery of a management unit, the co-managers may, at their discretion, and in concert with other specific habitat and enhancement actions, implement them (page 34 of the RMP).

Harvest in some coastal fisheries in British Columbia, Canada, has increased recently, approaching the limits agreed to by the United States under Annex IV, Chapter 3, of the Pacific Salmon Treaty. Increased impacts on Puget Sound chinook salmon associated with Canadian fisheries may contribute to total exploitation rates that exceed the proposed RMP's rebuilding exploitation rate. During preseason planning, if the total exploitation rate for a management unit is projected to exceed the RMP's rebuilding exploitation rate for a given management unit, the co-managers propose to constrain their fisheries such that either the RMP's rebuilding exploitation rate is not exceeded *or* the RMP's critical exploitation rate ceiling is not exceeded. The RMP's critical exploitation rate ceiling, in this circumstance, would constrain SUS fisheries to the same degree as if the abundance were below the low abundance threshold (page 35 of the RMP). Modeling exercises by the co-managers demonstrate the potential for the total exploitation rate to exceed the RMP's rebuilding exploitation rate in several management units with the proposed duration of the RMP.

The co-managers, independently and jointly, conduct a variety of research and monitoring programs. The RMP includes implementation, monitoring, and evaluation procedures designed to ensure fisheries are consistent with the RMP's management objectives. Chapter 7 of the RMP describes these procedures, which assess the effectiveness of the management actions in achieving the RMP management objectives. These programs also assess the validity of the assumptions used to derive management objectives. Information collected through these activities will be used in conjunction with proposed fisheries performance indicators to assess the effectiveness of the RMP in meeting its stated objectives.

(2) BIA Funding of Tribal Management, Enforcement, and Monitoring Projects:

The BIA proposes to fund Puget Sound tribes' management, enforcement, and monitoring projects in support of the RMP. Only project funding that may impact listed Puget Sound chinook salmon through April 30, 2010, is considered in this consultation. The co-managers manage Puget Sound fisheries pursuant to the Puget Sound Salmon Management Plan (PSSMP), which establishes guidelines for management of all marine and freshwater salmon fisheries from the Strait of Juan de Fuca eastward. The PSSMP was adopted by court order as a sub-proceeding related to *U.S. v. Washington* Civ. No. C70-9213 (W.D. Wash.) (see 384 F. Supp. 312 (W.D. Wash. 1974)). Puget Sound fisheries harvest all five salmon species. The BIA provides funding to the Puget Sound tribes to support the salmon fishery management programs conducted under the PSSMP. Because the programs that would be funded by the BIA are described in the RMP, NMFS' analysis of the RMP already considers the effects of the proposed funding by the BIA.

(3) USFWS Authorization of Fisheries Proposed in the RMP:

The USFWS proposes to authorize fisheries that are consistent with the implementation of the RMP, as approved under the ESA 4(d) Rule. Only fisheries that may impact listed Puget Sound chinook salmon through April 30, 2010, are considered in this consultation. The USFWS, the State of Washington, and the treaty tribes within the Hood Canal, are parties to the Hood Canal Salmon Management Plan (HCSMP). The HCSMP is a regional management plan, which stipulates orders related to the PSSMP. All salmon species originating in Hood Canal, including listed chinook salmon, are managed under the HCSMP. Any change in management objectives under the HCSMP requires authorization by the USFWS, as a party to the plan. Because USFWS would consider for authorization only those fisheries consistent with the RMP, the analysis of the RMP includes and fully represents effects of the USFWS action under the HCSMP.

Each of these three actions requires consultation with NMFS because the Federal agency (NMFS, BIA, or USFWS) is funding or authorizing actions that may adversely affect listed salmon (section 7(a)(2) of the ESA).

1.4 Action Area

The action area for this Biological Opinion (referred hereafter as the Puget Sound Action Area) encompasses the area included in the Puget Sound Chinook Salmon ESU, as well as the western portion of the Strait of Juan de Fuca within the United States (see Figure 1 in the ERD).

1.5 Status of the Species and Critical Habitat

Species Affected**:** With respect to salmonids, only impacts on listed Puget Sound chinook salmon are addressed in this Biological Opinion. However, leatherback sea turtles (*Dermochelys coriacea*), Steller sea lions (*Eumetopias jubatus*), and humpback whales (*Megaptera novaeangliae*) are also listed under the ESA under NMFS' jurisdiction, and these species may occur in Puget Sound. Leatherback sea turtles use of inland Washington waters is accidental at best; and therefore, this species is unlikely to interact with Puget Sound salmon fisheries (B. Norberg, NMFS, per. comm. with S. Bishop, NMFS, May 6, 2004). The Marine Mammal Protection Act of 1972 (MMPA) requires all commercial fisheries to be placed in one of three categories, based on the relative frequency of incidental serious injuries and mortalities of marine mammals in each fishery. Every year, NMFS reviews and revises its list of fisheries based on new information. These categories are:

(1) Category I designates fisheries with frequent serious marine mammal injuries and mortalities incidental to commercial fishing;

(2) Category II designates fisheries with occasional serious marine mammal injuries and mortalities; and

(3) Category III designates fisheries with a remote likelihood or no known serious marine mammal injuries or mortalities.

For 2003, only the Washington Puget Sound salmon drift gillnet fishery has been designated by NMFS as a Category II fisheries (68 FR 41725, July 15, 2003). All other Puget Sound salmon fisheries were identified as meeting the Category III designation. No ESA-listed marine mammal species were documented to have been killed or caught and released in any salmon fishery in Puget Sound (68 FR 1414, January 10, 2003). Therefore, because these fisheries are not likely to adversely affect ESA-listed marine mammals, effects on listed marine mammals will not be discussed further in this Biological Opinion.

Current Status**:** For the reasons stated above, the remainder of this Biological Opinion will be restricted to addressing the effects of the proposed Federal actions on Puget Sound chinook salmon.

On March 24, 1999, NMFS listed Puget Sound chinook salmon, both naturally-produced and selected artificially propagated populations, as a threatened species (64 FR 14308, March 24, 1999). The ESU encompasses all naturally spawned populations of chinook salmon from rivers and streams flowing into Puget Sound, including the Straits of Juan de Fuca from the Elwha River eastward, and rivers and streams flowing into Hood Canal, South Sound, North Sound, and the Strait of Georgia in Washington. NMFS also listed chinook salmon and their progeny from the following hatchery stocks because they were considered essential to the recovery of the ESU: Kendall Creek; North Fork Stillaguamish River; White River; Dungeness River; and Elwha River.

Since the 1999 listing, NMFS has conducted a series of reviews of the status of West Coast populations of Pacific salmon and steelhead with respect to the ESA (West Coast Salmon Biological Review Team 2003). This ESU status review updates were undertaken to allow consideration of new data that accumulated over the various time periods since the last updates and to address issues raised in recent court cases regarding the ESA status of hatchery fish and resident (non-anadromous) populations. By statute, ESA listing determinations must take into consideration not only the best scientific information available, but also those efforts being made to protect the species. As in the past, the Biological Review Team (BRT) used a risk-matrix method to quantify risks in different categories within each ESU. In the current review, the method was modified to reflect the four major criteria identified in the VSP document (McElhany *et al.* 2000): abundance, growth rate/productivity, spatial structure, and diversity. Based on the criterion of self-sustainability, the majority BRT conclusion was that the Puget Sound Chinook Salmon ESU was “likely to become endangered in the foreseeable future.” The current status of the Puget Sound Chinook Salmon ESU is threatened. The term threatened species is defined as “any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.”

Abundance and Distribution: The March 24, 1999 (64 FR 14308) listing determination and supporting species status reviews (NMFS 1998a; NMFS 1998b), along with subsequent status reviews (West Coast Salmon Biological Review Team 2003), provides relevant and recent information regarding the ESU’s distribution, trend, and status. As reported by NMFS (1998b), based on the estimated total Puget Sound commercial catch extrapolated from cannery pack statistics in 1908 (when both ocean harvest and hatchery production were negligible), Bledsoe *et al.* (1989) proposed an historical abundance of 670,000 chinook salmon in this ESU. This estimate of historical Puget Sound chinook salmon population size should be viewed cautiously. The statistic on which this estimate is based, the 1908 Puget Sound cannery pack, probably included an unknown proportion of fish landed at Puget Sound ports that originated from areas outside of Puget Sound. It is also likely that the cannery pack that year represented only a portion of the total catch.

The Puget Sound Technical Recovery Team (TRT) has completed a preliminary analysis of the population structure of chinook salmon within the Puget Sound Chinook Salmon ESU. The TRT is an independent scientific body convened by NMFS to develop technical delisting criteria and guidance for salmon recovery planning in Puget Sound.

The proposed RMP's delineation of populations within the ESU is the same as those preliminarily recognized by the Puget Sound TRT. The TRT reviewed several sources of information in deriving the preliminarily recognized delineations. These sources of information include geography, migration rates, genetic attributes, patterns of life history and phenotypic characteristics, population dynamics, and environmental and habitat characteristics of potential populations (NMFS 2004b). The TRT has identified 22 demographically independent populations within the ESU, representing the primary historical spawning areas of chinook salmon (PSTRT 2003). Recent year annual escapement estimates for chinook populations within the ESU are provided in Table 6 of the ERD document.

To assist in analyzing the impacts of the co-managers' proposed fisheries management actions, the RMP categorizes each chinook salmon population according to the population's life history and production characteristics. The co-managers used this method to assign populations to one of three possible watershed based categories:

Category 1 - Category 1 watersheds are areas where populations are genetically unique and indigenous to Puget Sound. Maintaining genetic diversity and integrity, and achieving abundance levels for long-term sustainability are the highest priorities for these populations. The management objective for Category 1 populations is to protect and recover these indigenous populations. The intent is to rebuild and manage for natural production. The co-managers propose to manage fisheries to meet interim escapement goals and/or the rebuilding exploitation rates for Category 1 populations based on the co-managers' understanding of natural chinook salmon production requirements for each population. The co-managers designated 17 of the 22 populations within the ESU as Category 1 (see Table 7 in the ERD document).

The status of Category 1 populations within the ESU varies. Some populations have fallen to such low levels that the ability to maintain their genetic diversity may be at risk. In some cases, lacking hatchery operations, populations would likely decline to very low levels or go extinct. In one case at least, the number of hatchery-origin fish spawning naturally may be a concern, in part because it may be masking the ability to evaluate the actual productivity of the natural-origin population. Other populations are more robust and the abundance levels are above what is needed to sustain genetic diversity, but often not at levels that will sustain maximum yield.

Category 2 - Category 2 watersheds are areas where indigenous populations are believed to no longer exist, but where sustainable wild populations existed historically. The co-managers believe that self-sustaining natural production is possible in Category 2 watersheds given suitable or productive habitat. Five Category 2 populations within the ESU have been identified by the co-managers (see Table 7 in the ERD document).

Category 2 populations are primarily found in southern Puget Sound and Hood Canal where hatchery production has been used extensively to mitigate for natural production lost to habitat degradation. Historically, these areas were managed for hatchery production. Consequently, in many of these systems, hatchery and natural fish are currently indistinguishable on the spawning grounds. In the future, on-going mass marking programs implemented at regional hatcheries will provide a means to distinguish between hatchery-origin and natural-origin adult chinook salmon upon return to their watersheds of origin. Given degraded habitat conditions within these watersheds, the co-managers' goal of harvest management is to provide sufficient escapement to the spawning grounds to increase natural productivity. Future decisions regarding the form and timing of recovery efforts in these watersheds will dictate the kinds of harvest actions that may be necessary and appropriate.

The co-managers have assigned populations to Category 2 based on current information. Ongoing monitoring and studies may identify remnant indigenous populations, which if found, may cause the population to be reassigned to Category 1. Decisions by the TRT about roles of these populations in the ESU may also require the populations to be re-categorized. The RMP includes monitoring and evaluation elements that will assist the TRT in these decisions. Additionally, the co-managers recognize that there is ongoing work by the TRT and other resource agencies or organizations that may also affect future harvest actions.

Category 3 - Category 3 watersheds are where populations are generally found in small tributaries that may now have some natural spawning, but never historically had independent, self-sustaining populations of chinook salmon. Consistent with the TRT guidance, these small tributary spawning aggregations characteristic of Category 3 watersheds do not meet criteria necessary for the aggregations to be identified as independent populations. Several Category 3 watersheds were identified in the 2001 RMP (PSIT and WDFW 2001). However, similar to the 2003 RMP (PSIT and WDFW 2003), the proposed RMP evaluated in this Biological Opinion does not identify or establish management objectives for any Category 3 watersheds. Instead, this RMP focuses on management of populations in Category 1 and Category 2 watersheds. These watersheds harbor all of the 22 chinook salmon independent populations delineated as extant by the Puget Sound TRT

Chinook salmon population escapement trends were also considered by NMFS in evaluating and determining the extinction risk status of the Puget Sound Chinook Salmon ESU. Declining escapement trends for most chinook salmon populations in the region helped lead NMFS to list the ESU as a threatened species in March, 1999. A general post-listing assessment of each population's escapement trend as either decreasing, remaining stable or increasing since the time of listing can be made by comparing the 1999 to 2002 average escapement with the 1990 to 1998 average escapement (see Table 8 in the ERD document). The following system was used to determine the trend of the populations:

Increasing - The trend of a population was considered increasing if the difference in the 1999 to 2002 average escapement was greater then 10 percent above the pre-listing 1990 to 1998 average escapement;

Decreasing - The trend of a population was considered decreasing if the difference in the 1999 to 2002 average escapement was less then 10 percent below the pre-listing 1990 to 1998 average escapement; and

Stable - The trend of a population was considered stable if the difference in the 1999 to 2002 average escapement was within 10 percent of the pre-listing 1990 to 1998 average escapement.

Based on criteria described above, all populations were determined to have a stable (six populations) to increasing (16 populations) trend in escapement (see Table 9 in the ERD document.

1.6 Environmental Baseline

Environmental baselines for biological opinions are defined by regulation at 50 CFR 402.02, which states that an environmental baseline is the physical result of all past and present state, Federal, and private activities in the action area along with the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early consultation under section 7 of the ESA. The environmental baseline for this Biological Opinion is therefore the result of the impacts that many activities (summarized below) have had on the likelihood for the survival and recovery of Puget Sound chinook salmon.

In general, a wide variety of factors have contributed to the decline of chinook salmon populations in the Puget Sound area. In some cases, activities identified at the time of listing as factors for decline have received increasing attention, and their effects are being reduced. However, the most pervasive risks to improved status of listed salmon require long and difficult efforts to correct, and many actions geared towards reducing likelihood of extinction still require relatively long periods of time for their positive effects to become noticeable.

Human-Induced Habitat Degradation: Although some types of fishing gear used in the marine environment, such as bottom trawls, are known to have habitat impacts, these gears are not used in the salmon fisheries considered here. Bishop and Morgan (1996), identified a variety of habitat issues for streams in the range of this ESU resulting from urbanization, forest, and agricultural practices including (1) changes in flow regime (all basins), (2) sedimentation (all basins), (3) high temperatures (Dungeness, Elwha, Green/Duwamish, Skagit, Snohomish, and Stillaguamish Rivers), (4) streambed instability (most basins), (5) estuarine loss (most basins), (6) loss of large woody debris (Elwha, Snohomish, and White Rivers), (7) loss of pool habitat (Nooksack, Snohomish, and Stillaguamish Rivers), and (8) blockage or passage problems associated with dams or other structures (Cedar, Elwha, Green/Duwamish, Snohomish, and White Rivers). The above activities and habitat modifications have greatly degraded extensive areas of salmon spawning and rearing habitat in the Puget Sound.

NMFS has not completely analyzed the role of habitat loss and degradation in contributing to the decline of Puget Sound salmon, and how recovery of the ESU might benefit from any proposed protective or restoration strategies. Specifically, NMFS is unable at this time to quantify improvements in salmon survival productivity that should result from improvements in habitat conditions. It is reasonable to expect, however, that improvements in land management on state, Federal, and private land within the Puget Sound will result in improved overall survival for listed chinook salmon considered in this Biological Opinion.

Hatcheries: Fall-, summer-, and spring-run chinook salmon stocks are artificially propagated through 42 programs in Puget Sound. Currently, the majority of chinook salmon hatchery programs produce fall-run (also called summer/fall) stocks for fisheries harvest augmentation purposes. Captive broodstock and supplementation programs implemented as conservation measures to recover early returning chinook salmon operate in the White River (Appleby and Keown 1994) and the Dungeness River watersheds (Smith and Sele 1995). Conservation-directed supplementation programs currently exist for spring-run chinook salmon on North Fork Nooksack River and for summer-run chinook salmon on the North Fork Stillaguamish and Elwha Rivers (Fuss and Ashbrook 1995; NMFS 1998a).

Hatchery-origin fish may potentially pose risks to naturally-produced salmon and steelhead in four primary ways: (1) ecological effects, (2) genetic effects, (3) harvest effects, and (4) masking effects (NMFS 2000c). Ecologically, hatchery fish can prey upon, displace, and compete with wild fish for food and rearing space as juveniles. These risks to natural-origin fish may be highest in freshwater areas after the hatchery-origin juvenile fish are released. The risk of effects on the natural-origin fish likely diminish as the hatchery fish disperse seaward downstream. If carrying fish disease pathogens, released hatchery fish may transmit those pathogens to natural-origin fish when the fish intermingle in natural areas. If present in the hatchery, fish disease pathogens may also be transmitted to natural-origin fish rearing downstream of hatcheries in hatchery effluent. Hatchery fish can potentially affect the genetic composition of native fish that are genetically dissimilar by interbreeding with them.

There is currently a shift occurring in hatchery management from augmenting harvest to restoring, maintaining and conserving natural populations of anadromous salmonids (NMFS 2002b). Within the last decade, hatchery programs have responded to the ESA listings and the continuing declines in natural populations by shifting to conservation programs (Flagg and Nash 1999). The goals of conservation programs are to restore and maintain natural populations. The change to conservation-type hatchery programs has followed a general call for hatchery reform within the Pacific Northwest. The changes proposed are to ensure that existing natural salmonid populations are preserved, and that hatchery-induced genetic and ecological effects on natural populations are minimized.

Hatchery programs in the Pacific Northwest are in the process of phasing out use of dissimilar broodstocks, such as out-of-basin or out-of-ESU stocks, replacing them with fish derived from, or more compatible with, locally adapted populations. Producing fish that are better suited for survival in the wild is now an explicit objective of many salmon hatchery programs. Hatchery programs are also incorporating improved production techniques, such as NATURES-type rearing protocols[4] and limits on the duration of conservation hatchery programs.

Harvest: In the past, fisheries in Puget Sound were generally not managed in a manner appropriate for the conservation of naturally spawning chinook salmon populations. Fisheries exploitation rates were in most cases too high in light of the declining productivity of natural chinook salmon stocks. Additionally, high exploitation rates directed at hatchery stocks caused many natural stocks to fail to meet natural escapement goals in some years.

The co-managers implemented several strategies to manage fisheries to reduce harvest impacts in recent years and to implement harvest objectives that are consistent with the underlying production of the natural population. Time and area closures are implemented to reduce catches of weak stocks and to reduce chinook by-catch in other fisheries. Other regulations, such as size limits, bag limits, and requirements for the use of barbless hooks in all recreational fisheries are also used.

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4 A fundamental assumption is that improved rearing technology will reduce environmentally induced physiological and behavioral deficiencies presently associated with cultured salmonids. Enriched (NATURES) rearing environments hold promise for improving hatchery rearing technology. NATURES-type rearing protocols includes a combination of underwater feed-delivery systems, submerged structure, overhead shade cover, and gravel substrates, which have been demonstrated in most studies to improve instream survival of chinook salmon (*O. tshawytscha*) smolts during seaward migrations.

Natural Conditions: The declines in fish populations in Puget Sound in the 1980s and into the 1990s may reflect broad-scale shifts in natural limiting conditions, such as increased predator abundances and decreased food resources in ocean rearing areas. NMFS has noted that predation by marine mammals has increased as marine mammal numbers, especially harbor seals (*Phoca vitulina*) and California sea lions (*Zalophus californianus*) increase on the Pacific Coast (NMFS 1998a). In addition to predation by marine mammals, Fresh (1997) reported that 33 fish species and 13 bird species are predators of juvenile and adult salmon, particularly during freshwater rearing and migration stages.

Changes in climate and ocean conditions happen on several different time scales and have had a profound influence on distributions and abundances of marine and anadromous fishes. Recent evidence suggests that marine survival among salmonids fluctuates in response to 20- to 30-year cycles of climatic conditions and ocean productivity. Although recent climatic conditions appear to be within the range of historical conditions, the risks associated with climatic changes are probably exacerbated by human activities (Lawson 1993).

Scientific Research: Puget Sound chinook salmon, like other ESA-listed fish, are the subject of scientific research and monitoring activities. Most biological opinions issued by NMFS have conditions requiring specific monitoring, evaluation, and research projects to gather information to aid the preservation and recovery of listed fish.

The impacts of these research activities pose both benefits and risks to the listed species. In the short-term, a limited number of fish are harassed and even killed in the course of scientific research; however, these activities have a great potential to benefit to ESA-listed species in the long-term. Most importantly, the information gained during research and monitoring activities will assist in planning for the recovery of listed species.

1.7 Effects of the Proposed Action

In its biological opinions, NMFS analyzes the effects of proposed Federal actions, as defined in 50 CFR 402.02, to determine whether the actions are likely to jeopardize the continued existence of the affected listed ESUs or result in the destruction or adverse modification of designated critical habitat. NMFS considers the estimated level of injury or mortality attributable to the collective effects of the action and any cumulative effects and then determines the impact on species abundance and distribution. NMFS also evaluates whether the action directly or indirectly is likely to destroy or adversely modify designated critical habitat for listed species.

The co-managers, in cooperation with NMFS, have modeled the anticipated impacts of the implementation of the RMP. Table 3 in the ERD document indicates the anticipated range of exploitation rates and anticipated escapements for Puget Sound chinook salmon over the duration of the RMP implementation period. Two variables were used in the modeling the effects of future fisheries to provide these anticipated ranges of exploitation rates and anticipated escapements. These variables were abundance of returning salmon and impacts associated with Canadian fisheries. These variables are discussed in more detail in the ERD.

No critical habitat is designated for the Puget Sound Chinook Salmon ESU. Therefore, the proposed Federal sub-actions will not directly or indirectly destroy or adversely modify this ESU's critical habitat. However, in the absence of designated critical habitat for Puget Sound chinook salmon, it is still pertinent to evaluate the effects of the proposed action on the listed species' habitat to determine whether those actions are likely to jeopardize the species' continued existence. As described in the attached NMFS' Magnuson-Stevens Fishery Conservation and Management Act essential fish habitat consultation, fisheries consistent with the RMP are not expected to adversely affect EFH for Pacific salmon.

1.8 Cumulative Effects

Cumulative effects, defined in 50 CFR 402, include the effects of future state, tribal, local, or private actions not involving Federal activities that are reasonably certain to occur within the action area of the Federal action subject to this consultation. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA. Non-Federal actions that require authorization under other sections of the ESA, and not included here, will be considered in separate section 7 consultations. Non-Federal actions such as actions taken by state, tribal and local governments will likely to be in the form of legislation, administrative rules or policy initiatives. Government and private actions may include changes in land and water uses, including ownership and intensity, any of which could impact listed species or their habitat. Government actions are subject to political, legislative and fiscal uncertainties. These realities, added to the geographic scope of the action area which encompasses numerous government entities exercising various authorities and the many private landholdings, make any analysis of cumulative effects difficult and speculative.

Representative State Actions - The Washington state government is cooperating with other governments to increase environmental protection for listed salmon ESUs through development and implementation of habitat restoration, hatchery and harvest reform, and water resource management actions. The following list of major efforts and programs, described in the Summer Chum Salmon Conservation Initiative (WDFW and PNPTC 2000), are directed at or are contributing to the recovery of Puget Sound chinook salmon:

- Washington Wildlife and Recreation Program
- Wild Stock Restoration Initiative

- Joint Wild Salmonid Policy
- Hood Canal Coordinating Council
- Governor's Salmon Recovery Office
- Conservation Commission Watershed Limiting Factors Analyses
- Salmon Recovery Lead Entities
- Salmon Recovery Funding Board
- Forest and Fish Report
- Growth Management Act

There are other proposals, rules, policies, initiatives, and government processes that help conserve marine resources in the Puget Sound, improve the habitat of listed species, and assist in recovery planning. As with the above state initiatives, these programs could benefit the listed species if implemented and sustained.

In the past, Washington State's economy was heavily dependent on natural resources, with intense resource extraction activity. Changes have occurred in the last decade, and the region is likely to continue with less large scale resource extraction, more targeted extraction methods, and substantial growth in other economic sectors. Growth in new businesses is creating urbanization pressures and has contributed to population growth and movement in the Puget Sound area, a trend likely to continue for the next few decades. Such trends will place greater demands in the action area for electricity, water and build-able land; will affect water quality directly and indirectly; and will increase the need for transportation, communication and other infrastructure development. These impacts will affect habitat features, such as water quality and quantity, which are important to the survival and recovery of the listed species. The overall effect on listed salmon survival and productivity is likely to be negative, unless carefully planned for and mitigated through the initiatives and measures described above.

Local Actions: Local governments will be faced with similar but more direct pressures from population increases and attendant activities. There will be demands for intensified development in rural areas as well as increased demands for water, municipal infrastructure and other resources. The reaction of local governments to such pressures is difficult to assess at this time without certainty in policy and funding. In the past, local governments in the action area generally have accommodated additional growth in ways that adversely affected listed fish habitat, allowing for development to destroy wetlands, stream-banks, estuarine shorelines, and other areas critical to listed species.

Some local government programs, if submitted for consideration, may qualify for a limit under the ESA section 4(d) rule, which is designed to conserve listed species. Local governments also may participate in regional watershed health programs, although political will and funding will determine participation and therefore the effect of such actions on listed species. Overall, without comprehensive and cohesive beneficial programs and the sustained application of such programs, it is likely that local actions will have few measurable positive effects on listed species and their habitat, and may even contribute to further degradation.

Tribal Actions: Tribal governments participate in cooperative efforts involving watershed and basin planning designed to improve fish habitat and are expected to continue to do so. The results from changes in tribal forest and agriculture practices, water resource allocations, and land uses are difficult to assess for the same reasons discussed under State and Local Actions. The earlier discussions related to growth impacts apply also to tribal government actions. Tribal governments will need to apply comprehensive and beneficial natural resource programs to areas under their jurisdiction to produce measurable positive effects for listed species and their habitat.

Private Actions: The effects of private actions on ESA-listed resources are the most uncertain. Private landowners may convert current use of their lands, or they may intensify or diminish current uses. Individual landowners may voluntarily initiate actions to improve environmental conditions, or they may abandon or resist any improvement efforts. Their actions may be compelled by new laws, or may result from growth and economic pressures. Changes in ownership patterns will have unknown impacts.

Summary: Non-federal actions are likely to continue affecting listed species. The cumulative effects of these actions are difficult to analyze considering the geographic landscape of the action area for this Biological Opinion, the uncertainties associated with government and private actions, and the changing economies of the region. Whether effects associated with these actions will increase or decrease is a matter of speculation; however, based on the trends identified in this section, the adverse cumulative effects on listed salmon are likely to increase. Although Tribal, state, and local governments have developed plans and initiatives to benefit listed fish, they must be applied and sustained in a comprehensive way before NMFS can consider them “reasonably foreseeable” in its analysis of cumulative effects.

1.9 Integration and Synthesis of Effects

The Puget Sound TRT is in the process of developing recommended recovery biological criteria for listed salmonids in the Puget Sound region. The TRT has prepared a draft document that includes general guidelines for assessing recovery efforts across individual populations within Puget Sound and determining whether they are sufficient for delisting and recovery of the listed ESU (NMFS 2002a). The preliminary delisting and recovery criteria recommendation provided by the TRT (see Chapter 3 in NMFS 2002a) have been used to assist in the evaluation of the harvest management strategy of the RMP.

Although component populations contribute fundamentally to the structure and diversity of the ESU, it is the ESU, not an individual population, which is the listed species under the ESA. The TRT is charged with identifying the biological characteristics of a recovered ESU as part of developing delisting and recovery criteria. These biological characteristics are based on the collective viability of the individual populations, their characteristics, and their distributions throughout the ESU.

The geographical distribution of viable populations across the Puget Sound Chinook Salmon ESU is important for the ESU's recovery (NMFS 2002a). The TRT has identified five geographic regions (see Figure 7 in the ERD) within the Puget Sound Chinook Salmon ESU based on similarities in hydrographic, biogeographic, and geologic characteristics, which also correspond to regions where groups of populations could be affected similarly by catastrophes (volcanic events, earthquakes, oil spills, etc.). An ESU with well-distributed viable populations avoids the situation where populations succumb to the same catastrophic risk(s), allows for a greater potential source of diverse populations for recovery in a variety of environments (i.e., greater options for recovery), and will increase the likelihood of the ESU's survival in response to rapid environmental changes, such as an volcanic event. Geographically diverse populations in different regions also distribute the ecological and ecosystem services provided by salmon across the ESU.

The TRT recommends that an ESU-wide recovery scenario should include at least two to four viable chinook salmon populations in each of the five geographic regions within Puget Sound, depending on the historical biological characteristics and acceptable risk levels for populations within each region (NMFS 2002a). An ESU-wide recovery scenario should also include within each of these geographic regions one or more viable populations from each major genetic and life history group historically present within that geographic region (NMFS 2002a). While changes in harvest alone cannot recover the Puget Sound Chinook Salmon ESU, NMFS can use the preliminary TRT guidance for assistance in evaluating whether the proposed RMP would impede recovery and survival of the ESU.

The following risk assessment is presented in two stages. In the first stage, a potential area of concern or risk is identified by region. In the second stage, the likelihood of that concern or risk occurring is evaluated. The assessment in the second stage also considers the practical influence harvest may have on the potential concern or risk.

Estimated impacts from the fisheries proposed by the RMP will vary by region, consistent with population-specific management objectives specified in the RMP. In the ERD, NMFS evaluated the RMP's impacts on individual populations. Consistent with the TRT's guidance to assess ESU-wide effects, the following is an evaluation of the estimated impacts on the ESU, by region, from the fisheries proposed by the RMP:

Georgia Strait Region – Chinook salmon originating from the Georgia Strait Region are distinct from other Puget Sound chinook salmon in their genetic attributes, life history traits, and habitat characteristics (PSTRT 2003). There are two populations within the Georgia Strait Region: the North Fork Nooksack River and the South Fork Nooksack River populations (see Figure 7 in the ERD). Both populations are designated as Category 1 populations (see Table 7 in the ERD).

Straying between the two populations was historically low, as supported by available genetic data, but straying may have increased in recent years (PSTRT 2003). The more recent straying observations may be partially due to an increase in hatchery production. This potential source of straying may have been reduced by the co-managers with the implementation of a 50 percent reduction in on-station hatchery releases from Kendall Creek Hatchery (T. Scott, WDFW, e-mail to K. Schultz, NMFS, March 22, 2004). Habitat differences between the two populations exist, but are subtle (PSTRT 2003).

In the ERD, NMFS has evaluated the RMP's impacts on individual populations and identified an elevated level of risks to the North Fork Nooksack River and South Fork Nooksack River populations, when compared to NMFS' standards. A summary of the risk analysis for these two populations follows. A more detailed analysis of risks to these populations is provided in the ERD.

Nooksack River Populations - The North Fork Nooksack River natural-origin population has exhibited an increasing escapement trend since listing (see Table 9 in the ERD). However, the estimated 1999 to 2002 average escapement of 180 natural-origin spawners for the North Fork Nooksack River population is below the NMFS-derived critical threshold of 200 fish (see Table 8 in the ERD). The South Fork Nooksack River natural-origin population has also exhibited an increasing escapement trend since listing (see Table 9 in the ERD). The 1999 to 2002 average escapement of 249 natural-origin spawners for the South Fork Nooksack River population is slightly above the NMFS-derived critical threshold of 200 fish (see Table 8 in the ERD).

In NMFS' preliminary findings, the broodstock used for the Kendall Creek Hatchery program, located on the North Fork Nooksack River, retains the genetic characteristics of the original, donor, wild population and is considered essential for the survival and recovery of the ESU. When including Kendall Creek hatchery-origin fish, an average aggregate escapement of 3,438 natural spawners in the North Fork Nooksack River has been observed since listing (see Table 10 in the ERD). Adult fish produced by the Kendall Creek Hatchery program and migrating with the natural-origin fish are expected to buffer harvest-induced genetic and demographic risks to the natural-origin North Fork Nooksack River population (see discussion on pages 28 and 29 in the ERD).

Increased escapement of natural-origin fish into the Nooksack River in recent years may be due, in part, to harvest reductions. However, the abundance trend in the natural-origin returns suggests that, although escapement may be stable or even trend upward toward or above the optimum level associated with current habitat condition, natural-origin recruitment will not increase much beyond that level unless constraints limiting marine, freshwater, and estuary survival are alleviated. Augmentation of these natural-origin spawners on the natural spawning areas of the North Fork Nooksack River, with the addition of hatchery-origin spawners, will continue to test the natural production potential of the system at higher escapement levels. The escapement of hatchery-origin fish may also benefit the natural-origin production by capitalizing on favorable survival conditions in some years.

For the Nooksack Management Unit, the anticipated range of total exploitation rates is 20 to 26 percent. The most likely total exploitation rate within this range is 25 percent (see Table 14 in the ERD). Similar to recent years, the largest proportion of the total exploitation rate is expected to be accounted for by the Canadian fisheries (see Table 4 in the ERD). The SUS exploitation rate on the Nooksack River populations is not anticipated to exceed 7 percent under the proposed RMP (see Table 3 in the ERD). Even if the entire SUS exploitation rate on Nooksack River populations of 7 percent was eliminated, the NMFS-derived rebuilding exploitation rate of 12 percent for the Nooksack Management Unit would still not be achieved.

NMFS has evaluated the elevated risks to the Nooksack Management Unit associated with the SUS fisheries proposed in the RMP, using the NMFS-derived rebuilding exploitation rate as the standard for comparison. With the modeled Canadian fisheries, and assuming 2003 abundance, a 7 percent SUS fishery exploitation rate for the Nooksack River populations would lead to a 2 percentage point decrease in the probability of rebuilt populations in 25 years under current conditions. Modeling also suggests that the application of a 7 percent SUS fishery exploitation rate would result in a 14 percentage point increase in the probability that the populations will fall below the critical level during that same 25-year period (see Table 16 in the ERD).

Similar to recent years, it is likely that the vast majority of the SUS fishery harvest impacts on the Nooksack Management Unit populations under the RMP would occur in treaty Indian fisheries. Since 2001, the majority of the SUS harvest on the Nooksack Management Unit has occurred in tribal fisheries. In recognition of tribal management authority and the Federal government’s trust responsibility to the tribes, NMFS is committed to considering their judgment and expertise regarding the conservation of trust resources. Consistent with this commitment and as a matter of policy, NMFS has sought, where there is appropriate tribal management, to work with tribal managers to provide limited tribal fishery opportunities, so long as the risk to the population remains within acceptable limits.

Trends in the escapement of natural-origin Nooksack early chinook salmon populations are increasing. The additional contributions of hatchery origin spawners to the natural spawning areas are anticipated to reduce catastrophic and demographic risks to the North Fork Nooksack population. In addition, the Kendall Creek hatchery-origin chinook salmon shares the ecological and genetic characteristics of the natural origin spawners. Information suggests that past harvest constraints have had limited effect on increasing the escapement of returning natural-origin fish. The magnitude of Canadian harvest is expected to significantly exceed the NMFS-derived rebuilding exploitation rate for the Nooksack River populations. However, the SUS exploitation rate on the Nooksack River populations is not anticipated to exceed 7 percent. NMFS considers the tribes’ management authority, judgment, and expertise regarding conservation of trust resources. Taking all these factors into account, NMFS concludes that the implementation of the

RMP from May 1, 2005 through April 30, 2010, will adequately protect chinook salmon populations in the Georgia Straight Region.

North Puget Sound Region – The largest river systems in Puget Sound are found within the North Puget Sound Region. There are ten chinook salmon populations delineated by the TRT within the North Puget Sound Region (see Figure 7 in the ERD). NMFS has determined that the RMP will contribute to the rebuilding of seven of the ten populations (70 percent) within this region. NMFS has identified a potential elevated level of risk under the RMP for three of these ten populations, as assessed through a comparison of likely exploitation rate ranges for these populations under the RMP with their NMFS-derived rebuilding exploitation rates. These three populations are the lower Sauk River and lower Skagit River populations in the Skagit Summer/Fall Management Unit, and the Skykomish River population in the Snohomish Management Unit. A summary of the risk analysis for these three populations follows, but a more detailed analysis is provided in the ERD.

Lower Skagit River Population: The lower Skagit River population is classified as a Category 1 population (see Table 7 in the ERD). The population has shown an increasing escapement trend since listing (see Table 9 in the ERD). The 1999 to 2002 average escapement of 2,944 fish has been above the NMFS-derived viable threshold of 2,182 fish for the lower Skagit River population (see Table 8 in the ERD). The anticipated escapement under the implementation of the RMP for the lower Skagit River population is 1,182 fish (see Table 5 in the ERD). This level of escapement is well above the NMFS-derived critical threshold of 251 fish for the lower Skagit River population.

The anticipated total exploitation rate under the implementation of the RMP for the lower Skagit River population would range between 48 and 56 percent. The most likely total exploitation rate within this range would be 55 percent (see Table 14 in the ERD). The upper end of the range of anticipated total exploitation rates exceeds the NMFS-derived rebuilding exploitation rate of 49 percent for this population. Similar to recent years, it is anticipated that Canadian fisheries will account for the substantial portion of the anticipated total exploitation rate on this population under the implementation of the RMP (see Table 4 in the ERD).

The anticipated range of exploitation rates for the SUS fisheries for the lower Skagit River population is 16 to 18 percent (see Table 3 in the ERD). The most likely exploitation rate for the SUS fisheries within this range is 16 percent (see Table 5 in the ERD). Through modeling, NMFS assessed the increased risk to the lower Skagit River population associated with the SUS fisheries proposed in the RMP. With the modeled Canadian fisheries and abundance similar to 2003 levels, a 16 percent SUS exploitation rate would result in a 26 percentage point decrease in the probability of a rebuilt population in 25 years under current conditions. This modeling also indicates that there is no change in the probability that the population will fall below the critical level during that same 25-year period (see Table 16 in the ERD).

Lower Sauk River Population: The lower Sauk River chinook salmon population is classified as a Category 1 population (see Table 7 in the ERD). The population has exhibited an increasing escapement trend since listing (see Table 9 in the ERD). The 1999 to 2002 average escapement of 721 fish has been above the NMFS-derived viable threshold of 681 fish for the lower Sauk River population (see Table 8 in the ERD). The most likely escapement resulting from the implementation of the RMP for the lower Sauk River population is 588 fish (see Table 5 in the ERD). This level of escapement is above the NMFS-derived critical threshold of 200 fish defined for the for the lower Sauk River population (see Table 8 in the ERD).

Total exploitation rates on the lower Sauk River population under the implementation of the RMP on the lower Sauk River population are expected to range between 48 and 56 percent. The most likely total exploitation rate within this range is 55 percent (see Table 14 in the ERD). The upper end of the range of anticipated total exploitation rates exceeds the NMFS-derived rebuilding exploitation rate for this population of 51 percent. A lack of data prevented NMFS from determining the level of increased risk for to the lower Sauk River population in the event that the total exploitation rate exceeds the NMFS-derived rebuilding exploitation rate. The effects of the implementation of the RMP on the lower Sauk River population are assumed to be similar to those identified for the lower Skagit River population as discussed above.

Skykomish River Population: The Skykomish River chinook salmon population is classified as a Category 1 population (see Table 7 in the ERD). The population has exhibited an increasing escapement trend since listing (see Table 9 in the ERD). The 1999 to 2002 average escapement of 2,118 fish for the Skykomish River population has been above the NMFS-derived critical threshold of 1,650 fish, but below the NMFS-derived viable threshold of 3,500 fish (see Table 8 in the ERD). The estimated escapement for the Skykomish River population that is most likely to result from the implementation of the RMP is 2,385 fish (see Table 5 in the ERD).

The total exploitation rate of 22 percent that is most likely to result from the implementation of the RMP would exceed the NMFS-derived rebuilding exploitation rate for the Skykomish River population by 5 percentage points (see Table 19 in the ERD). The anticipated harvest impacts on the populations within the Snohomish Management Unit include those from Canadian fisheries (see Table 4 in the ERD). The management of Canadian fisheries is outside the jurisdiction of the co-managers. However, the co-managers do have jurisdiction over fisheries occurring within the SUS areas. For the Snohomish Management Unit, the anticipated range of exploitation rates for the SUS fisheries is 13 to 14 percent (see Table 3 in the ERD). The most likely exploitation rate within in this range is 13 percent (see Table 5 in the ERD).

Through modeling, NMFS identified the increased level of risk that may be associated with the SUS fisheries exploitation rates proposed in the RMP, when compared to the NMFS-derived rebuilding exploitation rate. Under the mostly likely scenario, a 13 percent SUS exploitation rate for the Skykomish River population will result in a 14 percentage point decrease in the probability of a rebuilt population in 25 years under current conditions. Modeling also suggests that the implementation of the RMP will result in a 3 percentage point increase in the probability that the population will fall below the critical level during that same 25-year period (see Table 16 in the ERD).

The TRT recommends that any ESU-wide recovery scenario include at least two to four viable chinook salmon populations in each of the five geographic regions within Puget Sound, depending on the historical biological characteristics and acceptable risk levels for populations within each region. NMFS' assessment is that the RMP will contribute to rebuilding for seven of the ten populations within the North Puget Sound Region. The life history and run timing characteristics of the three populations identified as having an elevated level of risk for rebuilding (the lower Sauk River, the lower Skagit River, and the Skykomish River populations), are similar to the seven other populations in the region (see Table 7 in the ERD). Two of these three "at risk" populations are currently above their identified viable thresholds, and all three populations have an increasing trend in escapement since listing. Therefore, NMFS concludes that the RMP's management objectives are adequately protective of the geographic distribution, life history characteristics, and diversity of populations within the North Puget Sound Region of the ESU.

South Puget Sound Region – There are six populations delineated by the Puget Sound TRT within the South Puget Sound Region (see Figure 7 in the ERD). Genetically, most of the present spawning aggregations in the South Puget Sound Region are similar, likely reflecting the extensive influence of transplanted stock hatchery releases, primarily from the Green River population (PSTRT 2003). The TRT found that life history and genetic variations were not useful in determining populations within the South Puget Sound Region. Most chinook salmon in the South Puget Sound Region have similar life history traits.

In the ERD, NMFS found that the proposed RMP is anticipated to contribute to the stabilization or rebuilding of all populations within this region[5]. However, NMFS has identified a concern for two South Puget Sound Region populations due primarily to anticipated low abundance under the implementation of the RMP from May 1, 2005 through April 2010. A summary of the concerns for these two populations follows, but a more detailed analysis is provided in the ERD.

Cedar River and Sammamish River Populations: The Lake Washington Management Unit includes two populations; the Cedar River (Category 1) and the Sammamish River (Category 2) populations. The 1999 to 2002 four-year average escapements of 385 fish for the Cedar River population and 373 fish for the Sammamish River population are above the identified critical thresholds. The four-year average escapement of 385 fish for the Cedar River population is

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[5] With the level of escapement for the Duwamish-Green River population anticipated to continue to exceed the NMFS-derived viable threshold, the level of risk to this population associated with the implementation of the RMP is consistent with NMFS' standards.

below the RMP's upper management threshold for the population of 1,200 fish (see Table 8 in the ERD). The RMP proposes no upper management threshold for the Sammamish River population.

Since listing, the trend in escapement to the Cedar River has been stable, while the escapement to the Sammamish River population has exhibited an increasing trend (see Table 9 in the ERD). However, it is noted that the total escapement estimates for the Cedar River, as presented in Table 6 in the ERD, are based on an expansion of a live fish counts. Expansions of redd counts in the Cedar River suggest that this historical expansion of the live counts may be a conservative estimate of the total escapement. Additionally, the escapement estimates for the Sammamish River population do not include escapement into the Upper Cottage Lake or Issaquah Creeks. Therefore, although the escapement information used in this evaluation is believed to be representative of trends, the escapement estimates are considered a conservative estimate of the total escapement. A direct comparison of the Cedar River and Sammamish River escapements with the VSP generic guidance for a critical threshold of 200 fish should be considered conservative, as the total escapements for these two systems are likely greater than those depicted in Table 6 in the ERD.

Since 1998, the estimated natural escapement levels for both populations within the Lake Washington Management Unit have exceeded the VSP generic guidance for a critical threshold of 200 fish, but have remained well below the guidance for a viable threshold of 1,250 fish. Escapements into the Cedar River and the Sammamish River tributaries resulting from the implementation of the RMP are anticipated to range from 214 to 305 fish each (see Table 3 in the ERD). The most likely escapement for each population within this range is 295 fish (see Table 5 in the ERD).

Harvest impact modeling for the Lake Washington Management Unit indicates that the co-managers will continue to meet or exceed the critical threshold of 200 natural spawners for both populations within the management unit under the implementation of the RMP. However, given that the range of anticipated escapements approaches the critical thresholds for each population, and considering the volatility in escapement observed for these populations in the past, NMFS is concerned that these populations could experience very low abundance in the next several years, below the critical thresholds. However, there is a substantial contribution of stray hatchery-origin fish to the natural escapement in the Sammamish River tributaries. The Sammamish River population (Category 2 population) is not genetically distinct from these straying hatchery-origin fish. These hatchery-origin fish may lessen demographic concerns that may arise regarding low escapement for that population.

In the ERD, NMFS expressed concern for the Sammamish River population because the RMP provides no low abundance threshold for managing harvest impacts on the population. The co-managers propose that protective measures imposed to safeguard the Cedar River population, which include management constraints that would be applied when the population falls below its low abundance threshold, will also incidentally benefit the Sammamish River population. The co-managers' argument is compelling because the Cedar River and Sammamish River populations are both affected by the same terminal area fisheries. NMFS agrees that it is reasonable to expect that terminal conservation management measures directed at migrating fish returning to the Cedar River would also benefit fish returning to the Sammamish River.

Limiting factors to chinook salmon survival and productivity in the Lake Washington basin are being addressed by improving fish passage conditions at the Ballard Locks, and restoration of anadromous fish access to 17 miles of the Cedar River above the Landsburg Dam. While these improvements will likely enhance spatial structure and productivity, there remain highly altered conditions in the Lake Washington basin and at the Ballard Locks that are daunting to juvenile salmon survival and emigration, and adult immigration.

The TRT recommends that an ESU-wide recovery scenario should include at least two to four viable chinook salmon populations in each of five geographic regions within Puget Sound, depending on the historical biological characteristics and acceptable risk levels for populations within each region. Despite potential risks that the Cedar River and Sammamish River populations may experience under the harvest management plan from May 1, 2005 through April 2010, the RMP is still expected to provide sufficient protection for four of the six populations in the South Puget Sound Region. The concerns for the Cedar River and Sammamish River populations do not represent much risk to the region. Identifying these two populations as a concern is considered a precautionary approach, as information suggests that the escapements estimated for these systems are likely conservative. NMFS believes that the RMP's management objectives are adequately protective of the geographic distribution, life history characteristics, and genetic diversity of the populations within the South Puget Sound Region of the ESU.

Hood Canal Region – Primarily because of their geographic isolation from other basins of the ESU, the TRT concluded that chinook salmon spawning historically in Hood Canal streams were independent from other chinook salmon spawning aggregations in the Puget Sound region (PSTRT 2003). There are two populations within the Hood Canal Region: the Skokomish River and the Mid-Hood Canal rivers populations (see Figure 7 in the ERD). Both populations are classified as a Category 2 population (see Table 7 in the ERD). Watersheds harboring Category 2 chinook salmon populations are areas where indigenous populations of the species are believed to no longer exist, but where sustainable wild populations existed historically and where habitat could still support such populations.

In the ERD, NMFS has identified a potential concern for harvest impacts on the spatial structure of the Mid-Hood Canal rivers population. This concern is heightened because of the low abundance in two of the individual rivers. A summary of the concerns for the Mid-Hood Canal rivers population follows, but a more detailed analysis is provided in the ERD.

Mid-Hood Canal Rivers Population: The 1999 to 2002 average escapement of 404 fish for the Mid-Hood Canal rivers population is only slightly above the RMP's low abundance threshold of 400 fish for the population (see Table 9 in the ERD). The Mid-Hood Canal rivers population has exhibited an increasing escapement trend since the time of listing (see Table 9 in the ERD). However, low levels of escapements in the Mid-Hood Canal Management Unit are anticipated to continue under the implementation of the RMP. The range of anticipated spawning escapements into the rivers of the Mid-Hood Canal Management Unit under the implementation of the RMP from May 1, 2005 through April 2010 is expected to range from is 344 to 531 fish (see Table 3 in the ERD). The most likely escapement within this range is 504 fish (see Table 5 in the ERD).

The Mid-Hood Canal rivers population includes spawning aggregations in the Hamma Hamma, Duckabush, and the Dosewallips Rivers. Most harvest impacts on this population occur in mixed stock areas outside of the Hood Canal region. The effects of these mixed stock fisheries on the three components of the population are variable and unpredictable. It is therefore difficult for the co-managers to impose differential harvest effects on the individual spawning aggregate components in order to adjust spawning distribution among the rivers. In 2002, the natural escapement of 95 spawners into the Mid-Hood Canal Management Unit fell well below the VSP guidance for a critical threshold of 200 fish for this population. Total annual spawning escapements below 40 fish have been observed in recent years in each of the Duckabush and Dosewallips Rivers.

For the Mid-Hood Canal Management Unit, the anticipated range of total exploitation rates that would result from the implementation of the RMP is 26 to 34 percent. The most likely total exploitation rate within this range is 32 percent (see Table 14 in the ERD). Similar to the more northern chinook salmon management units discussed above, Canadian fisheries are expected to accounts for a substantial proportion of the total exploitation rate on this population (see Table 4 in the ERD). The most likely SUS exploitation rate anticipated under the implementation of the RMP is 13 percent.

Escapement into the individual systems has varied, with the spawning aggregation in the Hamma Hamma River representing the majority of the total Mid-Hood Canal rivers population abundance in recent years (see Table 6 in the ERD). Adult returns resulting from the WDFW-administered Hamma Hamma River supplementation program, which relies partially on broodstock returning to the river, has likely contributed substantially to the Mid-Hood Canal rivers population's increasing abundance trend (see Table 12 in the ERD).

The hatchery-origin adult fish that are progeny of broodstock collected from the Hamma Hamma River may buffer demographic risks to the Mid-Hood Canal rivers population in the short term, particularly to the component of the population spawning in the Hamma Hamma River. The general characteristics of the Mid-Hood Canal rivers population, including life history and run timing, are also found in the Skokomish River population (see Figure 7 in the ERD), the only other population within the region. Genetically similar stocks are also sustained by several hatchery facilities in the Hood Canal area and in hatcheries in the South Puget Sound Region where the Green River-lineage are naturally or artificially sustained.

As mentioned in the ERD, the co-managers, in cooperation with NMFS, have modeled escapement results under a no Puget Sound fishery alternative. The most likely escapement for this management unit under the "no fishery" scenario is 527 fish, as discussed in more detail in the Final Environmental Impact Statement. With no Puget Sound fisheries, anticipated escapement into the Mid-Hood Canal rivers population would increase by only 23 fish, spread among the three component natural spawning rivers. Given the observed proportions of recent year escapements into the individual river systems comprising the Mid-Hood Canal Management Unit (see Table 12 in the ERD), the most likely increase in escapement into the Duckabush and Dosewallips Rivers will be only three and two fish, respectively. Based on modeling, further decreases in the proposed SUS fisheries-related impacts would have little effect on the persistence of the spawning aggregations in the Dosewallips and Duckabush Rivers.

The TRT recommends that an ESU-wide recovery scenario should include at least two to four viable chinook salmon populations in each of five geographic regions within Puget Sound, depending on the historical biological characteristics and acceptable risk levels for populations within each region. NMFS concludes the RMP's management objectives are adequately protective of the geographic, life history, and diversity of the populations within the Hood Canal Region of the ESU. This conclusion takes into consideration that the hatchery-origin production may buffer demographic risks associated with the RMP to the Mid-Hood Canal rivers population. Additionally, the genetic similarity between the Mid-Hood Canal rivers population and populations within the Skokomish River and the South Puget Sound Region, which could serve as reserves, was also a factor. However, the primary reasons for the recommendation are the total abundance status of the population, the increasing escapement trend observed for the population, the annual monitoring and evaluation actions outlined in the RMP (discussed in the ERD), and the likelihood that further decrease in the SUS fisheries-related impacts would have limited beneficial effects.

Strait of Juan de Fuca Region - The TRT delineated two populations within the Strait of Juan de Fuca Region: the Dungeness River and the Elwha River populations (see Figure 7 in the ERD). Both populations are classified as Category 1 populations (see Table 7 in the ERD). Although the TRT identified only two historically extant populations within the Strait of Juan de Fuca Region, important components of the historical diversity within the Strait of Juan de Fuca Region may have been lost (PSTRT 2003).

Genetically, the chinook salmon in the Elwha River are very distinct from other Puget Sound populations (see Figure 5a in PSTRT 2003). Chinook salmon in the Dungeness River are also genetically distinct from other populations in Puget Sound and appear intermediate in their characteristics between eastern Puget Sound and the Elwha River populations (PSTRT 2003).

Habitat differences also exist between the Dungeness and Elwha River basins and other Puget Sound watersheds (PSTRT 2003).

Bases on the analysis provided above and in the ERD, NMFS finds that the RMP provides sufficient protection for the Elwha River population. However, NMFS has identified a heightened level of concern for the Dungeness River population, primarily because of the current status and the annual anticipated escapement resulting from the implementation of the RMP is expected to approach the VSP-derived critical threshold of 200 for the population. A summary of the risk analysis for the Dungeness River population follows, but a more detailed analysis is provided in the ERD.

Dungeness River Population: Since listing, the average escapements of 345 fish for the Dungeness River population has been above the VSP generic guidance for a critical threshold of 200 fish for this population, but below the RMP's low abundance threshold of 500 fish. The Dungeness River population has exhibited an increasing escapement trend since listing (see Table 9 in the ERD). Modeling of the Dungeness Management Unit indicates that the co-managers would continue to meet or exceed the critical threshold of 200 natural spawners under the implementation of the RMP from May 1, 2005 through April 2010. The range of escapements to the Dungeness River under the implementation of the RMP is expected to be 231 to 356 fish (see Table 3 in the ERD). The most likely escapement within this range is 336 fish (see Table 5 in the ERD). The range of anticipated escapements is below the RMP's low abundance threshold of 500 fish and approaches the VSP generic guidance for a critical threshold of 200 fish for this population.

The co-managers, in cooperation with federal agencies and private-sector conservation groups, have implemented a captive brood stock program to rehabilitate chinook salmon runs in the Dungeness River. Juvenile and adult fish produced through the hatchery program on the Dungeness River are listed with the natural-origin fish under the ESA. The primary goal of the supplementation and an associated fishery restriction program is to increase the number of fish spawning naturally in the river, while maintaining the generic characteristics of the existing broodstock.

Although there are no fishery harvest distribution estimates for the Dungeness Management Unit, in the adjacent Elwha Management Unit, it is estimated that the Alaskan and Canadian harvests have represented, on average, almost 80 percent of the total fishery impacts. A similar Alaskan and Canadian harvest distribution is likely for the Dungeness River population. Through modeling, the estimated range of exploitation rates that may be anticipated for the Dungeness Management Unit under the implementation of the RMP from May 1, 2005 through April 2010 is 22 to 29 percent. The most likely total exploitation rate within this range is 27 percent (see Table 14 in the ERD). However, the anticipated SUS exploitation rate for this population is very small; the SUS fisheries exploitation rate on this population is most likely to be 5 percent (see Table 5 in the ERD).

The co-managers will review the status of populations within the ESU annually. The co-managers, in cooperation with NMFS, will use this information to assess whether impacts on listed fish are as expected. When a population is anticipated to fall below its low abundance threshold, the co-managers have committed to consider additional actions when application of the RMP is not sufficiently protective in a given year, and when such additional actions would benefit the stocks.

NMFS concludes that the RMP would provide sufficient protection for the Strait of Juan de Fuca Region populations. This conclusion takes into consideration that the conservation hatchery program operating in the Dungeness River buffers the demographic risk to the Dungeness River population. This conclusion also considers the status and increasing escapement trend of the populations within this region, annual monitoring and evaluation outlined in the RMP (which is discussed in the ERD), the small anticipated SUS exploitation rate of less than five percent, and the likelihood that any further decrease in the SUS fisheries-related impacts would have limited beneficial effects on these populations. As discussed above and in the ERD, NMFS finds that the RMP's management objectives would be adequately protective of the geographic distribution, life history characteristics, and genetic diversity of populations within the Strait of Juan de Fuca Region of the ESU.

ESU Summary - The Puget Sound Chinook Salmon ESU, not the component, individual populations, is the primary focus of NMFS' evaluation of the impacts of the RMP under the ESA. In conducting this evaluation, NMFS takes into account the recommendations of the TRT, which is charged with identifying the biological characteristics of a recovered ESU as part of developing delisting and recovery criteria. As noted earlier, the TRT's preliminary recommendation is that any ESU-wide recovery scenario should include at least two to four viable chinook salmon populations in each of five geographic regions within Puget Sound, depending on the historical biological characteristics and acceptable risk levels for populations within each region. Biological criteria outlined in the ESA 4(d) Rule, NMFS' other mandates under the Endangered Species Act, and federal trust responsibilities to treaty Indian tribes will also be considered in developing NMFS' evaluation and resultant determination for the RMP.

NMFS concludes that the implementation of the RMP from May 1, 2005 through April 30, 2010, will adequately protect chinook salmon populations in the Georgia Straight Region based primarily on the increasing trends of the natural-origin populations, the additional contributions of hatchery-origin spawners to the natural spawning areas, and the low anticipated SUS exploitation rate. Additionally, NMFS' conclusion is based on information suggesting that past harvest constraints have had limited effect on increasing escapement of returning natural-origin fish, when compared with the return of hatchery-origin fish, and taking into consideration NMFS' treaty responsibility.

NMFS has determined that implementation of the proposed RMP will contribute to rebuilding for seven of the ten populations within the North Puget Sound Region. The life history and run timing characteristics of the three populations identified as having an elevated level of risk for rebuilding, are represented by the seven other populations in the region. Escapements for two of three "at risk" populations are currently above their identified viable thresholds, and all three populations have shown an increasing trend in escapement since listing. Therefore, NMFS concludes that the RMP's management objectives would be adequately protective of the geographic distribution, life history characteristics, and genetic diversity of the populations within the North Puget Sound Region of the ESU.

Through its evaluation, NMFS expects that the proposed RMP would contribute to the stabilization or rebuilding of all populations within the South Puget Sound Region. Specific harvest impacts identified for two populations within the region, the Cedar River and Sammamish River populations, do not rise to a level that might represent a substantial risk to chinook salmon population rebuilding and recovery in the region when all populations are considered. Highlighting harvest impact concerns for these two populations is considered precautionary. Therefore, NMFS concludes that the RMP's management objectives are adequately protective of the geographic distribution, life history characteristics, and genetic diversity of the populations within the South Puget Sound Region of the ESU.

The RMP's management objectives are adequately protective of the geographic distribution, life history traits, and genetic diversity of the populations within the Hood Canal Region of the ESU. This conclusion is based on the production of the hatchery-origin fish that share the ecological and genetic traits of the natural-origin population, the status and increasing escapement trends of the two component populations, the annual monitoring and evaluation actions applied in the RMP to track population status and harvest impacts, the likelihood that further decrease in the SUS fisheries-related impacts would have limited effects on the persistence of the Mid-Hood Canal rivers population within this region, and the genetic similarity between the Mid-Hood Canal rivers population and populations within the Skokomish River and the South Puget Sound Region.

NMFS concludes that the RMP will also provide adequate protection for chinook salmon originating from the Strait of Juan de Fuca Region. This conclusion is based on the status and increasing escapement trends of the populations, the annual monitoring and evaluation actions outlined in the RMP, the low anticipated SUS exploitation rates, the likelihood that any further decrease in the SUS fisheries-related impacts would have limited beneficial effects on the persistence of these two populations, and on consideration that the hatchery-origin fish produced for conservation purposes in the two watersheds within this region share the ecological and genetic traits of the natural-origin populations.

1.10 Conclusion

Based on these conclusions and the analysis presented in previous sections, NMFS finds that the RMP's management objectives, in combination with other ongoing habitat and hatchery efforts, would provide adequate protection for each of the five regions of the ESU. Therefore, NMFS concludes that the implementation of the RMP from May 1, 2005, through April 2010, would not likely to jeopardize the continued existence of the Puget Sound Chinook Salmon ESU.

No critical habitat is designated for the Puget Sound Chinook Salmon ESU.

2.0 Incidental Take Statement

With NMFS' approval of the RMP, the ESA take prohibitions will not apply to activities conducted pursuant to the RMP. Therefore, the proposed Federal actions, including the approval of the RMP under the ESA 4(d) Rule are not subject to take prohibitions. Accordingly, no incidental take statement has been prepared.

3.0 Conservation Recommendation

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of threatened and endangered species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. NMFS believes the following conservation recommendations are consistent with these obligations, and therefore should be implemented by the BIA and USFWS.

(1) The BIA, USFWS, and NMFS, in collaboration with the affected states and tribes, should evaluate the ability of the listed Puget Sound Chinook Salmon ESU to survive over the longer term (past the duration of the RMP) and recover, given the totality of impacts affecting the ESU during all phases of the salmonid's life cycle, including freshwater, estuarine, and ocean life stages. For this effort, the BIA and USFWS should collaborate with the affected co-managers to evaluate available life cycle models or initiate the development of life cycle models where needed.

(2) The BIA, USFWS, and NMFS, in collaboration with the affected states and tribes, should evaluate possible improvement in gear technologies and fishing techniques that would reduce mortality of listed species.

(3) The BIA, USFWS, and NMFS, in collaboration with the affected states and tribes, should continue to evaluate the feasibility of selective and non-retention fishing techniques in commercial and recreational fisheries to reduce impacts on listed species without compromising data quality used to manage fisheries.

(4) The BIA, USFWS, and NMFS, in collaboration with the affected states and tribes, should continue to improve the quality of information gathered on ocean rearing and migration patterns to improve the understanding of the utilization and importance of these areas to listed ESUs.

(5) The BIA, USFWS, and NMFS, in collaboration with the affected states and tribes, should continue to evaluate the potential selective effects of fishing on the size, sex composition, or age composition of salmon populations.

4.0 Re-initiation of Consultation

This concludes formal consultation on the NMFS, BIA, and USFWS sub-actions as they relate to the RMP and the Puget Sound chinook ESU. As provided in 50 CFR §402.16, re-initiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if:

(1) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered;

(2) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the biological opinion; or

(3) a new species is listed or critical habitat designated that may be affected by the identified action.

In making its no jeopardy conclusion, NMFS recognizes the co-managers' adaptive management process outlined in the RMP. Consistent with an adaptive management approach, a change in the exploitation rate or rates proposed in the RMP will not be considered grounds to re-initiate this consultation as long as the change in the exploitation rate or rates are within the risk criteria NMFS used in its evaluation (page 25 of the ERD). The risk criteria are those used by NMFS to derive the rebuilding exploitation rates (e.g., Did the percentage of escapements less than the critical threshold value increase by less than five percentage points relative to the no-fishing baseline *and either* (b) Does the escapement at the end of the 25-year simulation exceed the viable threshold at least 80 percent of the time *or* (c) Does the percentage of escapements less than the viable threshold at the end of the 25-year simulation differ from the no-fishing baseline by less than 10 percentage points). Additionally, a change in the escapement goal or goals proposed in the RMP will not be considered grounds to re-initiate this consultation as long as the change in the escapement goal or goals are based on the best estimates of the productivity and capacity of the system. Prior to determining whether re-initiation is necessary, NMFS will review the change in the exploitation rate or escapement goal and document its findings.

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6.0 Magnuson-Stevens Act Essential Fish Habitat Consultation

This is NMFS' Magnuson-Stevens Fishery Conservation and Management Act (MSA) consultation on its determination for the RMP over the next five years, from May 1, 2005, through April 30, 2010, as described in the above ESA section 7 consultation.

6.1 Background

The MSA, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), established procedures designed to identify, conserve, and enhance EFH for those species regulated under a Federal fisheries management plan. Pursuant to the MSA:

> Federal agencies must consult with NMFS on all actions, or proposed actions, authorized, funded, or undertaken by the agency, that may adversely affect EFH (Section 305 (b)(2));
>
> NMFS must provide conservation recommendations for any Federal or State action that would adversely affect EFH (Section 305(b)(4)(A));
>
> Federal agencies must provide a detailed response in writing to NMFS within 30 days after receiving EFH conservation recommendations. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with NMFS' EFH conservation recommendations, the Federal agency must explain its reasons for not following the recommendations (Section 305(b)(4)(B)).

EFH means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (MSA Section 3). For the purpose of interpreting this definition of EFH: Waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities; necessary means the habitat required to support a sustainable fishery and the managed species= contribution to a healthy ecosystem; and Aspawning, breeding, feeding, or growth to maturity@ covers a species' full life cycle (50 CFR 600.10). Adverse effect means any impact which reduces quality and/or quantity of EFH, and may include direct (*e.g.*, contamination or physical disruption), indirect (*e.g.*, loss of prey or reduction in species fecundity), site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810).

EFH consultation with NMFS is required for any Federal agency actions that may adversely affect EFH, including actions that occur outside EFH, such as certain upstream and upslope activities.

The objectives of this EFH consultation are to determine whether the proposed action would adversely affect designated EFH and to recommend conservation measures to avoid, minimize, or otherwise offset potential adverse effects on EFH.

6.2 Identification of Essential Fish Habitat

Pursuant to the MSA, the Pacific Fisheries Management Council (PFMC) has designated EFH for three species of federally-managed Pacific salmon: chinook salmon; and coho salmon; and Puget Sound pink salmon (PFMC 1999). Freshwater EFH for Pacific salmon includes all those streams, lakes, ponds, wetlands, and other water bodies currently, or historically accessible to salmon in Washington, Oregon, Idaho, and California, except areas upstream of certain impassable man-made barriers (as identified by the PFMC 1999), and longstanding, naturally-impassable barriers (i.e., natural waterfalls in existence for several hundred years). Detailed descriptions and identifications of EFH for salmon are found in Appendix A to Amendment 14 to the Pacific Coast Salmon Plan (PFMC 1999). Assessment of potential adverse effects on these species= EFH from the proposed action is based, in part, on this information.

6.3 Proposed Action and Action Area

The proposed action and action area are detailed above in the above Biological Opinion. The action area for this EFH consultation is the area defined by the RMP, Washington waters from the mouth of the Strait of Juan de Fuca at Cape Flattery, eastward. The primary Federal sub-action is the NMFS proposal to issue a determination as to whether the RMP submitted by the co-managers meets the requirements of Limit 6 under the ESA 4(d) Rule. The action area includes habitats that have been designated as EFH for various life-history stages of Puget Sound chinook salmon.

NMFS is including two other proposed Federal actions in this consultation because they are similar actions within a given geographical area. The duration of all of the proposed Federal actions is through April 30, 2010. The three proposed actions are summarized here, and are described in more detail in the above Biological Opinion.

(1) The proposed NMFS determination as to whether the RMP adequately addresses the criteria outlined in the ESA 4(d) Rule. Management objectives specified in the RMP account for fisheries-related mortality throughout the migratory range of Puget Sound chinook salmon, from Oregon to Southeast Alaska.

(2) The proposed BIA funding of Puget Sound tribes’ management, enforcement, and monitoring projects in support of the RMP. Only the funding of projects that may impact listed Puget Sound chinook salmon through April 30, 2010, are considered in this consultation.

(3) The proposed USFWS authorization of fisheries, as a party to the Hood Canal Management Plan (Point No Point Treaty Council *et al.* 1986), that is consistent with the implementation of the RMP, as approved under the ESA 4(d) Rule. Only fisheries that may impact listed Puget Sound chinook salmon through April 30, 2010, are considered in this consultation.

6.4 Effects of the Proposed Action

The harvest-related activities of the proposed actions considered in this consultation involve boats using hook-and-line gear and commercial net gear. The use of these gears affects the water column and the shallower estuarine and freshwater substrates, rather than the deeper water, offshore habitats. The PFMC assessed the effects of fishing on salmon EFH and provided recommended conservation measures in Appendix A to Amendment 14 to the Pacific Coast Salmon Plan (PFMC 1999).

The PFMC identified five types of impact on EFH: (1) gear effects; (2) harvest of prey species by commercial fisheries; (3) removal of salmon carcasses; (4) redd or juvenile fish disturbance; and (5) fishing vessel operation on habitat. Of the five types of impact on EFH identified by the PFMC for fisheries, the concern regarding gear-substrate interactions, removal of salmon carcasses, redd or juvenile fish disturbance and fishing vessel operation on habitat are also potential concerns for the salmon fisheries in Puget Sound.

(1) *Gear effects and fishing vessel operation (4)*: Possible fishery-related impacts on riparian vegetation and habitat would occur primarily through bank fishing, movement of boats and gear to the water, and other stream side usages. The types of salmon fishing gear that are used in Puget Sound salmon fisheries in general actively avoid contact with the substrate because of the resultant interference with fishing and potential loss of gear. In addition, the proposed fishery implementation plan includes actions that would minimize these impacts, such as area closures. Also these effects would occur to some degree through implementation of fisheries or activities other than the Puget Sound salmon fisheries, i.e., recreational boating and marine species fisheries. Construction activities directly related to salmon fisheries are limited to maintenance and repair of existing facilities (such as boat launches), and are not expected to result in any additional impacts on riparian habitats because of the proposed salmon fisheries. The facilities used in association with the fisheries are essentially all in place. Therefore, the proposed fisheries would have a negligible additional impact on the physical environment.

(2) *Removal of salmon carcasses*: The PFMC conservation recommendation to address the concern regarding removal of salmon carcasses was to manage for maximum sustainable spawner escapement and implementation of management measures to prevent over-fishing. Both of these conservation measures are basic principles of the RMP. Therefore,

management measures to minimize the effects of salmon carcass removal on EFH are an integral component of the management of the proposed fisheries.

(3) *Redd or juvenile fish disturbance*: Trampling of redds during fishing has the potential to cause high mortality of salmonids. Boat operation can result in stranding and mortality related to pressure changes in juveniles (PFMC 1999). The PFMC report recommended angler education and the closer of key spawning areas during the time that eggs and juvenile salmon were present. Salmon fisheries are closed or fishing activities do not occur in freshwater areas in Hood Canal, North Puget Sound and the Strait of Juan de Fuca during peak spawning, rearing and out-migration periods (S. Theisfeld, WDFW and T. Johnson, WDFW, per. comm. with S. Bishop, NMFS, May 12, 2004). Notices are posted near fishing access areas by WDFW and the Washington Parks Department, and news releases are distributed by WDFW before each fishing season explaining responsible fishing behavior, including avoidance of spawning areas and damage to riparian areas (T. Johnson, WDFW per, comm. with S. Bishop, NMFS, May 12, 2004). The Puyallup and White River in South Puget Sound are closed to salmon fishing through much of chinook salmon migration and spawning. These management measures should minimize redd or juvenile fish disturbance due to conduct of the proposed Puget Sound salmon fisheries.

The fisheries consistent with the implementation of the RMP would have a negligible impact on the physical environment.

6.5 Conclusion

For the reason discussed above, NMFS concludes that the proposed Federal action would not adversely affect designated EFH for chinook salmon or for other fish species for which EFH has been designated.

6.6 EFH Conservation Recommendation

Pursuant to Section 305(b)(4)(A) of the MSA, NMFS is required to provide EFH conservation recommendations to Federal agencies regarding actions which may adversely affect EFH. However, because NMFS concluded that the proposed Puget Sound salmon fisheries would not adversely affect the EFH, no conservation recommendations are needed.

6.7 Statutory Response Requirement

Because there are no conservation recommendations, there are no statutory response requirements.

6.8 Consultation Renewal

The NMFS must reinitiate EFH consultation if the proposed actions are substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS= EFH conservation recommendations (50 CFR Section 600.920(k)).

7.0 References

Pacific Fisheries Management Council (PFMC). 1999. Appendix A to Amendment 14 to the Pacific Coast Salmon Plan. Identification and Description of Essential Fish Habitat, Adverse Impacts, and Recommended Conservation Measures for Salmon. Portland, Oregon. 146pp.

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8.0 Data Quality Act Documentation and Pre-Dissemination Review

Section 515 of the Treasury and General Government Appropriations Act of 2001 (Public Law 106-554) ("Data Quality Act") specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the Biological Opinion and the Magnuson-Stevens Act Essential Fish Habitat Consultations addresses these DQA components, documents compliance with the Data Quality Act, and certifies that this Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat Consultations have undergone pre-dissemination review.

8.1 Utility: Consultation by Federal agencies with NMFS is required under section 7 of the ESA whenever a Federal agency approves funds or carries out an action that might affect a listed species. This consultation was required under the ESA to determine whether the implementation of the RMP's proposed Puget Sound salmon fisheries would appreciably reduce chinook salmon population survival and recovery, jeopardizing, the affected ESU before the BIA could proceed with administration of tribal fishery management programs or the USFWS could approve fishing activities involving the proposed Puget Sound salmon fisheries. Supplying copies of the document to the management agencies provides them with the documentation that NMFS has determined that the proposed fisheries will not jeopardize the continued existence of the affected ESUs. Providing copies to WDFW and the NWIFC is consistent with their roles as fishery managers for the affected ESUs and with NMFS' obligations under Secretarial Order 3206 (Department of Interior Order 3206, American Indian Tribal Rights, Federal-Tribal Trust Responsibilities and the Endangered Species Act).

8.2 Integrity: This consultation was completed on a computer system managed by NOAA Fisheries in accordance with relevant information technology security policies and standards set out in Appendix III, "Security of Automated Information Resources," Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

8.3 Objectivity:

Information Product Category: Natural Resource Plan.

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased, and were developed using commonly accepted scientific research methods. They adhere to published standards including the NOAA Fisheries ESA Consultation Handbook, ESA Regulations, 50 CFR 402.01 et seq., and the Magnuson-Stevens Fishery Conservation and Management Act (MSA) implementing regulations regarding Essential Fish Habitat, 50 CFR 600.920(j).

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the literature cited section. The analyses in this biological opinion/EFH consultation contain more background on information sources and quality.

***Referencing*:** All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NOAA Fisheries staff with training in ESA and MSA implementation, and reviewed in accordance with Northwest Region ESA quality control and assurance processes.

Evaluation of and Recommended Determination on a Resource Management Plan (RMP), Pursuant to the Salmon and Steelhead 4(d) Rule

Evaluation of and Recommended Determination on a Resource Management Plan (RMP), Pursuant to the Salmon and Steelhead 4(d) Rule

TITLE OF RMP:	Puget Sound Comprehensive Chinook Management Plan: Harvest Management Component
RMP PROVIDED BY:	Puget Sound Treaty Tribes, Washington Department of Fish and Wildlife
FISHERIES:	Strait of Juan de Fuca, Hood Canal, and Puget Sound salmon fisheries and steelhead net fisheries potentially impacting listed Puget Sound chinook salmon
EVOLUTIONARILY SIGNIFICANT UNIT AFFECTED:	Puget Sound Chinook Salmon
NWR TRACKING NUMBER:	2003/01616
DATE:	December 15, 2004

Introduction:

On March 24, 1999, the National Marine Fisheries Service (NMFS) listed the Puget Sound chinook salmon (*Oncorhynchus tshawytscha*) as a threatened species under the Endangered Species Act of 1973 (ESA) (64 FR 14308). The Puget Sound Chinook Salmon Evolutionarily Significant Unit[1] (ESU) includes all naturally spawned populations of chinook salmon from rivers and streams flowing into Puget Sound from the Elwha River, eastward. Major river systems within the ESU supporting chinook salmon populations include the Nooksack, Skagit, Stillaguamish, Snohomish, Cedar, Duwamish-Green, White, Puyallup, Nisqually, Skokomish, Mid-Hood Canal, Dungeness, and Elwha Rivers. Chinook salmon (and their progeny) from the following hatchery stocks are also currently listed under the ESA: Kendall Creek (North Fork Nooksack River); North Fork Stillaguamish River; White River; Dungeness River; and Elwha River.

On July 10, 2000, NMFS issued a rule under section 4(d) of the ESA (referred hereafter as the ESA 4(d) Rule), establishing take prohibitions for 14 salmon and steelhead ESUs, including the Puget Sound Chinook Salmon ESU (50 CFR 223.203(b)(6); July 10, 2000, 65 FR 42422). The ESA 4(d) Rule provided limits on the application of the take prohibitions, i.e., take prohibitions would not apply to the plans and activities set out in the rule if those plans and activities met the

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[1] An Evolutionarily Significant Unit or "ESU" is a collection of one or more Pacific salmon populations that share similar genetic, ecological, and life history traits but differ in important ways from salmon in other ESUs. Salmon ESUs are considered to be "distinct population segments" under the Federal Endangered Species Act (ESA).

rule's criteria. One of those limits (Limit 6) applies to joint tribal and state resource management plans.

On March 18, 2004, the Puget Sound Treaty Tribes (PSTT) and the Washington Department of Fish and Wildlife (WDFW) provided a jointly developed resource management plan to NMFS, Northwest Regional Office. The resource management plan, titled the “Puget Sound Comprehensive Chinook Management Plan: Harvest Management Component,” dated March 1, 2004 (hereafter referred to as the RMP), provides the framework within which the tribal and state jurisdictions would jointly manage all salmon and gillnet steelhead fisheries that may impact listed chinook salmon within the greater Puget Sound area. The greater Puget Sound area consists of the State of Washington waters from the mouth of the Strait of Juan de Fuca at Cape Flattery, eastward.

The co-managers propose that the resource management plan be in effect for six years, from May 1, 2004, through April 30, 2010. However, a biological opinion issued by NMFS on June 10, 2004, titled “Effects of Programs Administered by the Bureau of Indian Affairs supporting tribal salmon fisheries management in Puget Sound and Puget Sound salmon fishing activities authorized by the U.S. Fish and Wildlife Services during the 2004 fishing season”, is effective through April 30, 2005 (2004a). Therefore, NMFS’ evaluation and determination under the ESA 4(d) Rule will only address May 1, 2005 to April 30, 2010 of the proposed duration of the RMP.

Recommended Pending Determination:

It is the recommended determination of NMFS Northwest Region’s Sustainable Fisheries Division, that implementing the resource management plan, titled the “Puget Sound Comprehensive Chinook Management Plan: Harvest Management Component,” from May 1, 2005 to April 30, 2010, would not appreciably reduce the likelihood of survival and recovery of the Puget Sound Chinook Salmon ESU. The Sustainable Fisheries Division recommends that the Regional Administrator determine that the RMP adequately addresses the criteria established for Limit 6 of the ESA 4(d) Rule for the listed Puget Sound Chinook Salmon ESU. If the Regional Administrator so determines, the take prohibitions would not apply to fisheries implemented in accordance with the RMP. The discussion of the biological analysis underlying this recommended determination follows.

Evaluation:

The ESA 4(d) Rule for the Puget Sound Chinook Salmon ESU states that the prohibitions of paragraph (a) of the rule (16 U.S.C. 1531-1543) do not apply to actions taken in compliance with a resource management plan jointly developed by the States of Washington, Oregon and/or Idaho and the Tribes, provided that: (1) The Secretary has determined pursuant to 50 CFR 223.209 (referred to as the Tribal ESA 4(d) Rule) and the government-to-government processes therein that implementing and enforcing the joint tribal/state plan will not appreciably reduce the likelihood of survival and recovery of affected threatened ESUs; and (2) in making the determination for a resource management plan submitted under Limit 6, the Secretary of Commerce has taken comment on how any fishery management plan addresses the criteria described under Limit 4 (Sec. 223.203(b)(4)) of the ESA 4(d) Rule (50 C.F.R. 223.203(b)(6)).

Regarding the first element, NMFS consulted with the PSTT during the development of the RMP through government-to-government meetings. Consistent with legally enforceable tribal rights and with the Secretary of Commerce's tribal trust responsibilities, NMFS provided technical assistance, exchanged information, and discussed what is needed to provide for the conservation of listed species with the PSTT.

Regarding the second element, as required in section (b)(6)(iii) of the ESA 4(d) Rule, the RMP must adequately address eleven criteria under Limit 4 section (b)(4)(i). The criteria under Limit 4 section (b)(4)(i) are outlined in Table 1.

Table 1. Description of the eleven criteria for an RMP under Limit 4 section (b)(4)(i), and the page on which the evaluation of the RMP on each criterion starts within this document.

Criterion	Section	Description	Evaluation of the RMP on the criterion starts on page:
1	Section (b)(4)(i)	Clearly defines its intended scope and area of impact.	4
2	Section (b)(4)(i)	Sets forth the management objectives and the performance indicators for the plan.	4
3	Section (b)(4)(i)(A)	Defines populations within affected Evolutionarily Significant Units, taking into account: spatial and temporal distribution, genetic and phenotypic diversity, and other appropriate identifiably unique biological and life history traits.	19
4	Section (b)(4)(i)(B)	Uses the concepts of ''viable'' and ''critical'' salmonid population thresholds, consistent with concepts in the Viable Salmonid Populations (VSP) paper (NMFS 2000b)	24
5	Section (b)(4)(i)(C)	Sets escapement objectives or maximum exploitation rates for each management unit or population based on its status, and assures that those rates or objectives are not exceeded.	47
6	Section (b)(4)(i)(D)	Displays a biologically based rationale demonstrating that the harvest management strategy will not appreciably reduce the likelihood of survival and recovery of the Evolutionarily Significant Unit in the wild, over the entire period of time the proposed harvest management strategy affects the population, including effects reasonably certain to occur after the proposed actions cease.	66
7	Section (b)(4)(i)(E)	Includes effective (a) monitoring and (b) evaluation programs to assess compliance, effectiveness, and parameter validation.	79
8	Section (b)(4)(i)(F)	Provides for (a) evaluating monitoring data; and (b) making any revisions of assumptions, management strategies, or objectives that data show are needed.	81
9	Section (b)(4)(i)(G)	Provides for (a) effective enforcement, (b) education, (c) coordination among involved jurisdictions.	83
10	Section (b)(4)(i)(H)	Includes restrictions on resident and anadromous species fisheries that minimize any take of listed species, including time, size, gear, and area restrictions.	84
11	Section (b)(4)(i)(I)	Is consistent with other plans and conditions established within any Federal court proceeding with continuing jurisdiction over tribal harvest allocations.	85

This evaluation will address each of the criteria separately, in the order as provided in the ESA 4(d) Rule. Some criteria require NMFS to evaluate the RMP's impacts on individual populations. However, the ESU, not the individual populations within the ESU, is the listed entity under the ESA. Evaluation of the estimated aggregate impacts on the ESU, resulting from the implementation of the RMP, will occur when addressing criterion 6.

The following is the Sustainable Fisheries Division's evaluation of the RMP's adequacy in addressing the eleven criteria specified in Limit 4, section (b)(4) of the ESA 4(d) Rule for the Puget Sound Chinook Salmon ESU.

(1) Section (b)(4)(i) Clearly defines its intended scope and area of impact.

The Puget Sound Comprehensive Chinook Management Plan: Harvest Management Component clearly defines the intended scope of the fisheries management regime and its rather broad area of impact. The RMP guides the implementation of salmon fisheries and steelhead net fisheries under the co-managers' jurisdiction that may affect Puget Sound chinook salmon in Washington waters from the mouth of the Strait of Juan de Fuca at Cape Flattery, eastward. This geographic scope (referred hereafter as the Puget Sound Action Area) encompasses the area included in the Puget Sound Chinook Salmon ESU, as well as the western portion of the Strait of Juan de Fuca within the United States (Figure 1). NMFS evaluated the RMP for implementation during the next five fishing seasons, encompassing annual fishing seasons from May 1, 2005, through April 30, 2010.

(2) Section (b)(4)(i) Sets forth the management objectives and the performance indicators for the plan.

The RMP's stated objective is to ensure that "fishery-related mortality will not impede rebuilding of natural Puget Sound chinook salmon populations, to levels that will sustain fisheries, enable ecological functions, and are consistent with treaty-reserved fishing rights" (see page 3 of the RMP).

The guiding principles of the RMP are listed on pages 3 and 4 and include: (1) conserve the productivity, abundance, and diversity of all populations within the Puget Sound Chinook Salmon ESU; (2) manage for risk and uncertainty; (3) meet the ESA jeopardy standards; (4) provide opportunity to harvest surplus production from other species and populations; (5) account for all sources of fishery-related mortality (including non-landed mortality); (6) follow the principles of the Puget Sound Salmon Management Plan (PSSMP 1985) and other legal mandates pursuant to *U.S. v. Washington* (384 F. Supp. 312 (W.D. Wash. 1974)); (7) achieve the guidelines on allocations of harvest and conservation objectives that are defined in the 1999 Annex IV, Chapter 3, Chinook Salmon of the Pacific Salmon Treaty (PST 1999); and, (8) protect Indian treaty rights.

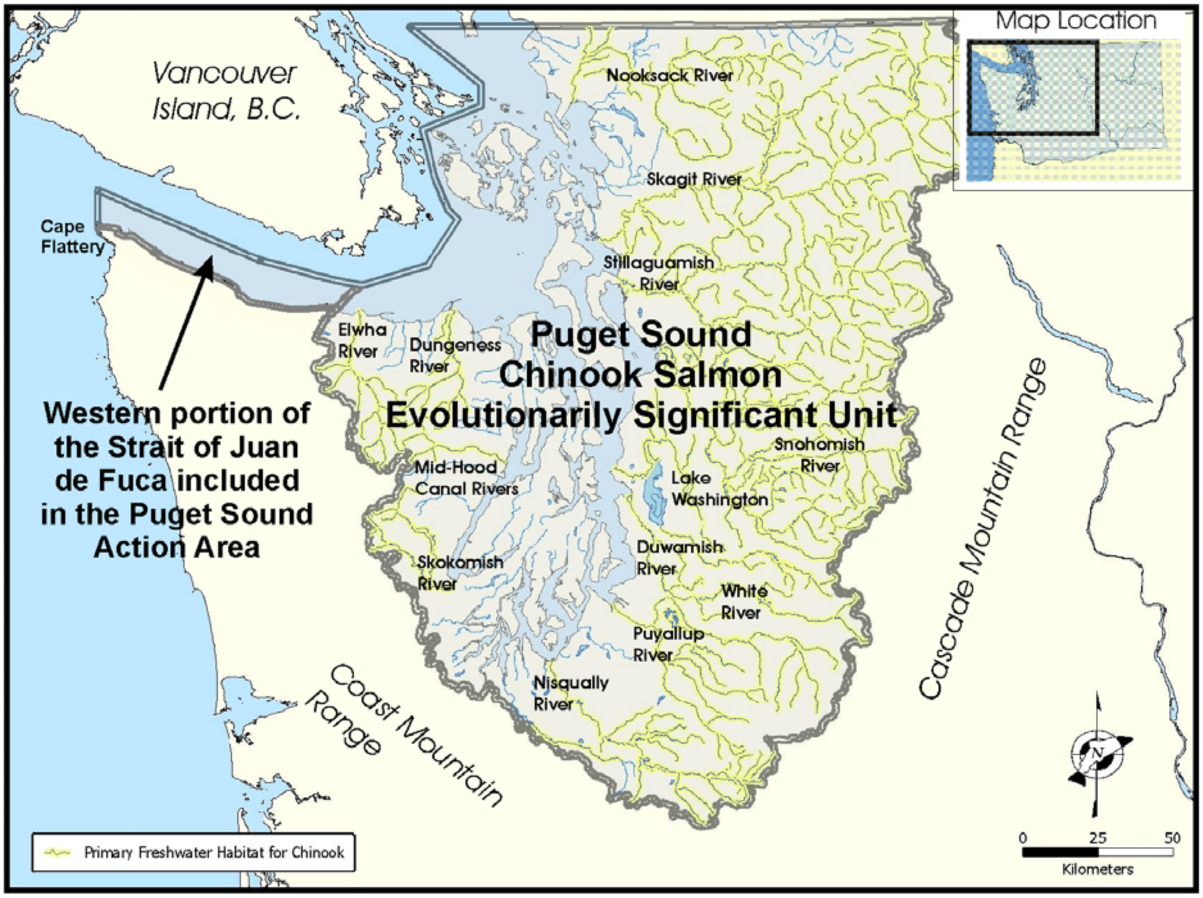
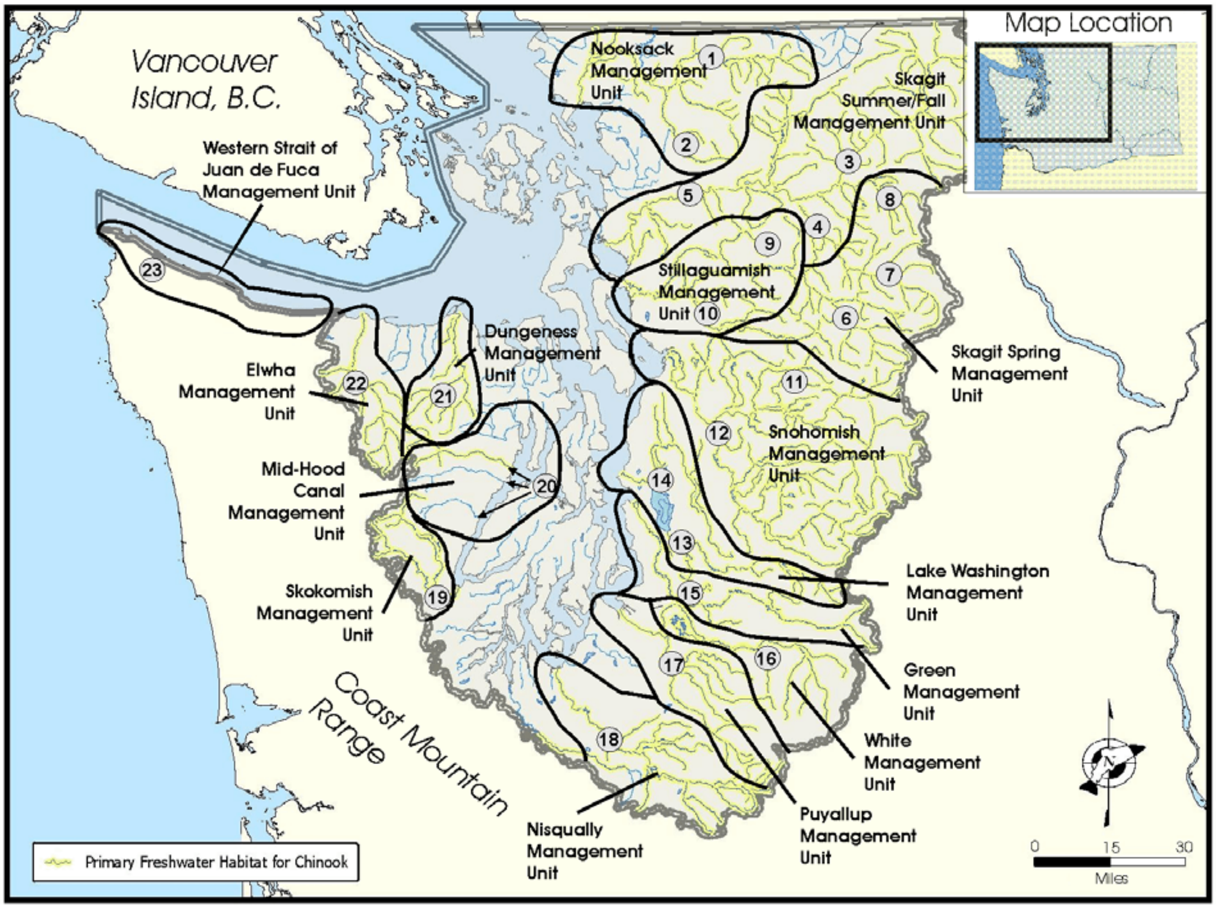


Figure 1. Puget Sound Action Area, which includes the Puget Sound Chinook Salmon Evolutionarily Significant Unit (ESU) and the western portion of the Strait of Juan de Fuca in the United States.

The RMP contains biologically-based management objectives that are generally expressed in terms of population-specific exploitation rates or escapement goals. In general, fisheries are managed to achieve these biological objectives, but there is a base level, referred to as the minimum fisheries regime, which the fisheries would not go below. A minimum fisheries regime is triggered by population-specific low abundance thresholds. From the co-managers' perspective, the RMP strikes a balance between biological and policy objectives by addressing conservation concerns "while still allowing a reasonable harvest of non-listed salmon" (page 17 of the RMP).

Performance Indicators:

The RMP provides a framework for fisheries management measures affecting 23 chinook salmon populations. Twenty-two populations are within the Puget Sound Chinook Salmon ESU, and one population (the Hoko River) is located in the western portion of Strait of Juan de Fuca (Figure 2).



Key: Chinook salmon populations.

1 - North Fork Nooksack River
2 - South Fork Nooksack River
3 - Upper Skagit River
4 - Lower Sauk River
5 - Lower Skagit River
6 - Upper Sauk River
7 - Siuattle River
8 - Upper Cascade River
9 - North Fork Stillaguamish River
10 - South Fork Stillaguamish River
11 - Skykomish River
12 - Snoqualmie River
13 - Cedar River
14 - Sammamish River
15 - Duwamish-Green River
16 - White River
17 - Puyallup River
18 - Nisqually River
19 - Skokomish River
20 - Mid-Hood Canal Rivers
21 - Dungeness River
22 - Elwha River
23 - Hoko River

Figure 2. Location of the RMP's salmon populations and management units within the Puget Sound Action Area. One salmon population identified in the RMP, the Hoko River (23), is not within the Puget Sound Chinook Salmon ESU.

The populations within the ESU are consistent with those defined by the Puget Sound Technical Recovery Team (TRT)[2]. For harvest management purposes, the RMP distributes the 23 populations among the 15 management units (Table 2). The RMP defines a management unit as a "stock or group of stocks which are aggregated for the purpose of achieving a management objective" (page 64 of the RMP). Six of the fifteen management units contain more than one

[2] The Puget Sound Technical Recovery Team (TRT) is an independent scientific body convened by NMFS to develop technical delisting criteria and guidance for salmon delisting in Puget Sound.

population, as defined by the co-managers. These populations are annually monitored by the co-managers, and their status will be used as the performance indicators for the RMP.

Sources of mortality for listed chinook salmon include fish killed incidentally in fisheries directed at unlisted chinook salmon or species, and fish taken in fisheries directed at listed chinook salmon. However, the co-managers foresee that “nearly all of the anticipated harvest-related mortality to natural [listed] Puget Sound chinook [salmon, under the implementation of the RMP,] will be incidental to fisheries directed at other stocks or species” (page 5 of the RMP). The RMP proposes the implementation of restrictions to the cumulative directed and incidental fishery-related mortality to each Puget Sound chinook salmon population or management unit. The RMP’s restrictions to the cumulative fishery-related mortality are expressed as: (1) a rebuilding exploitation rate; (2) an upper management threshold; (3) a low abundance threshold; and (4) a critical exploitation rate ceiling (Table 2). The following is a brief description of these RMP’s limits:

(1) Rebuilding Exploitation Rate

The RMP’s rebuilding exploitation rates are outlined in Table 2. The co-managers define exploitation rate as the “[t]otal mortality in a fishery or aggregate of fisheries expressed as the proportion of the sum of total mortality plus escapement” (page 63 of the RMP). The co-managers’ management objectives and tools have been evolving since the early 1990s in response to the declining status of Puget Sound salmon populations (page 6 of the RMP). When compared to pre-1990 management objectives, the co-managers propose that the RMP’s rebuilding exploitation rate for the individual management units would improve the viable status of the chinook salmon population or populations within that management unit. The intent of the co-managers is to not exceed the management unit’s rebuilding exploitation rate (see page 1 of the RMP). The co-managers used several methods to derive the RMP’s rebuilding exploitation rates.

NMFS also established rebuilding exploitation rates for nine individual populations within the ESU and for the Nooksack Management Unit, which will be discussed in more detail later in this document. For individual populations, NMFS has determined that exploitation rates at or below NMFS-derived rebuilding exploitation rates will not appreciably reduce the likelihood of rebuilding that population, assuming current environmental conditions based on specific risk criteria. The method used by NMFS to derive the rebuilding exploitation rates is described in a document titled “A risk assessment procedure for evaluating harvest mortality of Pacific salmonids,” dated May 30, 2000 (NMFS 2000a). This evaluation will include comparing the anticipated exploitation rates with the implementation of the RMP against NMFS-derived rebuilding exploitation rates.

Table 2. The RMP's management objectives (rebuilding exploitation rate, upper management threshold, low abundance thresholds, and the critical exploitation rate ceiling), by management units and populations.

Management Unit	Population [1]	Rebuilding Exploitation Rate [2]	Upper Management Threshold	Low Abundance Threshold	Critical Exploitation Rate Ceiling
Nooksack		-	4,000	-	9% SUS
	North Fork Nooksack River	-	2,000	1,000 [3]	-
	South Fork Nooksack River	-	2,000	1,000 [3]	-
Skagit		50%	14,500	4,800	15% SUS
Summer/Fall	Upper Skagit River	-	8,434	2,200	Even-Years
	Lower Sauk River	-	1,926	400	17% SUS
	Lower Skagit River	-	4,140	900	Odd-Years
Skagit Spring		38%	2,000	576	18% SUS
	Upper Sauk River	-	986	130	-
	Suiattle River	-	574	170	-
	Upper Cascade River	-	440	170	-
Stillaguamish		25%	900	650 [3]	15% SUS
	North Fork Stillaguamish River	-	600	500 [3]	-
	South Fork Stillaguamish River	-	300	-	-
Snohomish		21%	4,600	2,800	15% SUS
	Skykomish River	-	3,600	1,745 [3]	-
	Snoqualmie River	-	1,000	521 [3]	-
Lake Washington		15% PT SUS	-	-	12% PT SUS
	Cedar River	-	1,200	200 [3]	-
	Sammamish River [7]	-	-	-	-
Green	Duwamish-Green River	15% PT SUS	5,800	1,800	12% PT SUS
White River	White River	20%	1,000	200	15% SUS
Puyallup	Puyallup River	50%	-	500	12% PT SUS
	(South Prairie Creek Index Area)	-	500	-	
Nisqually	Nisqually River	-	1,100	-	- [4]
Skokomish	Skokomish River	15% PT SUS	3,650 [5]	1,300 [6]	12% PT SUS
Mid-Hood Canal	Mid-Hood Canal Rivers	15% PT SUS	750	400	12% PT SUS
Dungeness	Dungeness River	10% SUS	925	500	6% SUS

Elwha	Elwha River	10% SUS	2,900	1,000	6% SUS
Western Strait of Juan de Fuca	Hoko River	10% SUS	950	500	6% SUS

[1] Populations are consistent with the populations preliminarily recognized by the Puget Sound Technical Recovery Team (TRT) within the Puget Sound Chinook Salmon ESU. The Western Strait of Juan de Fuca Management Unit is not within the Puget Sound Chinook Salmon Evolutionarily Significant Unit (ESU).

[2] Exploitation rates are expressed as either total, southern United States (SUS), or pre-terminal southern United States (PT SUS). The SUS fishery includes all fisheries south of the border with Canada that may harvest listed Puget Sound chinook salmon. The SUS fishery includes both pre-terminal SUS and terminal SUS fisheries. The co-managers define a pre-terminal fishery as a "fishery that harvests significant numbers of fish from more than one region of origin" (page 65 of the RMP). The co-managers define a terminal fishery as a "fishery, usually operating in an area adjacent to or in the mouth of a river, which harvests primarily fish from the local region of origin, but may include more than one management unit" (page 65 of the RMP). The terminal SUS fisheries will vary by management unit and may occur in freshwater and marine areas.

[3] These thresholds are designated as representing natural-origin spawners by the co-managers. A natural-origin spawner is any naturally spawning salmon that has spent essentially all of its life-cycle in the wild and whose parents spawned in the wild. "Natural-origin spawner" is synonymous with "wild fish" in the RMP. "Natural spawner" is any naturally spawning salmon (hatchery or natural-origin).

[4] The Nisqually Management Unit is managed to achieve a 1,100 natural spawner escapement goal.

[5] Skokomish Management Unit's upper escapement goal of 3,650 spawners is composed of 1,650 natural-origin spawners and 2,000 hatchery-return spawners. If the recruit abundance is insufficient for the upper escapement goal to be met, *or* regardless of the total escapement, if the naturally spawning component of the Skokomish River population is expected to fall below 1,200 spawners, *or* the hatchery component is expected to result in less than 1,000 spawners, additional terminal fishery management measures would be taken, with a lower escapement objective of meeting or exceeding the 1,200 naturally spawning fish (see page 175 of the RMP).

[6] Skokomish Management Unit's low abundance threshold of 1,300 spawners is composed of 800 natural-origin spawners and 500 hatchery-return spawners.

[7] Usually referred to as the "north Lake Washington tributaries population" in the RMP.

The NMFS-derived rebuilding exploitation rates for individual chinook salmon populations may not be the same as the RMP's rebuilding exploitation rates. The co-managers' rebuilding exploitation rates are management unit based, which may contain more then one chinook salmon population. Some of the RMP's rebuilding exploitation rates are based on the same risk criteria as those used by NMFS. However, other RMP's rebuilding exploitation rates are based on observed minimum exploitation rates or on harvest ceilings set by the Pacific Salmon Treaty. In addition, NMFS-derived rebuilding exploitation rates are for all fishery-related mortality throughout the migratory range of Puget Sound chinook salmon. The RMP's rebuilding exploitation rates are in terms of either total, southern United States (SUS), or pre-terminal southern United States (PT SUS) and may not be directly comparable to NMFS-derived rebuilding exploitation rates.

The SUS fishery includes all fisheries south of the border with Canada that may harvest listed Puget Sound chinook salmon. This would include listed chinook salmon that are taken in fisheries off the coast of Washington, Oregon, and northern California. The SUS fishery includes both pre-terminal SUS and terminal SUS fisheries. The co-managers define a pre-terminal fishery as a "fishery that harvests significant numbers of fish from more than one region of origin" (page 65 of the RMP). The co-managers define a terminal fishery as a "fishery, usually operating in an area adjacent to or in the mouth of a river, which harvests primarily fish from the local region of origin, but may include more than one management unit. Non-local stocks may be present, particularly in marine terminal areas" (page 65 of the RMP). The terminal SUS fisheries will vary by management unit and may occur in freshwater and marine areas.

Calculating a rebuilding exploitation rate ideally requires knowledge of a spawner-recruit relationship based on escapement, age composition, coded-wire tag distribution, environmental parameters, and management error (N. Sands, NMFS, Northwest Fisheries Science Center (NWFSC), pers. com., to K. Schultz, NMFS, March 5, 2003). These types of data are available for several management units. The co-managers calculated the rebuilding exploitation rates using this method for the Skagit Summer/Fall, Skagit Spring, Stillaguamish, and Snohomish Management Units.

The co-managers' expectations are that application of these RMP's rebuilding exploitation rates will: (1) result in escapement levels that are less than the point of instability[3] no more than five percent more often than if no harvest had occurred over 25 or 40 years[4]; *and* (2) lead to a high (at least 80 percent) probability that spawning escapements will increase in 25 or 40 years to a specified (upper) threshold, *or* that the percentage of escapements less than the RMP's low abundance threshold at the end of 25 or 40 years will differ from a no-harvest regime by less than 10 percent (pages 13 and 14 of the RMP). Appendix A: Management Unit Status Profiles of

[3] The co-managers define the point of instability as "that level of population abundance (i.e., spawning escapement) that incurs substantial risk to genetic integrity, or exposes the stock to depensatory mortality factors" (page 65 of the RMP).

[4] Based on co-manager's expertise and explained in more detail in Appendix A: Management Unit Status Profiles of the RMP. The RMP uses a 25-year projection for the Stillaguamish and Snohomish Management Units in development of the proposed rebuilding exploitation rate. The co-managers used a 40-year projection for the Skagit Summer/Fall and Skagit Spring Management Units.

the RMP provides details on the methods the co-managers used to develop the RMP's rebuilding exploitation rates, which are based on a spawner-recruit relationship.

The data required to calculate a spawner-recruit relationship is not yet available for most Puget Sound chinook salmon populations. For the data-poor Lake Washington, Skokomish, and Mid-Hood Canal Management Units, the co-managers generally established the RMP's rebuilding exploitation rate at the lowest level of exploitation rates observed in the late 1990s (approximately 15 percent pre-terminal SUS). Overall, implementation of these lower exploitation rate levels by the co-managers has contributed to stable to increasing spawning escapement trends for populations within these management units.

Impacts associated with terminal fisheries would not be included in a pre-terminal SUS exploitation rate. Similar to recent years, the co-managers propose that the terminal fisheries in the Lake Washington and Mid-Hood Canal Management Units would have an exploitation rate of less than 5 percent. With the implementation of the RMP, the Skokomish Management Unit's terminal fisheries would be managed for a series of escapement objectives. The achievement of Skokomish Management Unit's escapement objectives would dictate the appropriate terminal exploitation rate.

Terminal fishery impacts are very low or non-existent in the Dungeness, Elwha, and Western Strait of Juan de Fuca Management Units. With the implementation of the RMP, the co-managers propose a rebuilding exploitation rate for these three management units of 10 percent SUS. The SUS fisheries include both pre-terminal SUS and terminal SUS fisheries. Thus, impacts associated with Alaska or Canadian fisheries would not be included in this SUS fishery exploitation rate limitation.

(2) Upper Management Threshold

Table 2 outlines the proposed RMP's upper management thresholds. The co-managers define the upper management threshold as the "escapement level associated with optimum productivity (i.e. maximum sustainable harvest........)" (page 12 of the RMP). The co-managers calculated the RMP's upper management threshold under current habitat conditions (page 13 of the RMP). The upper management thresholds proposed in the RMP equates to the upper escapement thresholds.

The RMP's annual management strategy depends on whether a harvestable surplus is forecast. A management unit is considered to have a harvestable surplus if the spawning escapement is expected to exceed its upper management threshold (page 12 of the RMP). The RMP prohibits directed harvest on listed populations of Puget Sound chinook salmon unless they have harvestable surplus. In other words, if a management unit does not have a harvestable surplus, then harvest-related mortality would be constrained to incidental impacts (see page 32 of the RMP).

With an exception, the RMP states that the "projected exploitation rate for management units with no harvestable surplus [and above their lower abundance threshold] will not be allowed to exceed their rebuilding exploitation rate ceiling" (see page 33 of the RMP). The exception is associated with the chinook salmon harvest in Canadian fisheries, which were approved under the Pacific Salmon Treaty. For those management units affected by Canadian fisheries, in some years the RMP's critical exploitation rate ceiling may be the restraining limit on Puget Sound fisheries, with the total exploitation rate in that year exceeding the RMP's rebuilding exploitation rate (see discussion of the RMP's critical exploitation rate ceiling below).

The technical basis for the RMP's upper management thresholds varies among management units (see footnotes on Table 12, page 43 of the RMP). For populations with sufficient information, the co-managers derived upper management thresholds using such methods as standard spawner-recruit calculations (Ricker 1975), empirical observations of relative escapement levels and catches, or Monte Carlo simulations that buffer for error and variability (Hayman 2003). The method used by the co-managers in establishing the upper management threshold for each management unit is described in Appendix A: Management Unit Status Profiles of the RMP.

(3) Low Abundance Threshold

Table 2 provides the RMP's proposed low abundance thresholds. The co-managers define the low abundance threshold as a "spawning escapement level, set intentionally above the point of biological instability, which triggers extraordinary fisheries conservation measures to minimize fishery related impacts and increase spawning escapement" (page 63 of the RMP).

The co-managers defined the RMP's low abundance thresholds as: (1) the lowest escapement with a greater than one return per spawner ratio; (2) the forecasted escapement for which there is "acceptably low" probability that the observed escapement will be below the point of instability (see page 15 of the RMP); or (3) in cases where specific data were lacking, the co-managers derived the RMP's low abundance threshold "in accordance with scientific literature [such as the generic guidelines found in the Viable Salmonid Populations (VSP) paper (NMFS 2000b)] or more subjectively, at annual escapement of 200 to 1,000" (see page 15 in the RMP). The method chosen by the co-managers depended on the quality and quantity of population-specific data available (see Appendix A: Management Unit Status Profiles of the RMP).

(4) Critical Exploitation Rate Ceiling

The co-managers established a critical exploitation rate ceiling for all management units with a low abundance threshold (see Table 2). For most management units, the RMP's critical exploitation rate ceiling imposes an upper limit on SUS exploitation rates when spawning escapement for a management unit is projected to fall below its low abundance threshold *or* if Canadian fisheries make it difficult or impossible to achieve the RMP's rebuilding exploitation rate. The RMP's rebuilding exploitation rate, the upper management threshold, and the low abundance threshold discussed above are primarily biologically-driven objectives. The RMP's critical exploitation rate ceilings are primarily driven by policy consideration.

The co-managers propose that the critical exploitation rate ceiling, when imposed on SUS fisheries, would result "in a significant reduction in incidental impacts on listed chinook salmon," while providing "minimally acceptable access" to non-listed salmon species, including non-listed hatchery chinook salmon, for which harvestable surpluses have been identified (see page 15 of the RMP). The RMP provides a general description of the fisheries, which represents the lowest level of fishing mortality on listed chinook salmon proposed by the co-managers. A description of these minimal fisheries is outlined in Appendix C: Minimum Fisheries Regime of the RMP.

For the majority of the management units, the RMP's critical exploitation rate ceilings are defined as an exploitation rate ceiling for the all SUS fisheries. For the Lake Washington, Green, Puyallup, Nisqually, Mid-Hood Canal and Skokomish Management Units, the RMP's critical exploitation rate ceiling applies only to the pre-terminal SUS fisheries. For these units, the co-managers outline additional terminal fishery management conservation measures that may be considered (Appendix A: Management Unit Status Profiles and Appendix C: Minimum Fisheries Regime of the RMP).

The RMP's critical exploitation rate ceilings were established by the co-managers, after policy consideration of "recent fisheries regimes that responded to critical status for some management units" (see page 17 of the RMP). The co-managers' position is that if further resource protection is necessary, it must be found by reducing exploitation rates in mixed-stock fisheries in Alaska and Canada, improving habitat conditions, and/or providing artificial supplementation where necessary and appropriate (see page 16 of the RMP). However, where analysis can demonstrate that additional conservation measures in fisheries would contribute substantially to recovery of a management unit, the co-managers may, at their discretion, and in concert with other specific habitat and enhancement actions, implement them (see page 34 of the RMP).

Harvest in some coastal fisheries in British Columbia, Canada has increased recently, approaching the limits agreed to by the United States under Annex IV, Chapter 3 of the Pacific Salmon Treaty. Increased impacts on Puget Sound chinook salmon associated with Canadian fisheries may contribute to the total exploitation rates exceeding the proposed RMP's rebuilding exploitation rate. During preseason planning, if the total exploitation rate for a management unit is projected to exceed the RMP's rebuilding exploitation rate for a given management unit, the co-managers propose to constrain their fisheries such that either the RMP's rebuilding exploitation rate is not exceeded *or* the RMP's critical exploitation rate ceiling is not exceeded. The RMP's critical exploitation rate ceiling, in this circumstance, would constrain SUS fisheries to the same degree as if the abundance were below the low abundance threshold (see page 35 of the RMP). Modeling exercises by the co-managers demonstrate the potential for the total exploitation rate to exceed the RMP's rebuilding exploitation rate in several management units during the duration of the proposed RMP.

Anticipated impacts under the implementation of the RMP:

The co-managers, in cooperation with NMFS, have modeled the anticipated impacts under the implementation of the RMP. Appendix A of this evaluation contains the individual model run results. Table 3 provides the anticipated range of exploitation rates and anticipated escapements for Puget Sound chinook salmon under the implementation of the RMP.

Table 3. Anticipated range of the annual total exploitation rates, southern United States (SUS) exploitation rates, and escapements for Puget Sound chinook salmon by management unit under the implementation of the RMP from May 1, 2005 through April 2010. Unless otherwise noted, exploitation rates and escapements are for natural fish.

Management Unit	Range of Anticipated Total Exploitation Rates	Range of Anticipated SUS Exploitation Rates	Range of Anticipated Pre-terminal SUS Exploitation Rates	Range of Anticipated Escapements
Nooksack (early) [1]	20 to 26%	7%	2 to 3%	252 to 388
Skagit Summer/Fall	48 to 56%	16 to 18% [2]	8 to 9%	7,551 to 11,633
Skagit Spring	23 to 28%	14 to 15%	12 to 13%	1,270 to 1,921
Stillaguamish [1]	17 to 20%	11 to 12%	10 to 11%	1,584 to 2,322
Snohomish [1]	19 to 23%	13 to 14%	11 to 12%	3,399 to 5,073
Lake Washington	31 to 38%	20 to 23%	9 to 10%	428 to 610
Duwamish-Green	49 to 63%	36 to 51%	9 to 10%	5,800 EG [3]
White	20%	17 to 19%	8 to 9%	1,011 to 1,468
Puyallup	49 to 50%	35 to 39%	9 to 10%	1,798 to 2,419
Nisqually	64 to 76%	53 to 68%	24 to 26%	1,100 EG [3]
Skokomish	45 to 63%	26 to 50%	12 to 13%	1,200 EG [3]
Mid-Hood Canal	26 to 34%	12 to 13%	12 to 13%	344 to 531
Dungeness	22 to 29%	5%	4 to 5%	231 to 356
Elwha	22 to 30%	5%	4 to 5%	1,395 to 2,125

[1] Based on natural-origin fish.
[2] Based on Skagit Summer/Fall Management Unit modeling, which assumes 2003 fisheries and abundance. Anomalous age structure and the presence of pink salmon fisheries in 2003 make the estimates of exploitation rates used in this modeling a likely overestimate of the harvest impacts. The SUS exploitation rates are more likely to be similar to recent years, 6 to 18 percent exploitation rates.
[3] Management units are managed by the co-managers to achieve natural spawner escapement goals (EGs).

Two variables were used in the modeling of the future fisheries to provide these anticipated ranges of exploitation rates and anticipated escapements. These variables were abundance of returning salmon and impacts associated with the level of Canadian fisheries.

Abundance Variable - The modeled salmon abundance in 2003 was used to estimate the upper end of the annual abundance returns under the implementation of the RMP from May 1, 2005 through April 2010. A 30 percent reduction from the 2003 abundance was used to represent the lower range of modeled returns. This range of modeled abundance is considered conservative. Given the general trend of stable to increasing abundance, which will be discussed later in this document, it is likely that if the actual abundance in the next five years falls outside this range, the actual abundance would most likely be greater. Of these two abundance scenarios, the most likely abundance to occur under the implementation of the RMP from May 1, 2005 through April 2010 is the abundance at the 2003 level.

Canadian Fisheries Variable - Depending on the management unit, Canadian fisheries on average, can account for the majority of the total fishery-related mortality (Table 4). The proportion of fishery-related mortality on individual populations within the ESU by Canadian fisheries has ranged from 4.5 percent for the population in the White River Management Unit to 75.7 percent for populations in the Nooksack Management Unit. The management of Canadian fisheries is outside the jurisdiction of the co-managers.

Table 4. The average distribution of fishery-related mortality for the management seasons 1996 to 2000, by management unit (Chinook Technical Committee (CTC) 2003). Canadian fisheries, on average, have accounted for over 50 percent of the fishery-related mortality in the Nooksack, Skagit Spring, Stillaguamish, and Elwha Management Units.

Management Unit	Alaska	British Columbia, Canada	Washington Troll	Puget Sound Net	Washington Recreational
Nooksack	1.6%	75.7%	1.5%	3.0%	18.3%
Skagit Summer/Fall [1]	2.3%	43.0%	1.8%	40.2%	12.7%
Skagit Spring	1.0%	51.4%	1.2%	7.1%	39.2%
Stillaguamish	17.8%	50.3%	0.3%	2.6%	29.1%
Snohomish	1.7%	23.2%	6.2%	54.8%	14.1%
Lake Washington	-	-	-	-	-
Green	2.1%	30.1%	9.4%	23.7%	37.7%
White	0.0%	4.5%	0.6%	3.5%	91.4%
Puyallup	-	-	-	-	-
Nisqually	0.5%	14.5%	2.6%	44.9%	37.6%
Skokomish	1.7%	37.4%	9.0%	7.2%	44.7%
Mid-Hood Canal	-	-	-	-	-
Dungeness	-	-	-	-	-
Elwha [2]	16.2%	58.8%	1.9%	0.8%	22.3%

[1] Samish River.
[2] The 1993 to 1997 average distribution of fishery-related mortality for the Elwha River was obtained from Table 3, page 185 of the RMP.

The level of Canadian fisheries is an important consideration in anticipating potential impacts into the future. In recent years, Canadian fisheries have not harvested chinook salmon at levels allowed under the Pacific Salmon Treaty due to internal Canadian conservation issues. These conservation concerns primarily pertain to depressed west coast Vancouver Island chinook salmon and Thompson River coho salmon populations (NMFS 2003a).

Under the implementation of the RMP, it is unclear if Canadian conservation actions will continue or if impacts will increase to maximum levels allowed under the Pacific Salmon Treaty. In modeling the Canadian fisheries, the impacts similar to fisheries in 2003 were used to represent the lower range of anticipated impacts. Maximum harvest levels allowed under the

Pacific Salmon Treaty were modeled to represent the upper range of impacts associated with Canadian fisheries. This proposed evaluation used the modeling based on the maximum harvest levels under the Pacific Salmon Treaty as the most likely to occur within this range. Table 5 provides the most likely exploitation rate and escapement numbers within modeled forecasts for Puget Sound chinook salmon by management unit or population under the RMP.

However, some caution must be exercised in using the results from this forecast modeling. For example, the 2003 fishery was used to model impacts for future fisheries. In 2003, the Skagit River chinook salmon return had an anomalously high estimated percentage of age-2 and age-3 fish. Age-2 and age-3 contribute little to natural spawning escapement in the Skagit River (B. Hayman, Skagit River System Cooperative, e-mail to S. Bishop, NMFS, January 28, 2004). Therefore, the estimated exploitation rate of 48 percent in 2003 is likely an overestimate of the actual exploitation rate experienced by the individual brood years present in that year. An exploitation rate of 36 percent is estimated for the individual brood years represented in 2003, 12 percentage points less than what was used in the modeling (B. Hayman, Skagit River System Cooperative, e-mail to S. Bishop, NMFS, January 28, 2004). In addition, 2003 was a high return year in the two-year pink salmon high-low abundance cycle. A higher exploitation rate on chinook salmon would be expected, when compared to low abundance pink salmon years. Incidental harvest of chinook salmon occurs in pink salmon directed fisheries.

Through forecast modeling, using 2003 as a base year, the anticipated range of the SUS exploitation rates is 16 to 18 percent for the Skagit Summer/Fall Management Unit (see Table 3). The actual SUS exploitation rates under the implementation of the RMP for the Skagit Summer/Fall Management Unit would most likely remain within what has been seen in recent years (B. Hayman, Skagit River System Cooperative, e-mail to S. Bishop, NMFS, January 28, 2004). The SUS exploitation rates on this management unit have ranged from 6 to 18 percent since 1999, with an average exploitation rate of 12 percent. The average exploitation rate of 12 percent is 4 percentage points less than the modeled exploitation rate assumed under the implementation of the RMP for the Skagit Summer/Fall Management Unit. Modeling results for this management unit, as depicted in Table 3 and Table 5, should be considered conservative, with the actual future exploitation rates likely less.

The co-managers will provide annual fishing-related mortality information as well as information on escapement for all populations identified in the RMP. The co-managers and NMFS will continue to evaluate the status and trends of populations, which may lead modification of the co-managers’ proposed management of the fisheries.

Table 5. The most likely total exploitation rates, southern United States (SUS) exploitation rates, and escapements within the modeled forecasts under the implementation of the RMP by Puget Sound chinook salmon management unit or population.

Management Unit	Population	Anticipated Total Exploitation Rate	Anticipated SUS Exploitation Rate	Anticipated Pre-terminal SUS Exploitation Rate	Anticipated Escapement	Minimum Fisheries Regime Imposed [1]
Nooksack	Natural-Origin Spawner:	25%	7%	2 %	365	Yes
	North Fork Nooksack	-	-	-	164	
	South Fork Nooksack	-	-	-	201	
Skagit Summer/Fall [2]	Natural Spawners:	55%	16%	8%	11,029	Yes
	Upper Skagit River	-	-	-	9,258	
	Lower Sauk River	-	-	-	588	
	Lower Skagit River	-	-	-	1,182	
Skagit Spring	Natural Spawners:	27%	14%	13%	1,845	No
	Upper Sauk River	-	-	-	683	
	Suiattle River	-	-	-	621	
	Upper Cascade River	-	-	-	539	
Stillaguamish	Natural-Origin Spawners:	19%	11%	10%	2,281	No
	N.F. Stillaguamish River	-	-	-	1,860	
	S.F. Stillaguamish River	-	-	-	421	
Snohomish	Natural-Origin Spawners:	22%	13%	11%	4,901	Yes
	Skykomish River	-	-	-	2,385	
	Snoqualmie River	-	-	-	2,516	
Lake Washington	Natural Spawners:	35%	20%	10%	588	No
	Cedar River	-	-	-	294	
	Sammamish River	-	-	-	294	
Green	Natural Spawners:					
	Duwamish-Green River	63%	47%	10%	5,800 EG [3]	No
White	Natural Spawners:					
	White River	20%	18%	9%	1,459	No
Puyallup	Natural Spawners:					
	Puyallup River	50%	35%	10%	2,419	No
Nisqually	Natural Spawners:					

	Nisqually River	76%	65%	26%	1,100 EG [3]	No
Skokomish	Natural Spawners: Skokomish River	63%	44%	12%	1,200 EG [3]	Yes
Mid-Hood Canal	Natural Spawners: Mid-Hood Canal Rivers	32%	13%	12%	504	No
Dungeness	Natural Spawners: Dungeness River	27%	5%	4%	336	Yes
Elwha	Natural Spawners: Elwha River	27%	5%	4%	2,031	No

[1] A general description of these minimal fisheries, as proposed by the co-managers, is outlined in Appendix C: Minimum Fisheries Regime of the RMP.

[2] Information presented is based on Skagit Summer/Fall Management Unit modeling, which assumes 2003 fisheries and abundance. Anomalous age structure and the presence of pink salmon fisheries in 2003 make the estimates of exploitation rates used in this modeling a likely overestimate of the harvest impacts. The SUS exploitation rates are more likely to be similar to recent rears, 6 to 18 percent exploitation rates.

[3] These management units are managed by the co-managers to achieve a natural spawner escapement goal or "EG."

(3) Section (b)(4)(i)(A) Defines populations within affected Evolutionarily Significant Units, taking into account: spatial and temporal distribution, genetic and phenotypic diversity, and other appropriate identifiably unique biological and life history traits.

The TRT, in cooperation with the co-managers, has completed a preliminary analysis to identify populations of chinook salmon within the Puget Sound Chinook Salmon ESU (PSTRT 2003). The RMP's delineation of populations within the ESU is the same as those preliminarily recognized by the Puget Sound TRT. The TRT reviewed several sources of information in deriving the preliminarily recognized delineations. These sources of information include geography, migration rates, genetic attributes, patterns of life history and phenotypic characteristics, population dynamics, and environmental and habitat characteristics of potential populations (NMFS 2004b). The TRT has identified 22 demographically independent populations within the ESU, representing the primary historical spawning areas of chinook salmon (PSTRT 2003). The annual escapement of populations within the ESU since 1990 is provided in Table 6.

To assist the co-managers in analyzing the impacts of their management actions, the RMP categorizes each chinook salmon population according to the population's life history and production characteristics. The co-managers used this method to assign populations to one of three possible watershed based categories. A description of Category 1, Category 2, and Category 3 watersheds follows:

Category 1 - Category 1 watersheds are areas where populations are genetically unique and indigenous to Puget Sound. Maintaining genetic diversity and integrity, and achieving abundance levels for long-term sustainability are the highest priorities for these populations. The management objective for Category 1 populations is to protect and recover these indigenous populations. The intent is to rebuild and manage for natural production. The co-managers propose to manage fisheries to meet interim escapement goals and/or the rebuilding exploitation rates for Category 1 populations based on the co-managers' understanding of natural chinook salmon production requirements for each population. The co-managers designated 17 of the 22 populations within the ESU as Category 1 (Table 7).

The status of Category 1 populations within the ESU varies. Some populations have fallen to such low levels that the ability to maintain their genetic diversity may be at risk. In some cases, lacking hatchery operations, populations would likely decline to very low levels or go extinct. In one case at least, the number of hatchery-origin fish spawning naturally may be a concern, in part because it may be masking the ability to evaluate the actual productivity of the natural-origin population. Other populations are more robust and the abundance levels are above what is needed to sustain genetic diversity, but often not at levels that will sustain maximum yield.

Table 6. Natural-origin or natural escapement for Puget Sound chinook salmon populations, 1990 to 2002.

Management Unit	Population	1990	1991	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*
Nooksack	Natural-Origin Spawner:	142	444	403	444	113	421	353	223	128	255	442	517	503
	North Fork Nooksack	6	87	345	285	26	175	210	121	39	91	159	250	221
	South Fork Nooksack	136	357	58	159	87	246	143	102	89	164	283	267	282
Skagit Summer/Fall	Natural Spawners:	16,792	5,824	7,348	5,801	5,549	6,877	10,613	4,872	14,609	4,924	16,930	13,793	19,591
	Upper Skagit River [1]	11,793	3,656	5,548	4,654	4,565	5,948	7,989	4,168	11,761	3,586	13,092	10,084	13,815
	Lower Sauk River [1]	1,294	658	469	205	100	263	1,103	295	460	295	576	1,103	910
	Lower Skagit River [1]	3,705	1,510	1,331	942	884	666	1,521	409	2,388	1,043	3,262	2,606	4,866
Skagit Spring	Natural Spawners:	1,511	1,346	986	783	470	855	1,051	1,041	1,086	471	906	1,856	1,065
	Upper Sauk River [1]	557	747	580	323	130	190	408	305	290	180	273	543	460
	Suiattle River [1]	685	464	201	292	167	440	435	428	473	208	360	688	265
	Upper Cascade River [1]	269	135	205	168	173	225	208	308	323	83	273	625	340
Stillaguamish	Natural-Origin Spawners:	701	1,279	716	725	743	654	935	839	863	767	1,127	936	1,090
	N.F. Stillaguamish River	434	978	422	380	456	431	684	613	615	514	884	653	737
	S.F. Stillaguamish River	267	301	294	345	287	223	251	226	248	253	243	283	353
Snohomish	Natural-Origin Spawners:	3,662	2,447	2,242	3,190	2,039	1,252	2,379	3,517	2,919	2,430	2,900	5,869	4,544
	Skykomish River	2,551	1,951	1,642	942	1,478	1,144	1,719	1,696	1,500	1,382	1,773	3,052	2,264
	Snoqualmie River	1,111	496	600	2,248	561	108	660	1,821	1,419	1,048	1,127	2,817	2,280
Lake Washington	Natural Spawners:	787	661	790	245	888	930	336	294	697	778	347	1,269	637
	Cedar River [1, 2]	469	508	525	156	452	681	303	227	432	241	120	810	369
	Sammamish River [3]	318	153	265	89	436	249	33	67	265	537	227	459	268
Green River	Natural Spawners:													
	Duwamish-Green River	7,035	10,548	5,267	2,476	4,078	7,939	6,026	9,967	7,300 [6]	9,100 [6]	6,170	7,975	13,950
White River	Natural Spawners:													
	White River	275	194	406	409	392	605	628	402	316	553	1,523	2,002	803
Puyallup	Natural Spawners:													
	Puyallup River [4]	3,515	1,702	3,034	1,999	1,328	2,344	2,111	1,110	1,711	1,988	1,193	1,915	1,590
	S. Prairie Creek Index Area [4]	-	-		-	798	1,408	1,268	667	1,028	1,430	695	1,154	840
Nisqually	Natural Spawners:													
	Nisqually River	994	953	106	1,655	1,730	817	606	340	834	1,399	1,253	1,079	1,542
Skokomish	Natural Spawners:													
	Skokomish River	642	1,719	825	960	657	1,398	995	452	1,177 [6]	1,692 [6]	926 [6]	1,913 [6]	1,479
Mid-Hood Canal	Natural Spawners													
	Mid-Hood Canal Rivers:	-	86	96	112	384	103	-	-	287	762	438	322	95
	Hamma Hamma River [5]	35	30	52	28	78	25	11	-	172	557	381	248	32
	Duckabush River [5]	10	14	3	17	9	2	13	-	57	151	28	29	20
	Dosewallips River [5]	1	42	41	67	297	76	-	-	58	54	29	45	43
Dungeness	Natural Spawners:													
	Dungeness River	310	163	158	43	65	163	183	50	110	75	218	453	633
Elwha	Natural Spawners:													

Elwha River [6, 7]	2,956	3,361	1,222	1,562	1,216	1,150	1,608	2,517	2,358	1,602	1,851	2,208	2,376
ESU Total	39,964	29,240	26,284	19,457	20,887	25,610	27,773	26,380	36,238	27,326	36,087	43,341	52,744

[1] The majority are natural-origin spawner.

[2] The escapement estimates for the Cedar River are based on an expansion of a live count of fish. However, Cedar River redd counts suggests that this expansion of the live count may be a conservative estimate of the total escapement (P. Hage, Muckleshoot Tribe, e-mail to S. Bishop, NMFS, February 10, 2004).

[3] Does not include escapement into the Upper Cottage Lake Creek, which has been surveyed since 1998. Surveys of the Upper Cottage Lake Creek have exceeded 100 fish (S. Foley, WDFW, pers. com., to K. Schultz, NMFS, February 19, 2004). Escapement counts also do not include spawners in Issaquah Creek, which are believed to be primarily Issaquah Hatchery returns (N. Sands, NMFS, e-mail to S. Bishop, NMFS, February 26, 2004). Therefore, escapement information presented is a conservative estimate of the total Sammamish River population's escapement.

[4] The area surveyed for the South Prairie Creek index increased from 1.5 to 12.5 stream miles in 1994. Escapement results for 1994 to 2002 were provided by W. Beattie, Northwest Indian Fisheries Commission (NWIFC), on January 31, 2004.

[5] Escapement information obtained from the RMP.

[6] Escapement information provided by W. Beattie, NWIFC, on February 4, 2004.

[7] Escapement is considered in-river gross escapement plus hatchery voluntary escapement minus pre-spawning mortality.

Table 7. The RMP's assigned categories and run timing of the chinook salmon populations within the ESU.

RMP's Management Unit	RMP's Populations	RMP's Assigned Population Category	Run Timing
Nooksack	North Fork Nooksack River	1	Early
	South Fork Nooksack River	1	Early
Skagit Summer/Fall	Upper Skagit River	1	Summer
	Lower Sauk River	1	Summer
	Lower Skagit River	1	Fall
Skagit Spring	Upper Sauk River	1	Spring
	Suiattle River	1	Spring
	Upper Cascade River	1	Spring
Stillaguamish	North Fork Stillaguamish River	1	Summer
	South Fork Stillaguamish River	1	Fall
Snohomish	Skykomish River	1	Summer
	Snoqualmie River	1	Fall
Lake Washington	Cedar River	1	Fall
	Sammamish River	2	Fall
Green	Duwamish-Green River	1	Fall
White	White River	1	Spring
Puyallup	Puyallup River	2	Fall
Nisqually	Nisqually River	2	Fall
Skokomish	Skokomish River	2	Fall
Mid-Hood Canal	Mid-Hood Canal Rivers	2	Fall
Dungeness	Dungeness River	1	Summer
Elwha	Elwha River	1	Summer

Category 2 - Category 2 watersheds are areas where indigenous populations are believed to no longer exist, but where sustainable wild populations existed historically. The co-managers believe that self-sustaining natural production is possible in Category 2 watersheds given suitable or productive habitat. Five Category 2 populations within the ESU have been identified by the co-managers (Table 7).

Category 2 populations are primarily found in southern Puget Sound and Hood Canal where hatchery production has been used extensively to mitigate for natural production lost to habitat degradation. Historically, these areas were managed for hatchery production. Consequently, in many of these systems, hatchery and natural fish are currently indistinguishable on the spawning grounds. In the future, on-going mass marking programs implemented at regional hatcheries will provide a means to distinguish between hatchery-origin and natural-origin adult chinook salmon on the spawning grounds. Given degraded habitat conditions within these watersheds, the co-managers' goal of harvest management is to provide sufficient escapement to the spawning grounds to increase natural productivity. Future decisions regarding the form and timing of recovery efforts in these watersheds will dictate the kinds of harvest actions that may be necessary and appropriate.

The co-managers have assigned populations to Category 2 based on current information. Ongoing monitoring and studies may identify remnant indigenous populations, which if found, may cause the population to be reassigned to Category 1. Decisions by the TRT about roles of these populations in the ESU may also require the populations to be re-categorized. The RMP includes monitoring and evaluation elements that will assist the TRT in these decisions. Additionally, the co-managers recognize that there is ongoing work by the TRT and other resource agencies or organizations that may also affect future harvest actions.

Category 3 - Category 3 watersheds are where spawning chinook salmon are generally found in small tributaries that may now have some natural spawning, but never historically had independent, self-sustaining populations of chinook salmon. Chinook salmon in these watersheds are probably hatchery strays or progeny from hatchery strays. Consistent with the TRT guidance, these small tributary spawning aggregations characteristic of Category 3 watersheds do not meet the current definition of an independent population. Therefore, the TRT has not identified any populations in these watersheds as part of the Puget Sound chinook salmon ESU. Several Category 3 watersheds were identified in the 2001 RMP by the co-managers to characterize the chinook salmon spawning (PSIT and WDFW 2001). However, similar to the 2003 RMP (PSIT and WDFW 2003), the RMP does not identify or establish management objectives for any Category 3 watersheds, but focuses on Category 1 and Category 2 watersheds where the spawning aggregates meet the criteria for all of the extant independent populations identified by the TRT. NMFS' assessment only considers those populations the TRT has identified in the Puget Sound chinook salmon ESU (Category 1 and Category 2), and therefore will consider the effects of the proposed fisheries in Category 3 watersheds only to the extent they affect the populations identified by the TRT.

There are two main reasons why naturally spawning chinook salmon may not be designated as an independent population. First, spawning adults are known to occur intermittently in certain streams, spawning in the tens to hundreds in some years and none in others. A plausible biological explanation for intermittent occurrence of chinook salmon in some streams is that those adults are part of a larger independent population that uses the spawning habitat only during years of high abundance or favorable habitat conditions (NMFS 2004b). While these areas may not contain independent populations, the TRT may conclude that fish and habitat outside independent population boundaries may be important for the viability of the ESU (NMFS 2001). Second, in streams currently containing chinook salmon but which never historically supported naturally spawning chinook salmon, the natural spawning chinook salmon present may be of hatchery origin (NMFS 2004b). As additional information is gained in some of these systems, one or more populations may be identified and assigned to Category 1 or Category 2 by the co-managers.

In the RMP, the Nooksack, Skagit Summer/Fall, Skagit Spring, Stillaguamish, Snohomish, and Lake Washington Management Units include multiple populations. The co-managers aggregated populations within these management units for several reasons: (1) information is currently insufficient to derive population-specific objectives; (2) there is no information suggesting the populations are exploited unequally in mixed-population fisheries, and none of the populations have discrete extreme terminal areas where they could be harvested independently; (3) the populations have similar migration timing, catch distribution and productivity such that harvest objectives should also be similar; or (4) objectives have been derived for each population, and the management unit as a whole is managed to achieve the most constraining population objective. NMFS' evaluation took into consideration the adequacy of the RMP's population(s) structure of the management units in determining whether the RMP would not appreciably reduce the likelihood of survival and recovery of the ESU.

(4) Section (b)(4)(i)(B) Uses the concepts of ''viable'' and ''critical'' salmonid population thresholds, consistent with concepts in the Viable Salmonid Populations (VSP) paper (NMFS 2000b).

The regulations in the ESA 4(d) Rule require that the RMP must use the concepts of "viable" and "critical" thresholds in a manner so that fishery management actions: (1) recognize significant differences in risk associated with viable and critical population threshold states; and (2) respond accordingly to minimize long-term risks to population persistence. The RMP defines its own upper management and low abundance thresholds, but these are readily comparable to the viable and critical thresholds. Given considerations of actions in the other "Hs" (Habitat, Hatchery, and Hydropower), harvest actions that impact populations that are currently at or above their viable thresholds must maintain the population or management unit at or above that level. Fishing-related mortality on populations above critical levels but not at viable levels (as demonstrated with a high degree of confidence) must not appreciably slow rebuilding to viable function. Fishing-related mortality to populations functioning at or below their critical thresholds must not appreciably increase genetic and demographic risks facing the population and must be designed to permit achievement of viable functions, unless the RMP demonstrates the likelihood of survival and recovery of the entire ESU in the wild would not be appreciably reduced by greater risks to an individual population.

As required by the ESA 4(d) Rule, the harvest regime specified by the co-managers in the RMP takes into account the different risks facing a population depending on the status of the population: above the upper management threshold; below the upper management threshold but above a low abundance threshold, as defined by the RMP; or below the defined low abundance threshold. In most cases, the co-managers have set the low abundance threshold intentionally above what would be defined by the VSP paper as the critical threshold under current conditions.

After taking into account uncertainty, the critical threshold is defined as a point under current conditions below which: (1) depensatory processes are likely to reduce the population below replacement; (2) the population is at risk from inbreeding depression or fixation of deleterious mutations; or (3) productivity variation due to demographic stochasticity becomes a substantial source of risk (see page 15 of NMFS 2000b). A viable population is defined as: (1) a population large enough to have a high probability of surviving environmental variation of the patterns and magnitudes observed in the past and expected in the future; (2) a population with sufficient abundance for compensatory processes to provide resilience to environmental and anthropogenic perturbation; (3) a population sufficiently large to maintain its genetic diversity over the long term; and (4) a population sufficiently abundant to provide important ecological functions throughout its life-cycle (see page 14 of NMFS 2000b). Population status evaluations should take uncertainty regarding abundance into account.

However, viable and critical thresholds in the context of this evaluation are a level of spawning escapement associated with rebuilding to recovery, consistent with current environmental conditions. For most populations, these thresholds are well below the escapement levels associated with recovery, but achieving these goals under current conditions is a necessary step to eventual recovery when habitat and other conditions are more favorable. Survival and recovery of the Puget Sound Chinook Salmon ESU will depend, over the long term, on necessary actions in other sectors, especially habitat actions, and not on harvest actions alone. There is an on going recovery planning effort for the Puget Sound Chinook ESU. Completion of the recovery plan and decisions regarding the form and timing of recovery efforts described in the recovery plan will determine the kinds of harvest actions that may be necessary and appropriate in the future. Absent that guidance at the time of this writing, NMFS must evaluate the proposed harvest actions by examining the impacts of harvest within the current context. Therefore, NMFS has evaluated the future performance of populations in the ESU under recent productivity conditions; i.e., assuming that the impact of hatchery and habitat management actions remain as they are now.

NMFS has completed a comprehensive analysis to derive viable and critical thresholds for a subset of Puget Sound chinook salmon populations under current habitat and environmental conditions (Table 8). A more detailed description of the process NMFS used in deriving these population-specific viable and critical thresholds is presented in Appendix C: Technical Methods - Derivation of Chinook Management Objectives and Fishery Impact Modeling Methods of the environmental impact statement on the proposed determination of this RMP (Final Environmental Impact Statement (FEIS), Puget Sound Chinook Harvest Resource Management Plan). The NMFS-derived viable and critical thresholds were used to develop rebuilding exploitation rates for these same populations. NMFS developed the critical thresholds after consideration of genetic, demographic, and spatial risk factors for each population. NMFS' rebuilding exploitation rate was derived by using a simulation model to identify an exploitation rate that meets specific criteria related to both survival and recovery, given the specified thresholds and estimated spawner/recruit parameters (NMFS 2000a).

The simulation used the population-specific threshold levels to identify a rebuilding exploitation rate that met the following criteria: (a) Did the percentage of escapements less than the critical threshold value increase by less than five percentage points relative to the baseline *and either* (b) Does the escapement at the end of the 25-year simulation exceed the viable threshold at least 80 percent of the time *or* (c) Does the percentage of escapements less than the viable threshold at the end of the 25-year simulation differ from the no-fishing baseline by less than 10 percentage points. These criteria are similar, or identical, to the criteria used by the co-managers in developing several of the RMP's rebuilding exploitation rates. See Appendix C: Technical Methods - Derivation of Chinook Management Objectives and Fishery Impact Modeling Methods of the FEIS on the proposed determination for additional information on how NMFS developed its rebuilding exploitation rates (page 24 of the FEIS).

Table 8 compares the RMP's low abundance (lower) and upper management (upper) thresholds with the NMFS-derived critical (lower) and viable (upper) thresholds. For populations lacking the NMFS-derived critical and viable population thresholds, generic guidance from the VSP paper or available analyses of habitat capacity (such as using Ecosystems Diagnosis and

Treatment methodology) have been used to assist NMFS in evaluating the proposed RMP's thresholds.

Generic guidance from the VSP paper suggests that effective population sizes of less than 500 to 5,000 fish per generation are at increased risk (NMFS 2000b). The population size range per generation was converted to an annual spawner abundance range of 125 to 1,250 fish by dividing by four, which is the approximate generation length for Puget Sound chinook salmon. The VSP generic guidance for a critical threshold of 200 fish has been used to evaluate the RMP's proposed thresholds for populations lacking the NMFS-derived critical thresholds.

The VSP paper also suggests that effective population sizes of 5,000 to 16,700 fish are robust against most sources of risk (NMFS 2000b). Using the same average generation length of four years, the annual spawner range would be 1,250 to 4,175 spawners. Where the actual viable thresholds fall within these ranges depends on the characteristics of the populations themselves. The viable threshold of 1,250 fish, or when available, the analyses of habitat capacity have been used to evaluate populations lacking the NMFS-derived viable thresholds. The co-managers have completed several habitat studies for select systems within the ESU. These studies estimate the chinook salmon production potential of those systems under current conditions. When available, NMFS used the results from these studies to assess the risk of the thresholds in the RMP for those management units that lack the NMFS-derived viable thresholds.

These VSP-derived thresholds offer only general guidance as to what generally represents points of stability or instability. Some population may be fairly robust at very low abundances, while other populations in large river systems may become unstable at higher abundances depending on resource location and spawner density. However, without population-specific information, NMFS believes these generic guidelines offer the best available information.

The use of the threshold concept by the RMP is required by the ESA 4(d) Rule. A population will be identified in this proposed evaluation as having a potential increased level of risk[5] when the abundance of that population does not meet its critical threshold. In this evaluation, populations with abundance slightly above the critical threshold will also be highlighted and identified as of a population of concern. Additional discussion of the populations identified with an increased level of risk or concern, in regards to the likelihood of survival and recovery of the ESU, will be provided in Section (b)(4)(i)(D).

The trend in escapement was also considered in evaluating the population's status. In March 1999, the Puget Sound Chinook Salmon ESU was listed as a threatened species under the ESA. A general post-listing assessment of each population's escapement trend as either decreasing, remaining stable or increasing can be made by comparing the 1999 to 2002 average escapement with the 1990 to 1998 average escapement (Table 8). The following system was used to determine the trend of the populations:

[5] When compared to populations at or above its critical threshold.

Increasing - The trend of a population was considered increasing if the difference in the 1999 to 2002 average escapement was greater than 10 percent above the pre-listing 1990 to 1998 average escapement;

Decreasing - The trend of a population was considered decreasing if the difference in the 1999 to 2002 average escapement was less than 10 percent below the pre-listing 1990 to 1998 average escapement; and

Stable - The trend of a population was considered stable if the difference in the 1999 to 2002 average escapement was within 10 percent the pre-listing 1990 to 1998 average escapement.

One of the criteria for Limit 6 of the ESA 4(d) Rule is that harvest actions that impact populations at or above their viable thresholds must maintain the population or management unit at or above that level (50 C.F.R. 223.203(b)(4)(i)(B)). Nine of the twenty-two Puget Sound Chinook Salmon ESU populations are above their respective viable thresholds (Table 9). Based on the method described above, all populations above their respective viable thresholds have a stable (two populations) to increasing (seven populations) trend in escapement (Table 9). Overall, along with other on-going habitat and hatchery programs, the results of harvest actions since the ESA listing of the Puget Sound Chinook Salmon ESU appears to be maintaining these populations above the viable threshold levels as required by the ESA 4(d) Rule.

Another criterion for Limit 6 of the ESA 4(d) Rule is that fishing-related mortality on populations above critical levels, but not at viable levels (as demonstrated with a high degree of confidence), must not appreciably slow achievement to viable function. Twelve populations are above their respective critical levels, but below their respective viable levels (Table 9). Of these, four populations have a stable escapement trend and eight populations have an increasing escapement trend (Table 9). Overall, along with other on-going habitat and hatchery programs, the results of harvest actions since the ESA listing of the Puget Sound Chinook Salmon ESU appears to have not appreciably slowed achievement to viable function for these populations, as required by the ESA 4(d) Rule.

The criterion for populations at or below their critical thresholds is that fishing-related mortality on the population must not appreciably increase genetic and demographic risks facing the population, and does not preclude achievement of viable functions, unless the RMP demonstrates the likelihood of survival and recovery of the entire ESU in the wild would not be appreciably reduced by greater risks to an individual population. Only one population in the ESU, the North Fork Nooksack River population, is considered to be below its critical threshold (Table 9). A discussion concerning the status of the North Fork Nooksack River population follows.

North Fork Nooksack River Population - The 1999 to 2002 four-year average natural-origin spawning escapement for the North Fork Nooksack River population, which includes the Middle Fork Nooksack River, is 180 fish. The four-year average abundance of the North Fork Nooksack River population falls below the NMFS-derived critical threshold of 200 fish. The North Fork Nooksack River natural-origin population has an increasing escapement trend since listing (Table 9).

Table 8. Recent average annual escapement levels compared with the RMP's and the NMFS-derived lower and upper thresholds for Puget Sound chinook salmon management units and individual populations.

Management Unit	Population	1990 to 1998 Average Escapement	1999 to 2002 Average Escapement	RMP's Threshold Lower	RMP's Threshold Upper	NMFS-derived Thresholds Lower [1]	NMFS-derived Thresholds Upper [2]
Nooksack	Natural-Origin Spawner:	297	429	-	*4,000*	*400*	*500*
	North Fork Nooksack	144	180	*1,000*	*2,000*	*200*	-
	South Fork Nooksack	153	249	*1,000*	*2,000*	*200*	-
Skagit Summer/Fall	Natural Spawners:	8,698	13,810	*4,800*	*14,500*	-	-
	Upper Skagit River	6,676	10,144	*2,200*	*8,434*	*967*	*7,454*
	Lower Sauk River	539	721	*400*	*1,926*	*200*	*681*
	Lower Skagit River	1,484	2,944	*900*	*4,140*	*251*	*2,182*
Skagit Spring	Natural Spawners:	1,014	1,075	*576*	*2,000*	-	-
	Upper Sauk River	392	364	*130*	*986*	*130*	*330*
	Suiattle River	398	380	*170*	*574*	*170*	*400*
	Upper Cascade River	224	330	*170*	*440*	*170*	-
Stillaguamish	Natural-Origin Spawners:	828	980	*650*	*900*	-	-
	N.F. Stillaguamish River	557	697	*500*	*600*	*300*	*552*
	S.F. Stillaguamish River	271	283	-	*300*	*200*	*300*
Snohomish	Natural-Origin Spawners:	2,627	3,936	*2,800*	*4,600*	-	-
	Skykomish River	1,625	2,118	*1,745*	*3,600*	*1,650*	*3,500*
	Snoqualmie River	1,003	1,818	*521*	*1,000*	*400*	-
Lake Washington	Natural Spawners:	624	767	-	-	-	-
	Cedar River	417	385	*200*	*1,200*	-	-
	Sammamish River	208	373	-	-	-	-
Green River	Natural Spawners:						
	Duwamish-Green River	6,737	9,299	*1,800*	*5,800*	*835*	*5,523*
White River	Natural Spawners:						
	White River	403	1,220	*200*	*1,000*	-	-
Puyallup	Natural Spawners:						
	Puyallup River	2,173	1,672	*500*	-	-	-
	South Prairie Cr. Index Area	1,032	1,029	-	*500*		
Nisqually	Natural Spawners:						
	Nisqually River	893	1,318	-	*1,100*	-	-
Skokomish	Natural Spawners:						
	Skokomish River	981	1,503	*1,300* [3]	*3,650* [4]	-	-
Mid-Hood Canal	Natural Spawners:						
	Mid-Hood Canal Rivers	178	404	*400*	*750*	-	-
Dungeness	Natural Spawners:						
	Dungeness River	138	345	*500*	*925*	-	-
Elwha	Natural Spawners:						
	Elwha River	1,994	2,009	*1,000*	*2,900*	-	-

[1] Critical threshold under current habitat and environmental conditions.

[2] Viable thresholds under current habitat and environmental conditions

[3] Skokomish Management Unit's critical escapement threshold of 1,300 spawners is composed of 800 natural-origin spawners and 500 hatchery-return spawners.

[4] Skokomish Management Unit's escapement goal of 3,650 spawners is composed of 1,650 natural-origin spawners and 2,000 hatchery-return spawners. If the recruit abundance is insufficient for the goal to be met, OR regardless of the total escapement, the naturally spawning component of the Skokomish River population is expected to fall below 1,200 spawners, *or* the hatchery component is expected to result in less than 1,000 spawners, additional terminal fishery management measures will be taken, with the objective of meeting or exceeding the 1,200 naturally spawning levels (see page 175 of the RMP).

Table 9. Post-listing threshold classification and escapement trend since listing for Puget Sound chinook salmon populations.

Classification [1]	Management Unit	Population	Percent Difference Since Listing [2]	Trend Since Listing [3]
Since listing, the average escapement is above the upper threshold:	Skagit Summer/Fall:	Upper Skagit River	52%	Increasing
		Lower Sauk River	34%	Increasing
		Lower Skagit River	98%	Increasing
	Skagit Spring	Upper Sauk River	-7%	Stable
	Stillaguamish	N.F. Stillaguamish River [4]	25%	Increasing
	Snohomish	Snoqualmie River [4]	81%	Increasing
	Green River	Duwamish-Green River	38%	Increasing
	Puyallup	Puyallup River S. Prairie Creek Index Area [5]	0%	Stable
	Nisqually	Nisqually River	48%	Increasing
Since listing, the average escapement is above the lower threshold but below the upper threshold:	Nooksack	S. F. Nooksack River [4]	63%	Increasing
	Skagit Spring:	Suiattle River	-5%	Stable
		Upper Cascade River	48%	Increasing
	Stillaguamish	S.F. Stillaguamish River [4]	5%	Stable
	Snohomish	Skykomish River [4]	30%	Increasing
	Lake Washington:	Cedar River	-8%	Stable
		Sammamish River	79%	Increasing
	White River	White River	203%	Increasing
	Skokomish	Skokomish River: Natural Spawners	53%	Increasing
	Mid-Hood Canal	Mid-Hood Canal Rivers	127%	Increasing
	Dungeness	Dungeness River	149%	Increasing
	Elwha	Elwha River	1%	Stable
Since listing, the average escapement is below the lower threshold:	Nooksack	N. F. Nooksack River [4]	25%	Increasing

[1] The thresholds used in the classification were either the NMFS-derived critical and viable population thresholds under current conditions or thresholds derived using the VSP guidance for critical and viable levels.

[2] The percent difference in the post-listing 1999 to 2002 average escapement when compared to the pre-listing 1990 to 1998 average escapement.

[3] The trend of a population was considered increasing if the 1999 to 2002 average escapement was 10 percent or greater than the 1990 to 1998 average escapement. The trend of a population was considered decreasing if the 1999 to 2002 average escapement was 10 percent or less than the 1990 to 1998 average escapement. The trend of a population was considered stable if the 1999 to 2002 average escapement was within 10 percent of the 1990 to 1998 average escapement.

Footnote to Table 9 continued:

[4] Natural-origin spawners.
[5] NMFS assumed that the escapement trend for the South Prairie Creek and Wilkeson Creek (jointly referred to as the South Prairie index area) are representative of the escapement trend for the entire Puyallup River population. It is believed that the South Prairie index area provides a more accurate trend in the escapement for the Puyallup River because it is the only area in the Puyallup River for which spawners or redds can be consistently counted (W. Beattie, NWIFC, e-mail to K. Schultz, NMFS, January 31, 2004). Additionally, available information suggests that South Prairie Creek contains the highest quality spawning habitat in the system. Confidence in the South Prairie index area escapement estimates improved when the area surveyed increased from 1.5 to 12.5 stream miles in 1994. Surveys consistently identified substantial numbers of spawners in the mainstem Puyallup River, Carbon Creek, and other tributaries. However, total escapement estimates into the Puyallup River system is considered unreliable at this time.

Chinook salmon produced through the Kendall Creek Hatchery program, located on the North Fork Nooksack River, is also listed under the ESA, as they were considered essential for the recovery of the ESU. Production from Kendall Creek Hatchery contributes extensively to the annual return abundance of the North Fork Nooksack River population. If escapement of the hatchery-origin fish to the natural spawning grounds is considered, the 1999 to 2002 four-year average spawning escapement is 3,438 fish for the North Fork Nooksack River (Table 10).

Table 10. Natural-origin and natural spawners, North Fork Nooksack River, 1999 to 2002.

Management Unit	North Fork Nooksack River Population	1999	2000	2001	2002	1999 to 2002 Average
Nooksack	Natural-Origin Spawners:	91	159	250	221	180
	Natural Spawners [1]	911	1,365	4,057	7,419	3,438

[1] Natural spawners include first generation hatchery-origin adults that spawn in natural spawning areas.

Genetic analysis of natural origin and Kendall Creek Hatchery-origin spring chinook salmon indicate that there are no significant differences between the natural and hatchery populations, and that they are one distinct stock (Young and Shaklee 2002). Additionally, the co-managers are applying operational techniques that decrease the likelihood for divergence of the hatchery population from the extant natural population. Adult fish production resulting from the Kendall Creek hatchery program buffers genetic and demographic risks to the North Fork Nooksack River population. Therefore, at this time, NMFS concludes that the RMP does not appreciably increase genetic and demographic risks facing this population, as required by the ESA 4(d) Rule, for a population below their critical level. Discussion of this population’s status, in regards to the likelihood of survival and recovery of the ESU, is in the Section (b)(4)(i)(D).

In addition to the discussions of the status of the populations, the ESA 4(d) Rule requires a risk analysis of the populations under the implementation of the RMP. The VSP document (NMFS 2000b) describes four key parameters for evaluating the status of salmonid populations. These parameters are: (1) population size (abundance); (2) population growth rate (productivity); (3) spatial structure; and (4) diversity. Below is an evaluation of how the RMP addresses these four VSP parameters for the Puget Sound Chinook Salmon ESU.

(1) Population Size

To analyze risks posed by the RMP on Puget Sound chinook salmon population's size or abundance, anticipated escapement results under the implementation of the RMP are compared with NMFS' standards of a critical (lower) and viable (upper) thresholds.

Lower Thresholds:

Table 2 provides the proposed RMP's low abundance thresholds. NMFS has derived critical thresholds for 13 populations. The NMFS-derived critical thresholds ranged from 170 to 1,650 fish (see Table 8). For those populations for which the RMP identifies a corresponding low abundance threshold, the RMP's thresholds are either the same, or more commonly, greater than the NMFS-derived population-specific critical thresholds. For these populations with NMFS-derived critical thresholds, the corresponding RMP's proposed low abundance thresholds are consistent with NMFS' standards.

There are nine populations for which NMFS has yet to derive a critical threshold (see Table 8). The proposed RMP's low abundance thresholds for these nine populations exceed the minimum VSP generic guidance of 200 annual spawners. For these nine populations, the RMP's proposed low abundance thresholds are consistent with the VSP guidance for a critical threshold.

However, for two populations, the RMP does not propose a low abundance threshold to use in a comparison with NMFS' standards. For the Stillaguamish Management Unit, NMFS has derived a critical threshold for both populations. The RMP did not establish a low abundance threshold for one of these populations, the South Fork Stillaguamish River population (see Table 8). The RMP also provides no low abundance threshold for the Sammamish River population (see Table 2). The following is a risk analysis associated with the lack of a low abundance threshold in the RMP for the South Fork Stillaguamish River and Sammamish River populations.

South Fork Stillaguamish River - The Stillaguamish Management Unit includes two populations: the North Fork Stillaguamish River and the South Fork Stillaguamish River populations. Both populations are classified as a Category 1 watershed population (see Table 7). The RMP establishes a low abundance threshold for the Stillaguamish Management Unit of 650 fish, and a low abundance threshold for the North Fork Stillaguamish River population of 500 fish (see Table 2). Both low abundance thresholds are based on natural-origin spawners. However, the RMP provides no low abundance threshold for the South Fork Stillaguamish River population, citing that there is very little information concerning the productivity of this population (page 134 of the RMP).

The 1999 to 2002 four-year average of 697 fish for the North Fork Stillaguamish River population is above the NMFS-derived viable threshold (see Table 8). Since listing, the escapement trend of the North Fork Stillaguamish River population is considered increasing (see Table 9). The escapement trend for the South Fork Stillaguamish River population is considered stable (see Table 9). The 1999 to 2002 four-year average of 283 fish for the South Fork Stillaguamish River population is above the NMFS-derived critical threshold of 200 fish but below the NMFS-derived viable threshold of 300 fish (see Table 8).

Recent (1999 to 2002) natural-origin escapement observations for these two systems were used to estimate the South Fork Stillaguamish River population escapement when the population nears the management unit's proposed low abundance threshold of 650 fish. On average, escapement into the South Fork Stillaguamish River was 28.9 percent of the total natural-origin escapement in the Stillaguamish River (Table 11). At natural-origin escapements approaching the RMP's low abundance threshold of 650 natural-origin fish for this management unit, assuming similar proportions to recent escapement observations, the natural-origin escapement into to the South Fork Stillaguamish River population would be 188 fish (28.9 percent of 650).

Table 11. Recent range and average natural-origin escapements for the two populations within the Stillaguamish Management Unit.

	1999 to 2002 Escapement		
Population:	Range	Average	Percent
N. F. Stillaguamish River	514 to 884	697	71.1%
S. F. Stillaguamish River	253 to 353	283	28.9%
Total		980	100%

An escapement of 188 fish is slightly below the NMFS-derived critical threshold of 200 fish for the South Fork Stillaguamish River population, suggesting a potential elevated level of risk for South Fork Stillaguamish River population under the implementation of the RMP. However, this potential elevated level of risk would only occur when the returning abundance approaches the RMP's low abundance threshold of 650 fish for this management unit. Actual impacts on the South Fork Stillaguamish River population, associated with the implementation of the RMP, will depend on the returning abundance in the next five years, from May 1, 2005 through April 2010, the remaining duration of the proposed RMP.

The anticipated returns to the Stillaguamish Management Unit are well above the 650 fish RMP's low abundance threshold. The range of anticipated escapements to the Stillaguamish Management Unit under the implementation of the RMP is 1,584 to 2,322 fish. The range of anticipated escapements to the South Fork Stillaguamish River population under the implementation of the RMP is 293 to 429 fish (see Appendix A of this evaluation). The most likely South Fork Stillaguamish River escapement under the implementation of the RMP is 421 fish (see Table 5). The most likely escapement to the South Fork Stillaguamish River exceeds the NMFS-derived viable threshold of 300 fish. Therefore, it is unlikely the level of risk to the South Fork Stillaguamish River population will increase in the next five years, from May 1, 2005 through April 2010, when compared to NMFS' standards, resulting directly from the lack of a low abundance threshold in the RMP.

Sammamish River - The Lake Washington Management Unit contains two chinook salmon populations; the Cedar River (Category 1) and the Sammamish River (Category 2) populations (see Table 7). The RMP's low abundance threshold for the Cedar River population is 200 chinook salmon. Total escapement estimates for the Cedar River population are based on an expansion of a live count of fish. However, Cedar River redd counts suggests that this expansion of the live count may be a conservative estimate of the total escapement (P. Hage, Muckleshoot Tribe, e-mail to S. Bishop, NMFS, February 10, 2004). Therefore, a direct comparison of Cedar

River escapements, based on an expansion of a live count, with the VSP generic guidance for a critical threshold of 200 fish should be considered conservative, as the total escapements are likely greater.

The RMP contains no low abundance thresholds for the Sammamish River population. The status of Sammamish River population natural production is not well understood. The contribution of non-listed hatchery-origin chinook salmon to the natural spawning escapement in the Sammamish River has not been quantified in the past, although mass marking of Issaquah Creek Hatchery production will enable this in the future (W. Beattie, NWIFC, e-mail to K. Schultz, NMFS, January 31, 2004). However, as evidenced by its Category 2 classification, hatchery contribution to the Sammamish River population is believed to be high. Since listing, the trend for the Sammamish River population's escapement is considered increasing (see Table 9).

Escapement estimates presented in Table 6 for the Sammamish River population do not include escapement into the Upper Cottage Lake Creek. The Upper Cottage Lake Creek has only been surveyed since 1998, preventing a longer term trend analysis. Annual salmon count surveys of the Upper Cottage Lake Creek have exceeded 200 fish in recent years (see Table 2, page 154 of the RMP). Additionally, Sammamish River escapement counts presented in Table 6 do not include spawners in Issaquah Creek, which are believed to be primarily Issaquah Hatchery returns (N. Sands, NMFS, e-mail to S. Bishop, NMFS, February 26, 2004). Therefore, although the escapement information present in Table 6 is believed to be representative of this population's abundance trend, the escapement estimates are to be considered a minimum estimate of the total Sammamish River population's escapement. As with the Cedar River population, a direct comparison of Sammamish River escapements with the VSP generic guidance for a critical threshold of 200 fish should be considered conservative, as the total escapements are likely greater.

The range of anticipated escapements to the Sammamish River under the implementation of the RMP is 214 to 305 fish (see Table 3). These estimates are based upon the spawner index database, and since that database represents a minimum estimate, and excludes fish in tributaries and reaches that are not included in the index, these estimates are assumed to be minimums. The most likely escapement for the Sammamish River population under the implementation of the RMP is a minimum of 294 fish (see Table 5). The most likely escapement for the Sammamish River population is above the VSP guidance of 200 fish for a critical threshold. Concerns do exist for this population, given that the range of anticipated escapements approaches the VSP-derived critical threshold. However, it is recognized that the actual total escapements into these systems will probably be greater given the conservative nature of the estimates. Additional discussion of the increased concern for this population's status, in regards to the likelihood of survival and recovery of the ESU, will be provided in Section (b)(4)(i)(D).

Upper Thresholds:

The RMP's upper management thresholds for the various management units or populations range from 300 to 14,500 fish (see Table 2). NMFS has independently derived viable thresholds for nine individual populations and one management unit ranging from 300 to 7,454 fish (see Table

8). NMFS used the RMP's upper management thresholds as a proxy for viable thresholds. For those populations for which the RMP identifies a corresponding upper management threshold, the RMP's thresholds are the same, or more commonly, greater than the NMFS-derived viable thresholds. For these populations, the RMP's upper management thresholds are consistent with NMFS' standards.

For populations which NMFS has yet to derive a viable threshold, the proposed RMP's upper management threshold exceeds the VSP generic guidance for a viable population of 1,250 fish for three populations (Cedar River[6], Skokomish River, and Elwha River). For these three populations, the levels of risk associated with the implementation of the proposed upper management thresholds are consistent with NMFS' standards.

For five populations without NMFS-derived viable thresholds (upper Cascade River, Snoqualmie River, White River, Nisqually River, and the Dungeness River), the proposed RMP's upper management threshold is less than a viable threshold that would be established using the VSP generic guidance. However, the RMP's upper management threshold for each of these populations is based on habitat studies or modeling results which suggests that each proposed threshold is consistent with the current capacity and productivity of the system. For these five populations, the levels of risk associated with the implementation of the proposed upper management thresholds are consistent with NMFS' standards.

For two of the remaining three populations without NMFS-derived viable thresholds (Sammamish River and Mid-Hood Canal rivers populations), the ranges of anticipated escapements over the next five years, from May 1, 2005 through April 2010, are very low, well below the proposed RMP's upper management threshold. Escapement levels are not expected to exceed the proposed upper management threshold under the implementation of the RMP (see Table 5 and Table 8). Therefore, it is unlikely that an elevated level of risk from harvest impacts on these two populations will result directly from the implementation of the proposed upper management thresholds in the RMP. However, the low levels of anticipated escapements for these two populations do raise concerns, which will be addressed later in this document.

The RMP proposes an upper management threshold of 500 fish for the remaining population without a NMFS-derived viable threshold, the Puyallup River population. The co-managers' threshold is based on escapement levels for the South Prairie Creek index area. The co-managers propose that by achieving an escapement to South Prairie Creek index area of at least 500 fish, viable natural production for the entire system would be assured (see page 166 of the RMP). The anticipated range of escapements to the Puyallup River under the implementation of the RMP is 1,798 to 2,419 fish (see Table 3). Since the entire range of anticipated escapements exceeds the VSP generic guidance of 1,250 fish, the level of risk for the Puyallup River population associated with the implementation of the proposed RMP's upper management thresholds are consistent with NMFS' standards.

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6 Given the conservative nature of the Cedar River escapement estimates, the RMP's upper management threshold of 1,200 fish for this population is considered to meet the VSP guidance of 1,250.

In summary of the upper management thresholds proposed by the co-managers in the RMP, most Puget Sound chinook salmon populations meet or exceed the NMFS-derived or VSP-derived viable thresholds. For several populations, the anticipated abundance levels over the next five years, from May 1, 2005 through April 2010, make the application of the RMP's upper thresholds very unlikely. Therefore the levels of risk associated under the implementation of the RMP's upper management thresholds are consistent with NMFS' standards.

(2) Productivity

Harvest management objectives must be appropriate for the habitat capacity and productivity requirements of individual populations. The RMP provides no explicit management objectives for productivity. The exploitation rates, upper management thresholds, escapement goals, and the low abundance thresholds are based, when feasible, on current survival and productivity rates, with adjustments to account for data uncertainty and management imprecision.

Productivity is generally understood to be the ratio of the abundance of juvenile or adult produced in one generation to the abundance of their parent spawners. Productivity is primarily driven by habitat quantity, quality, and reproductive fitness. All watersheds in Puget Sound have degraded habitat from a variety of causes, including logging, road building, agriculture, urbanization, flood control and hydropower. The degree to which each of these causes contributes to the decline in habitat quality or quantity varies from watershed to watershed.

Another aspect of habitat quality is the level of marine-derived nutrients introduced into an ecosystem by eggs deposited by spawning salmon and by decaying salmon carcasses. This can be influenced in part, by fisheries, since they will have a negative effect on escapement. The RMP addresses the role of adult salmon in nutrient re-cycling in Appendix D: Role of Salmon in Nutrient Enrichment of Fluvial Systems of the RMP. Marine-derived nutrients are a source of food for juvenile salmonids, invertebrates, and provide basic nutrients to the ecosystems (Larkin and Slaney 1996; Gresh *et al.* 2000; Murota 2003; Wipfli *et al.* 1998). However, nutrient dynamics in aquatic systems is very complex (Polis *et al.* 1997; Bisson and Bilby 1998; Murphy 1998; Naiman *et al*. 2000). The importance of salmon nutrient re-cycling within a given aquatic ecosystem remains very poorly understood and is dependent on numerous site-specific factors. These factors include: the species of salmon; spawning density; spawning location; stream discharge regimes in the area; stream habitat complexity; basin geology; light; temperature; and ecosystem community structure.

The role of returning adult chinook salmon as a means of re-cycling nutrients into a freshwater ecosystem must be examined in the context of the limitations of current research on the subject, chinook salmon life history, and chinook salmon abundance relative to the generally more abundant escapement of coho salmon (*Oncorhynchus kisutch)*, pink salmon (*O. gorbuscha*), and chum salmon (*O. keta*) in the larger river systems that typically support the Puget Sound chinook salmon populations. Additionally, while the limited available research suggests that salmon-derived nutrients can benefit coho salmon, sockeye salmon (*O. nerka*), and cutthroat trout (*O. clarki*) populations, data and technical tools establishing or quantifying the relationship between marine-derived nutrients and chinook salmon are not available.

Chinook salmon populations in Puget Sound typically exhibit a relatively short freshwater residence, at least when compared with coho salmon, sockeye salmon, and steelhead. It is not known if newly emerged chinook salmon fry actively feed on chinook salmon carcasses, or if chinook salmon carcasses are retained for a sufficient period in the freshwater ecosystem to allow direct consumption by emerging fry, especially in the larger river systems which support chinook salmon. The larger river systems in the action area generally exhibit peak winter flow events which may flush the chinook salmon carcasses from the freshwater ecosystem prior to the emergence of juvenile chinook salmon.

The benefits of marine derived nutrients for juvenile chinook salmon may be more fully realized in estuaries (Simenstad 1997), where most chinook salmon rear for a critical period prior to migrating seaward. However, even less is known about the role of marine-derived nutrients in estuaries. Consequently, it has not been demonstrated that carcass nutrient limitation, as it may affect secondary production of prey species or direct enhancement of food supply, currently exerts a key limit on the productivity of chinook salmon in the Puget Sound Action Area.

The co-managers propose to continue monitoring and the evaluation of the fisheries as required in the RMP. Based on information they obtain and that may be provided by other resource managers, the co-managers may revise the management objective in future plans, reflecting changes in environmental conditions and scientific understanding of carcass nutrient limitation. The intent of the co-managers is to increase spawning escapement in concert with the recovery of the system's productivity and capacity resulting from habitat restoration efforts. Under this approach, the co-managers will annually provide sufficient escapement to enable each management unit to generate maximum surplus under progressively improving habitat conditions. The RMP's harvest strategy will complement concurrent efforts to restore and protect habitat, improve hatchery management practices, and mitigate the impacts of hydroelectric operations. In addition, spawner recruit functions used to derive many of the RMP's objectives express the impacts of all the factors that influence productivity, including nutrient input. However, changes in productivity will be exceedingly difficult to attribute to changes in nutrient input relative to other environmental responses.

Natural Factors

Changes in the abundance of salmonid populations are substantially affected by changes in the freshwater and marine environments. For example, large scale climatic regimes, such as El NiZo, affect changes in ocean productivity. Much of the Pacific coast was subject to a series of very dry years during the first part of the 1990s. In more recent years, severe flooding has adversely affected some stocks.

Salmon are exposed to high rates of natural predation, particularly during freshwater rearing and migration stages. Ocean predation may also contribute to natural mortality, although the levels of predation are largely unknown. In general, salmonids are prey for pelagic fishes, birds, and marine mammals, including harbor seals, sea lions, and killer whales. There have been recent concerns that rebounding seal and sea lion populations, following their protection under the Marine Mammal Protection Act of 1972, has resulted in substantial mortality for salmonids.

Recent evidence suggests that marine survival of salmon species fluctuates in response to 20 to 30 year long periods of either above or below average survival that is driven by long-term cycles of climatic conditions and ocean productivity (Cramer *et al.* 1999). This phenomenon has been referred to as the Pacific Decadal Oscillation (Mantua *et al.* 1997). Ocean conditions that affect the productivity of Puget Sound salmonid populations appear to have been an important contributor to the decline of many stocks prior to listing. Ocean conditions appear to have improved in recent years, which may have contributed to the increase in abundance of Puget Sound salmonid populations since listing. However, NMFS does not have data to corroborate an improved marine survival trend for Puget Sound populations at this time. The survival and recovery of these species will depend on their ability to persist through periods of low ocean survival when stocks may depend on better quality freshwater habitat and lower relative harvest rates.

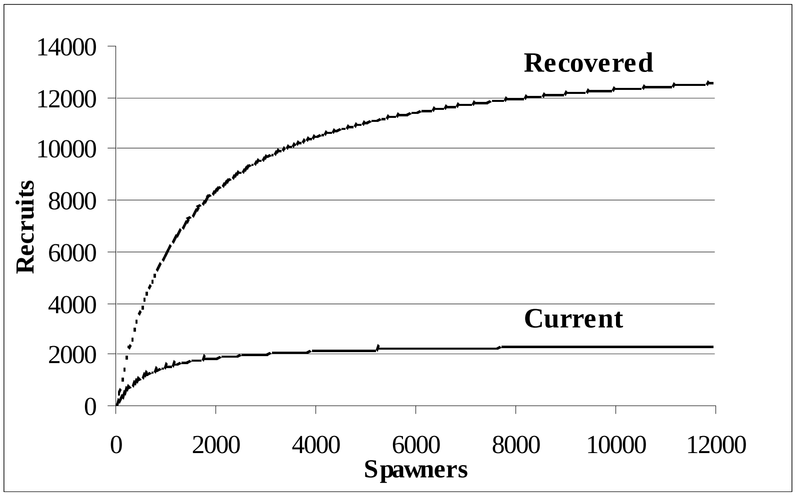
Performance under Current Habitat and Environmental Conditions:

The survival and recovery of the Puget Sound Chinook Salmon ESU will depend, over the long term, on responses to limiting factors, including those associated with hatchery and habitat. Completion of the ESU recovery plan and decisions regarding the form and timing of recovery efforts described in the recovery plan is ongoing, but will determine the kinds of harvest actions that may be necessary and appropriate in the future. Absent guidance provided in a recovery plan, NMFS evaluated the RMP by examining the isolated impacts of harvest on the ESU under current conditions. Therefore, this document evaluates the future performance of the population under current productivity conditions, assuming that the impacts of the hatchery and habitat actions remain as they are presently.

Though the Puget Sound TRT has not specifically determined what is needed for recovery of the Puget Sound Chinook Salmon ESU, the TRT have derived preliminary recovery goals for most populations (NMFS 2002a). The TRT's preliminary recovery goals can provide a useful contrast between current productivity and the level of potential productivity associated with recovery. For most Puget Sound chinook salmon populations, recovery is dependent on an increase in productivity (recruitment) relative to current status, not simply achieving the optimum escapement levels associated with current habitat conditions. Past harvest constraints have contributed to stable or increasing trends in escapements, which for several populations include hatchery-origin adults. However, the trend in natural-origin returns, when compared with hatchery returns, into several systems suggests that marine, freshwater, and estuary habitat quality and quantity is the primary constraint on productivity. Spawner-recruit functions derived from Ecosystems Diagnostics and Treatment or EDT [7] modeling of habitat capacity under current

[7] The Ecosystems Diagnostics and Treatment or EDT model provides a conceptual framework for organizing information to describe a watershed ecosystem in order to apply scientific principles to the understanding of that ecosystem. The model describes how the fish population would respond to conditions in a stream based on our scientific understanding of their needs. It is an analytical tool used to analyze environmental information and draw conclusions about the ecosystem, and designed to provide a practical, science-based approach for developing and implementing watershed plans. EDT models have been used to develop fish and wildlife plans for many watersheds throughout the Pacific Northwest.

and recovered conditions demonstrates that natural production is constrained below that associated with a recovered habitat condition (Figure 3).



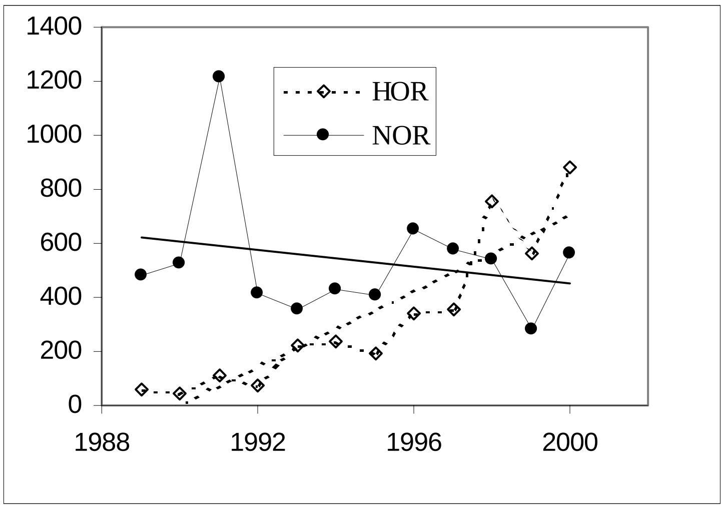
Source: T. Scott, WDFW, March 22, 2004.

Figure 3 Productivity (adult recruits) of North Fork Stillaguamish summer chinook salmon under current and recovered habitat conditions. Beverton-Holt functions derived from habitat analysis using the Ecosystems Diagnostics and Treatment or EDT method.

Further harvest constraint will not, by itself, effect an increase above the asymptote associated with current productivity, until habitat conditions improve. Very similar conclusions can be drawn from examination of current natural-origin escapement trends in the North Fork Nooksack, Skykomish, and Dungeness rivers. In these systems, natural-origin returns have remained at very low levels, while total natural escapement has increased due to hatchery supplementation programs.

In making an evaluation of future escapement performance under current productivity conditions, it would be useful to examine recent escapement trends in relation to past reductions in harvest rates. Mass marking of hatchery production has enabled managers to begin accurate accounting of the contribution of natural-origin and hatchery-origin spawners to the natural escapement for several Puget Sound chinook salmon populations (see Chapter 6 of the RMP and Appendix A: Management Unit Status Profiles of the RMP). Sufficient data has accumulated to conclude that reductions in harvest rates, along with more favorable conditions for marine survival, have contributed to an increasing trend in hatchery-origin returns. In some systems the harvest rates have been reduced by 30 to 70 percent from the mid-1980s. However, the returns of natural-origin fish in those same systems have not responded similarly. This evidence suggests that, in some systems, natural production is constrained primarily by the condition of the marine, freshwater, and estuary habitat.

The population trend for the North Fork Stillaguamish River is cited here as an example, although, similar escapement data is available for the populations within the North Fork Nooksack and Skykomish Rivers. Fingerlings released by the summer chinook salmon supplementation program are coded wire tagged, enabling accurate estimation of their contribution to escapement. The 2001 to 2003 three-year average total, adult-equivalent exploitation rate for the Stillaguamish Management Unit of 15 percent has declined 71 percent when compared with the 1983 to 1987 five-year average total, adult-equivalent exploitation rate of 54 percent (see Table 13, page 47, of the RMP). Although the return of hatchery-origin chinook salmon appear to have responded to this decrease in exploitation rate, exceeding 800 since 1989, the natural-origin returns have remained relatively stable in the last five years, averaging 522 fish (Figure 4). Hatchery production since 1989 has been relatively constant (T. Tynan, NMFS, pers. com., to K. Schultz, NMFS, March 25, 2004).



Source: T. Scott, WDFW, March 22, 2004.

Figure 4. The return of natural-origin (NOR) chinook salmon to the North Fork Stillaguamish River has remained relatively stable, while the number of hatchery-origin adults (HOR) have increased substantially.

Harvest constraint, along with other ongoing conservation efforts; has contributed to stable or increasing abundance trends in escapement. However, the abundance trend in the natural-origin returns suggests that, although escapement may be stable or even trend upward toward or above the optimum level associated with current habitat condition, natural-origin recruitment will not increase much beyond that level unless constraints limiting survival prior to entry to fisheries are alleviated

The reductions of harvest pressure, along with improvements in other sectors, appears to have contributed to stabilized natural-origin escapement, in areas where data is available, and the listed hatchery supplementation program further guards against catastrophic decline. While acknowledging the risk of density dependent effects, implementing the RMP will experimentally test production at these higher escapement levels, and capitalize on favorable survival conditions that may occur.

(3) Spatial Structure

The spatial structure of a population results from a complex interaction of the genetic and life history characteristics of a population, the geographic and temporal distribution and quality of habitat, and the disturbance level of the habitat. Although the understanding of these interactions is limited, the ability of individuals to successfully colonize and move through habitat at each subsequent life stage is essential for population viability.

Spatial structure should be taken into account in the analysis of the populations with the implementation of the RMP for at least three reasons: 1) the spatial and temporal distribution, quantity, and quality of habitat (landscape structure) dictates how effectively juvenile and adult salmon can bridge freshwater, estuarine, nearshore and marine habitat patches during their life cycle; 2) there is a time lag between changes in spatial structure and population response, and extinction risk at the 100-year time scale may be affected in ways not readily apparent from short-term observations of abundance and productivity; and 3) population spatial structure affects evolutionary processes and may therefore alter a population's ability to respond to environmental change (PSTRT 2003).

A fishery could target a certain portion of the run, which may result in a decrease in the number of spawners destined to a particular spawning location or population through time. For example, the early portion of a run of salmon may be the fish that will spawn the farthest upstream. If a fishery harvests just the early portion of the total adult return, the percentage of the population spawning in the upper portion of the system may be changed.

In Puget Sound, the co-managers generally shape salmon fisheries to harvest throughout the run timing of the returning adults. However, when harvest must be reduced, fishing-related mortality on listed chinook salmon is reserved as incidental harvest in salmon fisheries directed at other species. In these situations, the salmon fishery may concentrate incidental fishing-related mortality on the extreme ends of the run timing of listed fish in order to protect the majority of the run while providing access to other salmon species. The extent that a fishery may concentrate incidental fishing-related mortality on the extreme ends of the run could vary from year to year. In mixed-population salmon fisheries, harvest generally occurs throughout the migration of the returning chinook salmon. In terminal areas where chinook salmon are caught incidentally in fisheries targeting other species, harvest probably affects 15 percent or less of the run on either end of the run timing. There is currently no information to indicate that these incidental impact salmon fisheries are having deleterious effects on certain segments of the populations or to the ESU. For example, NMFS' status review (Myers *et al.* 1998) did not note any trends in size, weight, fecundity or other life history traits for Puget Sound chinook salmon that might be a result of fishing activities.

The spatial structure of the Mid-Hood Canal Management Unit is unique among the proposed management units. The Mid-Hood Canal Management Unit contains only one population, the Mid-Hood Canal rivers population (Category 2), which is composed of an aggregation of spawners from several adjacent rivers that are tributaries to Hood Canal. Unlike other populations within the ESU, these spawning aggregations are separated by salt water. Since most harvest impacts on this population occur outside Hood Canal, it is difficult for the co-managers to impose differential harvest effects on the individual spawning aggregate components in order to adjust spawning distribution among the rivers (W. Beattie, NWIFC, e-mail to K. Schultz, NMFS, January 31, 2004). For all populations, the RMP provides general guidelines to avoid focusing harvest on any one temporal segment of the return. The RMP establishes a low abundance threshold of 400 fish, which combines all the spawning components within the Mid-Hood Canal Management Unit. The RMP's aggregate upper management threshold for the Hood Canal Management Unit is 750 fish.

The historical structure of the Hood Canal chinook salmon population is unknown (PSTRT 2003). Historical returns and distributions of chinook salmon in Hood Canal have been affected by construction of dams, fisheries, and the introduction of non-native fish. The largest uncertainty within the Hood Canal populations, as identified by the TRT, is the degree to which chinook salmon spawning aggregations are demographically linked in the Hamma Hamma, Duckabush, and the Dosewallips Rivers. A possible alternative scenario, as identified by the TRT, is that the chinook salmon in the Hammam Hamma, Duckabush, and Dosewallips were independent populations (NMFS 2004b). Habitat differences do exist among these Mid-Hood Canal rivers. The Dosewallips River is the only system in the snowmelt-transition hydroregion (PSTRT 2003).

Although the TRT has identified two independent populations within Hood Canal Region[8] (the Skokomish and Mid-Hood Canal rivers populations), the TRT noted that important components of the historical diversity may have been lost, potentially due, in part, to the use of transplanted Green River origin fish for hatchery production in the region (PSTRT 2003). Life history information for the extant populations within Hood Canal Region was not useful in discriminating different populations (PSTRT 2003). The TRT also found genetic data not informative in reconstructing population structure under historical conditions. Allele frequencies between the Skokomish River population and the spawning aggregate in the Hamma Hamma River (Mid-Hood Canal rivers population) were not different ($P = 0.136$ as reported in PSTRT 2003). Extant Hood Canal chinook salmon belonged to the same genetic cluster as late-returning chinook salmon southern populations within the South Puget Sound Region (see Figure 5 in PSTRT 2003).

The 1999 to 2002 average escapement of 404 fish for the Mid-Hood Canal rivers population is only slightly above the co-managers' low abundance threshold of 400 fish (see Table 9). The Mid-Hood Canal Management Unit has exhibited an increasing escapement trend since listing (see Table 9). However, escapement trends in the individual rivers comprising the Mid-Hood Canal rivers population have not varied uniformly.

In recent years, the spawning aggregation in the Hamma Hamma River has generally comprised the majority of the Mid-Hood Canal rivers population (Table 12). In comparison, the Dosewallips River has seen a decrease in escapement during this same time period. Spawning

[8] The TRT identified five geographic regions within the Puget Sound Chinook Salmon ESU, which are based on similarities in hydrographic, biogeographic, and geologic characteristics. The TRT's regions will be discussed in more detail later within this document.

levels below 40 fish have been observed in recent years in the Duckabush and Dosewallips Rivers (see Table 6). However, exchange among the three spawning aggregations within the Mid-Hood Canal Management Unit, and with other Hood Canal natural and hatchery populations is probable (W. Beattie, NWIFC, e-mail com., to K. Schultz, NMFS, January 31, 2004). The demographic risks to the Mid-Hood Canal rivers population may be buffered by this straying at all abundance levels.

Table 12. The trend of the Mid-Hood Canal rivers population's individual spawning aggregates.

Mid-Hood Canal Rivers Population	1991 to 1995, 1998		1999 to 2002		Percent Difference [1]
	Average	Percent of Total	Average	Percent of Total	
All Spawning Components:	178	100.0%	404	100.0%	127%
Hamma Hamma River	64	36.0%	304	75.3%	375%
Duckabush River	17	9.6%	57	14.1%	235%
Dosewallips River	97	54.4%	43	10.6%	-56%

[1] The Percent Difference is the difference in percent of the 1999 to 2002 average escapement when compared to the 1991 to 1995, 1998 average escapement

The TRT suggests that most of the historical chinook salmon spawning in the Mid-Hood Canal rivers was "likely to [have] occurred in the Dosewallips River because of its larger size and greater area accessible to anadromous fish" (PSTRT 2003). However, production from the Hamma Hamma Fall Chinook Restoration Program, a hatchery-based supplementation program, has contributed substantially to the Mid-Hood Canal rivers population. The goal of the restoration program is to restore a healthy, natural-origin, self-sustaining population of chinook salmon to the Hamma Hamma River. This hatchery production is at least partially responsible for the recent increase in escapement observed in the Hamma Hamma River.

During 1999, it is estimated that about 77 percent of age-3 chinook salmon and 97 percent of age-4 chinook salmon spawning in the Hamma Hamma River were of hatchery origin. Overall, 83 percent of the chinook salmon returning to the Hamma Hamma River was hatchery-origin fish (as cited by WDFW/LLK 2002). The Hamma Hamma River hatchery-origin production has contributed substantially to the Mid-Hood Canal Management Unit's overall increasing escapement trend since listing (see Table 9). The program may also buffer demographic risks to the Mid-Hood Canal rivers population in the short term, particularly to the natural-origin spawning aggregate returning to the Hamma Hamma River.

The range of anticipated aggregate spawning escapements into the rivers of the Mid-Hood Canal Management Unit under the implementation of the RMP is 344 to 531 fish (see Table 3). The most likely escapement within in this range is 504 fish (see Table 5). Benefits to this population from reductions in fisheries-related impacts are limited. The co-managers, in cooperation with NMFS, have modeled escapement results under a no Puget Sound fishery alternative, and the most likely escapement under the "no fishery" scenario is 527 fish in the Mid-Hood Canal Management Unit, as discussed in more detail in the FEIS. With no Puget Sound fishing, escapement into the Mid-Hood Canal rivers population is only predicted to be increase by 23 fish, from 504 to 527 fish. Given the ratio of recent escapements into the individual river systems in the Mid-Hood Canal Management Unit (see Table 12), totally eliminating Puget Sound fisheries would only increase escapements into the Duckabush (14.1 percent of 23) and Dosewallips (10.6 percent of 23) Rivers by 3 and 2 fish, respectively.

Because of the currently low numbers of spawners in the individual rivers, and with there being no provision within the RMP to preserve the spatial structure of the escapement within and between component rivers for the Mid-Hood Canal rivers population there is a increased level of concern for the spatial structure of the escapement for this population. Additional discussion on this elevated level of concern for the Mid-Hood Canal rivers population, in regards to the likelihood of survival and recovery of the ESU, will be provided in Section (b)(4)(i)(D).

(4) Diversity

The transfer from parents to offspring (heritability) of certain biological traits such as age at maturity, growth rate, and the effect of these traits on each other has been researched and described (Clark and Blackbird 1994; Donaldson and Menasveta 1961; Hankin *et al.* 1993; Heath *et al.* 1994b; and Silverstein *et al.* 1998). Under certain circumstances, fishing may influence the biological traits of salmon that return to spawn, and potentially the traits that are conveyed to their offspring.

Diversity in biological traits is important so that populations can successfully respond to changing environmental conditions. For example, numerous studies have emphasized the possible importance of large size in naturally-spawning populations of chinook salmon for mate choice and reproductive success (Baxter 1991; Berejikian *et al.* 2000; Healey 2001; Healey and Heard 1984; and Silverstein and Hershberger 1992). A fishery is characterized as selective whenever fish with particular characteristics are caught more frequently than they occur in the population at large. Selective fishing may affect the diversity of size, age and sex ratio in the salmon population escaping to spawn.

Salmon fisheries may be size-selective, stock-selective, or species-selective. Size-selective fisheries catch fish within a certain size range at a greater rate than smaller or larger fish. Stock-selective fisheries harvest some populations at different rates than other populations. Fisheries are usually deliberately structured to be stock-selective or species-selective by shaping the time, location or physical attributes of fish that may be caught. Harvest managers have implemented stock- and species-selective fisheries in Puget Sound.

Selective Effects of Fishing in Puget Sound:

Although the potential consequences of size-selective fishing have been recognized, the ability of fisheries managers to address the potential long-term consequences is limited. The magnitude of selective effects will vary depending on the intensity of selective-fishing on a particular salmon population, the period of time over which those effects are encountered, and the biological characteristics of the population itself (Heath *et al.* 1994a; and Hard 2004). Hard (2004) predicted that, in general, reducing the exploitation rate reduces the selection intensity, and that changes in life history traits under most of the harvest scenarios he examined were modest, at best, over a few generations.

Information on the effects of fishery selectivity on Puget Sound chinook salmon is very limited. NMFS found a decline in the size of Puget Sound coho salmon spawners since the 1970s, and noted it as a risk factor (Weitkamp *et al.* 1995). However, in its review of west coast chinook salmon populations (Myers *et al*. 1998), NMFS did not note any trends in recent decades for size, weight, or age for Puget Sound chinook salmon that might be the result of fishing activities. The lack of an observed selective-fishing effect may be the result of the way Puget Sound fisheries are structured. Puget Sound salmon fisheries, including those harvesting chinook salmon, are managed for stock-specific exploitation rates that depend on the underlying productivity of each population.

With regard to the potential age-selectivity of fishing gear types, Puget Sound gillnet fisheries do not appear to be any more age-selective for chinook salmon than gear types like purse seines that use small mesh and are thus considered to be relatively non-selective (Table 13 and Figure 5). Based on the Puget Sound population-specific data that are available, there are no trends in age structure observed in Puget Sound chinook salmon escapement over the last 24 to 30 years that one might expect if there were age-selective fishing effects (Figure 6).

Table 13. Average age composition of the Puget Sound chinook salmon catch by gear type.

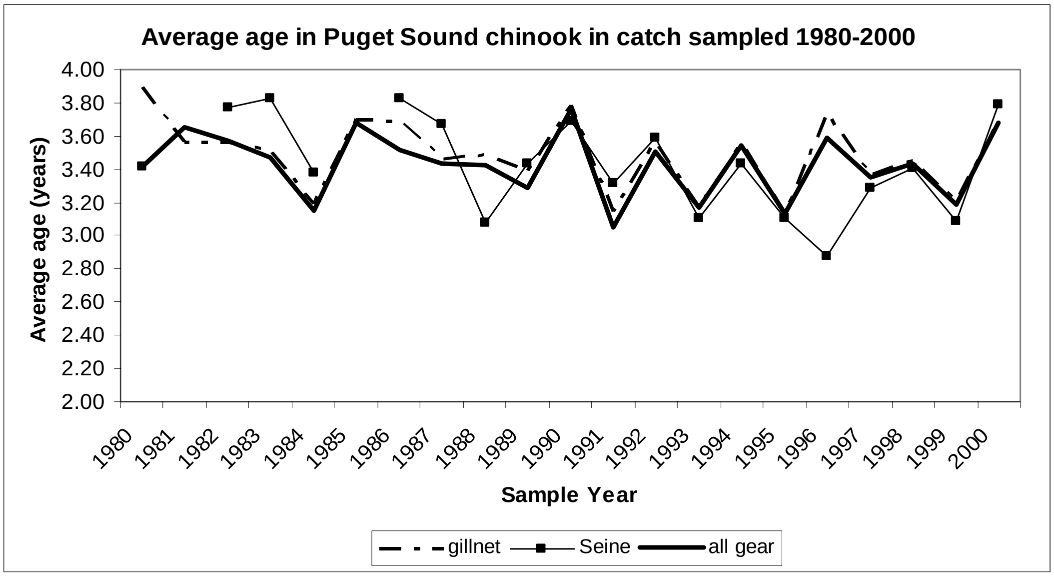
Gear Type	Age composition of Puget Sound chinook salmon catch (1980–2000)			
	Age-2	Age-3	Age-4	Age-5
Gillnet	3%	34%	59%	5%
Purse seine	7%	37%	54%	4%
All gear types	3%	35%	56%	6%

Source: S. Bishop, National Marine Fisheries Service, Northwest Region, based on data provided by the Washington Department of Fish and Wildlife.

NMFS also conducted analyses to determine whether there was a difference in size at age between Puget Sound chinook salmon caught in the fishery and those that spawn. NMFS focused its analyses on a subset of Puget Sound chinook salmon populations for which sufficient information was available and that represented some diversity in life history (spring and fall run types), geographic distribution and fishing intensity. NMFS also limited its analysis to terminal in-river net fisheries[9] for which data were available so that the analyses were not confounded by the catch of immature fish that commonly occurs in marine fisheries. The analyses were broken into three steps: (1) compare the average size at age and sex of coded-wire tagged fish recovered in the terminal net fishery with those recovered in the hatchery escapement; (2) size at age and sex information collected from naturally spawning adults was compared with results for

[9] These fisheries intercept fish returning to a single river system; the one in which the fishery occurs.

returning hatchery adults; and, (3) analysis was conducted to see whether the magnitude of change in size could be linked to effects of the terminal fishery.



Source: Puget Sound Technical Recovery Team data.

Figure 5. Age composition of Puget Sound chinook salmon catch. Average age has changed little since 1980.

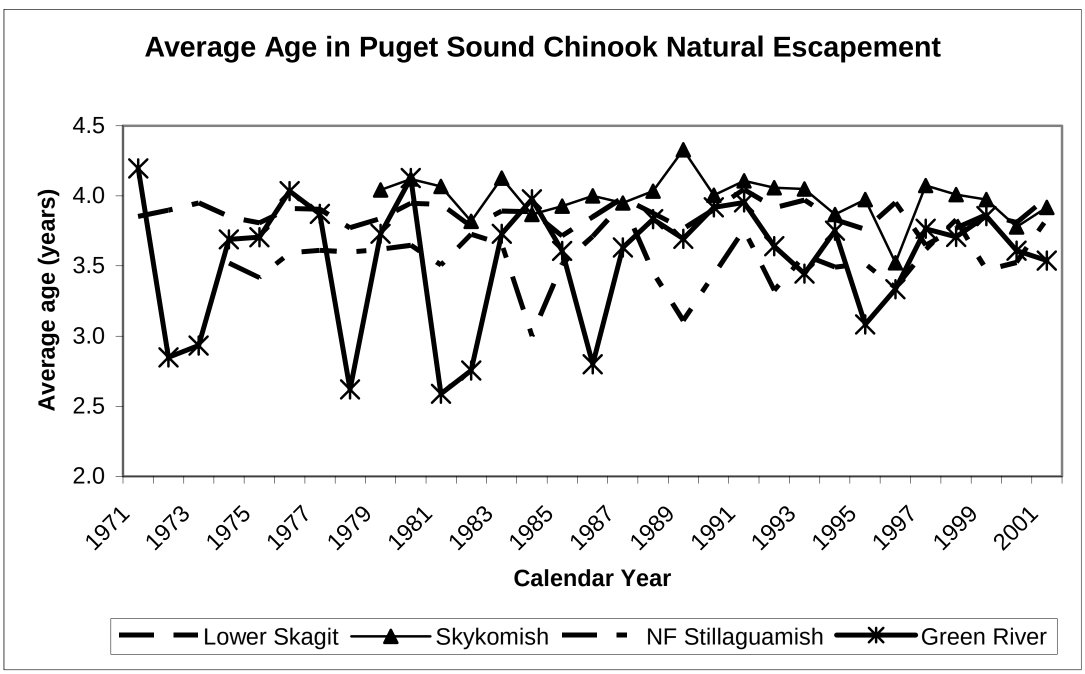


Figure 6. Age composition of Puget Sound chinook salmon escapement. Average age has changed little since the 1970s.

In the first step, the average size at age and sex of coded-wire tagged fish recovered in the terminal net fishery was compared with those recovered in the hatchery escapement during the period 1975-2001. The use of coded-wire tagged fish ensured that the analysis included only fish from the same population based on the unique coded-wire tag code implanted into the fish prior to their release from the hatchery.

Step 1 of the analysis indicates that there were significant trends in size at age and sex for some Puget Sound chinook salmon populations and shows some consistency with the expectation that populations with high exploitation rates would show declining trends in size for ages most likely to be affected by fishery selectivity. When populations with moderate to high terminal area exploitation rates are compared with populations with low exploitation rates, the populations with higher exploitation rates showed a consistent pattern of decreasing size at age for both male and female age four chinook salmon, one of the two ages most likely to experience any selective effects. Declines ranged from 0.11 to 0.45 centimeters per year or 0.55 to 2.5 centimeters per generation. Whether these changes are biologically significant is unknown. The majority of size at age trends for age three fish were not significant, regardless of fishing intensity.

On the other hand, other aspects of the results suggest factors other than fisheries are equally as likely: (1) the comparison between populations in moderate-high and low exploitation rate categories also compared populations with different life histories, so the difference could be due to differences in environmental conditions experienced by the different life history types; (2) the trends did not show consistent contrasts between the ages most vulnerable to selective fishing effects and those ages that are not, although this may have resulted from small numbers of samples for two- and five-year-old fish; (3) the trends in age-3 chinook which are also vulnerable to selective fishing effects were generally insignificant regardless of fishing intensity; (4) the trends would also have reflected the result of cumulative selective pressures of fisheries other than Puget Sound terminal net fisheries; (5) the trends were not entirely consistent between high and low exploitation rate populations when total exploitation rates are considered. While the terminal area exploitation rates were low for Skagit River spring chinook, the total exploitation rate was similar to those of the Green and Skokomish Rivers and the Samish River showed no significant trends in size-at-age, although it is classified as a moderate to high exploitation rate population.

In the second step of the analysis, size at age and sex information collected from naturally spawning adults was compared with results from the first step. Only three of the six Puget Sound chinook salmon populations, including only one of the four populations in the moderate-high exploitation rate category, evaluated in step 1 had sufficient data available to conduct the analysis. The trends in size at age were significant for five of the six analyses conducted. For all but one of these population/age groups examined, the trends in size at age were not significantly different among males and females. Although limited, the results of these did not indicate declining trends in size with higher exploitation rates. In general; (1) the trends were increasing for both high and low exploitation rate populations; (2) the trend of size-at-age is mixed among ages most likely to experience selective effects of fisheries; and (3) as in the step 1 analysis, the apparent differences in magnitude of change between the high and low exploitation rate populations could be the result of difference in environmental effects on different life history strategies.

The results in steps 1 and 2 are consistent in direction and significance of trends for only two of the six analyses that were compared and the magnitude of change was substantially different between the analyses that were similar. Both analyses indicated trends between male and female chinook salmon spawners were similar. The results of the analyses in step 2 seem to indicate that trends of size at age and sex between the hatchery and naturally spawning components are different. The results do not indicate that fisheries are affecting the naturally spawning component of the population in the ways that might be expected, i.e., declining size at age with increasing exploitation. The differences in the two analyses could reflect actual differences between trends in size-at-age in hatchery and naturally-spawning adult chinook, differences in the sampling and data collection in the two environments, or differences in life history.

From the discussion above, it is evident that analyses of observed trends alone cannot confirm that harvest is primarily responsible for declines in size at age; therefore, an analysis was conducted to see whether the magnitude of change in size could be linked to the intensity of the fishery (Step 3). To do this, the populations were assessed using the models of Hard (2004) to determine to what extent fisheries might be a factor where statistically significant patterns in size at age and sex were identified in the first two steps. The model examined four possible scenarios: two levels of legal size threshold (50 and 70 centimeters) and two levels of natural selection intensity (strong and weak) on size (J. Hard, Northwest Fisheries Science Center, pers. com., to S. Bishop, NMFS, September 16, 2004). This step compares what the trends in size at age would be under different levels of environmental and fishing conditions with the results in step 1 to see if the observed trends are consistent with any of the scenarios. The same general conclusions with regard to increasing and decreasing trends are equally applicable to results from step 2.

The analysis resulted in a mixture of upward and downward observed trends. The expected trends estimated by the harvest model generally explained less then 50 percent of corresponding observed trends. These results suggest that environmental influences on the observed size trends are large. For decreasing observed trends, these influences may include factors such as environmental conditions that reduce growth and size, or artificial or domestication selection in the hatchery. However, these influences also appear to vary considerably among the populations, pointing to the possibility of marked population-environment interaction effects. For increasing observed trends, these influences are likely to reflect environmental conditions that enhance growth and size, which could result from more favorable marine conditions, improvements in hatchery practices, reductions in harvest intensity, changes in migration patterns, or other factors that affect growth and size. Unfortunately, it is not possible from the present analysis to determine the directions or magnitudes of these environmental effects for any particular population with confidence because harvest and environmental effects on growth and size cannot be discriminated reliably.

(5) Section (b)(4)(i)(C) Sets escapement objectives or maximum exploitation rates for each management unit or population based on its status, and assures that those rates or objectives are not exceeded.

Table 2 identifies the proposed RMP’s rebuilding exploitation rates and critical exploitation rate ceilings, which when taken in concert with the RMP’s upper management thresholds and low abundance thresholds forms the framework of the co-managers’ harvest strategy. NMFS independently established rebuilding exploitation rates for nine individual populations within the ESU and for the Nooksack Management Unit (Table 14). For individual populations, exploitation rates at or below the NMFS-derived rebuilding exploitation rates are not likely to appreciably reduce the likelihood of rebuilding that population, assuming that current environmental conditions continue.

The following will provide a risk analysis of the anticipated exploitation rates under the implementation of the RMP's harvest strategy in those management units for which NMFS has derived rebuilding exploitation rates. Additionally, there are eight management units for which NMFS has yet to derive a rebuilding exploitation rate. These eight management units lacking a NMFS-derived rebuilding exploitation rates are the Lake Washington, White River, Puyallup, Nisqually, Skokomish, Mid-Hood Canal, Dungeness, and Elwha Management Units. NMFS did not develop rebuilding exploitation rates for these management units because adequate data were not available to assess current productivity or analysis is as yet incomplete. A risk analysis of the proposed RMP's harvest strategy for these eight management units will follow the analysis of management units with the NMFS-derived rebuilding exploitation rates.

Management Units that can be evaluated using NMFS-derived rebuilding exploitation rates as standards:

Modeling provides an estimate of the most likely exploitation rates and their ranges anticipated under the implementation of the RMP (see Table 3). The anticipated total exploitation rates under the implementation of the RMP are compared with the NMFS-derived rebuilding exploitation rates in Table 14.

The range of anticipated exploitation rates under the implementation of the RMP are equal to or less than the rebuilding exploitation rate developed by NMFS for five populations. These five populations are: the Upper Skagit River in the Skagit Summer/Fall Management Unit; the Upper Sauk River and Suiattle River populations in the Skagit Spring Management Unit; and, the North Fork Stillaguamish River and the South Fork Stillaguamish River populations in the Stillaguamish Management Unit. The level of risk associated with the anticipated range of exploitation rates for these five populations are consistent with the NMFS-derived rebuilding exploitation rates.

The entire range of anticipated exploitation rates for the Nooksack Management Unit and the Snohomish Management Unit exceeds the corresponding NMFS-derived rebuilding exploitation rate (Table 14). In addition, the most likely anticipated exploitation rates under the implementation of the RMP in three populations (the lower Skagit River and the lower Sauk River populations in the Skagit Summer/Fall Management Unit, and the Duwamish-Green River population in the Green River Management Unit) exceeds the corresponding rebuilding exploitation rate developed by NMFS.

Table 14. The range of anticipated total exploitation rates under the implementation of the RMP and the NMFS-derived rebuilding exploitation rate.

Management Unit	Population	Range of Anticipated Total Exploitation Rates	Most Likely Total Exploitation Rate	NMFS-derived Rebuilding Exploitation Rate
Nooksack	Natural-Origin Spawner:	20 to 26%	25%	*12%*
	North Fork Nooksack	-	-	-
	South Fork Nooksack	-	-	-
Skagit Summer/Fall [1]	Natural Spawners:			-
	Upper Skagit River	48 to 56%	55%	*60%*
	Lower Sauk River	-	-	*51%*
	Lower Skagit River	-	-	*49%*
Skagit Spring	Natural Spawners:	23 to 28%	27%	-
	Upper Sauk River	-	-	*38%*
	Suiattle River	-	-	*41%*
	Upper Cascade River	-	-	-
Stillaguamish	Natural-Origin Spawners:	17 to 20%	19%	-
	N.F. Stillaguamish River	-	-	*32%*
	S.F. Stillaguamish River	-	-	*24%*
Snohomish	Natural-Origin Spawners:	19 to 23%	22%	-
	Skykomish River	-	-	*18%*
	Snoqualmie River	-	-	-
Lake Washington	Natural Spawners:			-
	Cedar River	31 to 38%	35%	-
	Sammamish River	-	-	-
Green River	Natural Spawners:			
	Duwamish-Green River	49 to 63%	63%	*53%*
White River	Natural Spawners:			
	White River	20%	20%	-
Puyallup	Natural Spawners:			
	Puyallup River	49 to 50%	50%	-
Nisqually	Natural Spawners:			
	Nisqually River	64 to 76%	76%	-
Skokomish	Natural Spawners:			
	Skokomish River	45 to 63%	63%	-
Mid-Hood Canal	Natural Spawners:			
	Mid-Hood Canal Rivers	26 to 34%	32%	-
Dungeness	Natural Spawners:			
	Dungeness River	22 to 29%	27%	-
Elwha	Natural Spawners:			
	Elwha River	22 to 30%	27%	-

[1] Based on Skagit Summer/Fall Management Unit modeling, which assumes 2003 fisheries and abundance. Anomalous age structure and the presence of pink salmon fisheries in 2003 that lead to increased incidental harvest of chinook salmon make the estimates of exploitation rates used in this modeling a likely overestimate of the harvest impacts.

NMFS analyzed the increased risk associated with the proposed SUS fisheries by using the NMFS-derived rebuilding exploitation rates as the standard. The risk analysis simulates exposure of a population to a fixed brood-year exploitation rate, adjusted annually for management error and environmental variability, for a period of 25 years. When compared to NMFS-derived rebuilding exploitation rates, the risk analysis can predict: (1) the change in the probability of achieving the viable threshold; and (2) the change in probability of falling below the critical threshold.

In assessing the potential risk of SUS fisheries, NMFS assumes a low marine survival, which is conservative and risk adverse. Additionally, the actual brood-year exploitation rates experienced in this RMP over the next five years, from May 1, 2005 through April 2010, although fixed in the simulations, will vary. The RMP's rebuilding exploitation rates or escapement goals may modified in response to the most current information about the productivity and status of populations, or in response to better information about management error. There is also uncertainty in the risk analysis simulation about actual exploitation rates beyond the duration of the proposed RMP (April 30, 2010). The NMFS-derived rebuilding exploitation rates are based on simulations over a more conservative 25-year period, where the RMP's proposed duration is for a shorter duration, five years, from May 1, 2005 through April 2010.

Furthermore, the impact of fisheries in Alaska and British Columbia also adds uncertainty. Annex IV, Chapter 3, Chinook Salmon of the Pacific Salmon Treaty (PST 1999) imposes exploitation rate ceilings for fisheries impacts on indicator populations that are not achieving their escapement goals. Concern has heightened in recent years, as some Canadian chinook salmon fisheries have approached the limit imposed by Annex IV (W. Beattie, NWIFC, e-mail to K. Schultz, NMFS, January 31, 2004). The current Annex IV, Chapter 3, Chinook Salmon of the Pacific Salmon Treaty expires in 2009, so new guidelines could be imposed as a new annex is re-negotiated, or as the current harvest distribution of contributing populations is better defined.

Given these uncertainties, the following analyses estimate the potential elevated risk when compared to the NMFS-derived rebuilding exploitation rates as the standard for the proposed evaluation. This analysis is done for the four management units, identified above, in which the anticipated exploitation rates are above the rebuilding exploitation rates developed by NMFS. These four management units are the Nooksack, Snohomish, Skagit Summer/Fall, and the Green River Management Units.

Nooksack Management Unit - There are two populations within the Nooksack Management Unit: the North Fork Nooksack River and the South Fork Nooksack River populations. Both populations are currently classified as a Category 1 population (see Table 7). The North Fork Nooksack River natural-origin population has exhibited an increasing escapement trend (see Table 9). The 1999 to 2002 average escapement of 180 natural-origin spawners for the North Fork Nooksack River population is below the NMFS-derived critical threshold of 200 fish (see Table 8). The critical threshold for the Nooksack Management Unit is based on natural-origin fish. However, when including Kendall Creek hatchery-origin fish, an average aggregate escapement of 3,438 natural spawners for the North Fork Nooksack River has been observed since listing (see Table 10). The South Fork Nooksack River natural-origin population has also exhibited an increasing escapement trend since listing (see Table 9). The 1999 to 2002 average escapement of 249 natural-origin spawners for the South Fork Nooksack River population is slightly above the NMFS-derived critical threshold of 200 fish (see Table 8).

The co-managers propose to manage the Nooksack Management Unit by applying a 9 percent SUS critical exploitation rate ceiling (see Table 2). It also is the co-managers' intent to constrain fisheries affecting the management unit so that the projected SUS exploitation rate does not exceed 7 percent more than once during the duration of the RMP (see page 92 of the RMP). The RMP's SUS critical exploitation rate ceiling would not include impacts in Alaska or Canadian fisheries.

Similar to recent years, the largest proportion of the anticipated total exploitation rate for the Nooksack Management Unit is accounted for in Canadian fisheries (see Table 4). The resulting anticipated range of total exploitation rates for the Nooksack Management Unit under the implementation of the RMP is 20 to 26 percent (see Table 3). The most likely exploitation rate within this range is 25 percent (see Table 5). The NMFS-derived rebuilding exploitation rate for the Nooksack Management Unit is 12 percent (see Table 14). The entire range of anticipated exploitation rates under the implementation of the RMP for the Nooksack Management Unit of 20 to 26 percent exceeds the NMFS-derived rebuilding exploitation rate ceiling by 8 to 14 percentage points (Table 15).

Table 15. Comparison of the range of anticipated total exploitation rates with the NMFS-derived rebuilding exploitation rate for the Nooksack Management Unit.

Nooksack Management Unit or Population	Range of Anticipated Total Exploitation Rates	Most Likely Total Exploitation Rate	NMFS-derived Rebuilding Exploitation Rate	Difference in Percentage Points [1]		
				Low End of Range	Most Likely	High End of Range
Management Unit	20 to 26%	25%	12%	+8	+13%	+14%
N. F. Nooksack R.	-	-	-	-	-	-
S. F. Nooksack R.	-	-	-	-	-	-

[1] A positive number within the difference in percentage point column indicates that the corresponding anticipated exploitation rate exceeds the NMFS-derived rebuilding exploitation rate.

The management of Canadian fisheries is outside the jurisdiction of the co-managers. However, the co-managers do have jurisdiction over SUS fisheries. The most likely exploitation rate for the SUS fisheries is 7 percent (see Table 5). NMFS determined the increased risk associated with the SUS fisheries proposed by the co-managers in the RMP, when compared to the NMFS-derived rebuilding exploitation rate. With the modeled Canadian fisheries and a 7 percent SUS exploitation rate for the Nooksack River populations, assuming 2003 abundance, the anticipated total exploitation rate represents a 6 percentage point decrease in the probability of rebuilt populations in 25 years. Modeling also suggests that there is a 21 percentage point increase in the probability that the populations will fall below their respective critical threshold level during that same 25-year period (Table 16). The anticipated total exploitation rate includes impacts from both the Canadian and SUS fisheries. The exploitation rates from just the modeled Canadian fisheries exceeds NMFS-derived rebuilding exploitation rate for the Nooksack River populations of 12 percent. We can also isolate the effects of only the SUS fisheries. Using the exploitation rate in Canadian and Alaskan fisheries as a baseline, i.e., the mortality that has occurred prior to SUS fisheries, a 7 percent SUS exploitation rate for the Nooksack River populations represents a 2 percentage point decrease in the probability of rebuilt populations in 25 years. Modeling also suggests that a 7 percent SUS exploitation rate for the Nooksack River populations represents a 14 percentage point increase in the probability that the populations will fall below their respective critical threshold level during that same 25-year period.

Additional discussion on this identified elevated level of risk to the North Fork Nooksack River and South Fork Nooksack River populations under the implementation of the RMP, in regards to the likelihood of survival and recovery of the ESU, will be provided in Section (b)(4)(i)(D).

Skagit Summer/Fall Management Unit - The Skagit Summer/Fall Management Unit encompasses three populations: the upper Skagit, the lower Sauk, and the lower Skagit River populations. All three populations are classified as a Category 1 population (see Table 7). Since listing, all populations in the Skagit Summer/Fall Management Unit have exhibited an increasing escapement trend (see Table 9). The 1999 to 2002 average escapements for all three populations are above their respective viable thresholds (see Table 8).

The co-managers propose to manage the Skagit Summer/Fall Management Unit with a 50 percent total rebuilding exploitation rate, and a 15 percent SUS critical exploitation rate ceiling in even-years and a 17 percent SUS critical exploitation rate ceiling in odd-years (see Table 2). The resulting anticipated range of total exploitation rates for the Skagit Summer/Fall Management Unit under the implementation of the RMP is 48 to 56 percent (see Table 3). The most likely total exploitation rate within this range is 55 percent (see Table 5).

The NMFS-derived rebuilding exploitation rates for the individual populations within the Skagit Summer/Fall Management Unit are shown in Table 17. The lower end of the range of anticipated total exploitation rates of 48 percent under the implementation of the RMP is less than the NMFS-derived rebuilding exploitation rate ceiling for all three populations within the Skagit Summer/Fall Management Unit. When the most likely total exploitation rate of 55 percent is applied to the individual populations within the management unit, the exploitation rate is less than the NMFS-derived rebuilding exploitation rate for the upper Skagit River population, but exceeds the NMFS-derived rebuilding exploitation rate for the lower Sauk River and lower Skagit River populations by 4 and 6 percentage points, respectively (Table 17).

Table 16. The percentage point change in probability of a rebuilt population in 25 years and the percentage point difference in probability that the population will fall below the critical threshold in 25 years when the anticipated total exploitation rates are compared to the NMFS-derived rebuilding exploitation rates. The anticipated total exploitation rates include the impacted associated with the modeled Canadian fisheries and the anticipated southern United States (SUS) fisheries in the RMP.

		Lower End of Range		Most Likely		Upper end of Range	
Management Unit	Population	Percentage Point difference in Probability of a Rebuilt Population in 25 Years[1]	Percentage Point difference in Probability that the Population will fall below the Critical Threshold in 25 Years[2]	Percentage Point difference in Probability of a Rebuilt Population in 25 Years[1]	Percentage Point difference in Probability that the Population will fall below the Critical Threshold in 25 Years[2]	Percentage Point difference in Probability of a Rebuilt Population in 25 Years[1]	Percentage Point difference in Probability that the Population will fall below the Critical Threshold in 25 Years[2]
Nooksack		- 6%	9%	- 6%	21%	- 12%[3]	22%[3]
	N. F. Nooksack River	-	-	-	-	-	-
	S.F. Nooksack River	-	-	-	-	-	-
Skagit Summer/Fall	Upper Skagit River	-	-	-	-	-	-
	Lower Sauk River	-	-	-	-	-	-
	Lower Skagit River	-	-	- 26%	0%	- 33%	0%
Skagit Spring	Upper Sauk River	17%	- 0%	16%	- 0%	16%	- 0%
	Suiattle River	19%	-1%	19%	- 1%	18%	- 1%
	Upper Cascade River	-	-	-	-	-	-
Stillaguamish							
	N. F. Stillaguamish R.	14%	- 1%	14%	- 1%	15%	- 1%
	S.F. Stillaguamish R.	9%	- 1%	4%	- 1%	4%	- 1%
Snohomish							
	Skykomish River	- 4%	1%	- 14%	3%	- 15%	3%
	Snoqualmie River	-	-	-	-	-	-

[1] A negative number in the difference in probability of a rebuilt population in 25 years indicates a decrease in the probability of that population being rebuilt in 25 years, when compared to the NMFS-derived rebuilding exploitation rate. A positive number in the difference in probability of a rebuilt population in 25 years indicates an increase in the probability of that population being rebuilt in 25 years, when compared to the NMFS-derived rebuilding exploitation rate. Rebuilt is defined as the population's abundance meeting or exceeding its viable threshold under current conditions.

[2] A negative number in the difference in probability that the population will fall below the critical threshold in 25 years indicates a decrease in the probability of that population will fall below the critical threshold in 25 years, when compared to the NMFS-derived rebuilding exploitation rate. A positive number in the difference in probability that the population will fall below the critical threshold in 25 years indicates an increase in the probability of that population will fall below the critical threshold in 25 years, when compared to the NMFS-derived rebuilding exploitation rate.

[3] The anticipated total exploitation rate includes impacts from both the Canadian and SUS fisheries. The exploitation rates from just the modeled Canadian fisheries exceeds NMFS-derived rebuilding exploitation rate for the Nooksack River populations. When assessing the impacts of just the SUS fisheries, a 7 percent SUS exploitation rate for the Nooksack River populations represents a 2 percentage point decrease in the probability of rebuilt populations in 25 years. Modeling also suggests that a 7 percent SUS exploitation rate for the Nooksack River populations represents a 14 percentage point increase in the probability that the populations will fall below their respective critical threshold level during that same 25-year period.

Table 17. Comparison of the range of anticipated total exploitation rates for the Skagit Summer/Fall Management Unit with the NMFS-derived rebuilding exploitation rate for individual populations within the Skagit Summer/Fall Management Unit.

Skagit Summer/Fall Management Unit or Population	Range of Anticipated Total Exploitation Rates [1]	Most Likely Total Exploitation Rate [1]	NMFS-derived Rebuilding Exploitation Rate	Difference in Percentage Points [2]		
				Low End of Range	Most Likely	High End of Range
Management Unit	48 to 56%	55%	-	-	-	-
Upper Skagit River	-	-	60%	-12%	-5%	-4%
Lower Sauk River	-	-	51%	-3%	+4%	+5%
Lower Skagit River	-	-	49%	-1%	+6%	+7%

[1] Based on Skagit Summer/Fall Management Unit modeling, which assumes 2003 fisheries and abundance. Anomalous age structure and the presence of pink salmon fisheries in 2003 that lead to increased incidental harvest of chinook salmon make the estimates of exploitation rates used in this modeling a likely overestimate of the harvest impacts.

[2] A positive number within the difference in percentage point columns indicates that the corresponding anticipated exploitation rate exceeds the NMFS-derived rebuilding exploitation rate.

Similar to the Nooksack Management Unit discussed above, the anticipated impacts on the Skagit Summer/Fall Management Unit include those from the Canadian fisheries. The management of Canadian fisheries is outside the jurisdiction of the co-managers. However, the co-managers do have jurisdiction over fisheries within the SUS. For the Skagit Summer/Fall Management Unit, the anticipated exploitation rate[10] range for the SUS fisheries is 16 to 18 percent (see Table 3). The most likely exploitation rate for the SUS fisheries is 16 percent (see Table 5).

Through modeling, NMFS determined the increased risk to the lower Skagit River population associated with the SUS fisheries in the RMP. With the modeled Canadian fisheries and abundance similar to 2003, a 16 percent SUS exploitation rate represents a 26 percentage point decrease in the probability of a rebuilt population in 25 years. Modeling also suggests that there is no change in the probability that the population will fall below the critical level (see Table 16).

NMFS was unable to determine the increased risk associated with the anticipated exploitation rates under the implementation of the RMP exceeding the NMFS-derived rebuilding exploitation rate for the lower Sauk River population. However, the level of risk is assumed to be similar to that estimated for the lower Skagit River population. Additional discussion on the risks to the lower Sauk River and lower Skagit River populations under the implementation of the RMP, in

[10] Based on Skagit Summer/Fall Management Unit modeling, which assumes 2003 fisheries and abundance. Anomalous age structure and the presence of pink salmon fisheries in 2003 rates that lead to increased incidental harvest of chinook salmon make the estimates of exploitation rates used in this modeling a likely overestimate of the harvest impacts.

regards to the likelihood of survival and recovery of the ESU, will be provided in Section (b)(4)(i)(D).

Snohomish Management Unit - The Snohomish Management Unit encompasses two populations: the Skykomish River and the Snoqualmie River populations. Both populations are classified as a Category 1 population (see Table 7) and both have exhibited an increasing escapement trend since listing (see Table 9). The 1999 to 2002 average escapement of 2,118 for the Skykomish River population has been above the critical threshold of 1,650 fish, but below the viable threshold of 3,500 fish (see Table 8). The 1999 to 2002 average escapements of 1,818 fish for the Snoqualmie River population have been above the VSP guidance for a viable threshold of 1,250 fish (see Table 8).

The co-managers propose to manage fisheries affecting the Snohomish Management Unit by applying a 21 percent total rebuilding exploitation rate and a 15 percent SUS critical exploitation rate ceiling (see Table 2). The resulting anticipated range of exploitation rates for the Snohomish Management Unit under the implementation of the RMP is 19 to 23 percent. The most likely exploitation rate within this range is 22 percent (Table 18).

Table 18. Comparison of the RMP's rebuilding exploitation rates for the Snohomish Management Unit with the NMFS-derived rebuilding exploitation rate for the Skykomish River population.

Snohomish Management Unit or Population	Range of Anticipated Total Exploitation Rates	Most Likely Total Exploitation Rate	NMFS-derived Rebuilding Exploitation Rate	Difference in Percentage Points [1]		
				Low End of Range	Most Likely	High End of Range
Management Unit	19 to 23%	22%	-	-	-	-
Skykomish River	-	-	18%	+1%	+4%	+5%
Snoqualmie River	-	-	-	-	-	-

[1] A positive number within the difference in percentage point column indicates that the corresponding anticipated exploitation rate exceeds the NMFS-derived rebuilding exploitation rate.

The NMFS-derived rebuilding exploitation rate for the Skykomish River population is 18 percent. The range of anticipated total exploitation rates for the Snohomish Management Unit is 19 to 23 percent. The entire range exceeds the NMFS-derived rebuilding exploitation rate of 18 percent for the Skykomish River population; by 1 to 5 percentage points (see Table 18).

Although not as prominent as in the Nooksack and Stillaguamish Management Units discussed above, the anticipated impacts on the Snohomish Management Unit also include those from the Canadian fisheries (see Table 4). The management of Canadian fisheries is outside the jurisdiction of the co-managers. However, the co-managers do have jurisdiction over fisheries within the SUS. For the Snohomish Management Unit, the anticipated range of exploitation rates for the SUS fisheries is 13 to 14 percent (see Table 3). The most likely exploitation rate within in this range is 13 percent (see Table 5).

Through modeling, NMFS analyzed the increased impacts associated with the SUS fisheries in the RMP, when compared to the NMFS-derived rebuilding exploitation rate as the standard. With the modeled Canadian fisheries and assuming 2003 abundance, a 13 percent SUS exploitation rate for the Skykomish River population represents a 14 percentage point decrease in the probability of a rebuilt population in 25 years. Modeling also suggests that there is a 3 percentage point increase in the probability that the population will fall below the critical level during that same 25-year period (see Table 16). Additional discussion on the identified elevated level of risk to the Skykomish River population under the implementation of the RMP, in regards to the likelihood of survival and recovery of the ESU, will be provided in Section (b)(4)(i)(D).

Lacking sufficient data, no rebuilding exploitation rate has been developed by NMFS for the other population within the Snohomish Management Unit, the Snoqualmie River population. The risk associated with the proposed exploitation rate in the RMP to the Snoqualmie River population will be addressed in the following subsection, *Management Units for which NMFS-derived Rebuilding Exploitation Rate standards are not available*.

Green River Management Unit - The Green River Management Unit includes only one population, the Duwamish-Green River population (Category 1). The Duwamish-Green River population has exhibited an increasing escapement trend (see Table 9). The 1999 to 2002 average escapement of 9,299 for the Duwamish-Green River population has been above the viable threshold of 5,523 (see Table 8).

The co-managers propose to manage the Green River Management Unit with a 15 percent pre-terminal SUS rebuilding exploitation rate and a 12 percent pre-terminal SUS critical exploitation rate ceiling (see Table 2). The RMP's pre-terminal SUS rebuilding exploitation rate and the pre-terminal SUS critical exploitation rate ceiling would not include impacts in terminal fisheries. The co-managers propose to manage the terminal fisheries of the Green River Management Unit based on an in-season estimate of the run-size abundance. The in-season run-size abundance estimate allows the co-managers to manage the fisheries to achieve the natural escapement goal of 5,800 fish (see page 160 of the RMP). The resulting anticipated range of total exploitation rates for the Green River Management Unit under the implementation of the RMP is 49 to 63 percent. The most likely total exploitation rate within this range is 63 percent (Table 19). The NMFS-derived rebuilding exploitation rate for the Duwamish-Green River population is 53 percent (Table 19).

The lower end of the anticipated range of exploitation rates under the implementation of the RMP of 49 percent is less than the NMFS-derived rebuilding exploitation rate of 53 percent. The level of risk associated with the lower end of the range of anticipated exploitation rates for the Duwamish-Green River population is consistent with the NMFS-derived rebuilding exploitation rate as the standard. However, the most likely exploitation rate for the Duwamish-Green River population of 63 percent exceeds the NMFS-derived rebuilding exploitation rate by 10 percentage points (Table 19).

Table 19. Comparison of the RMP's rebuilding exploitation rates with the NMFS-derived rebuilding exploitation rate for the Duwamish-Green River population.

Green River Management Unit Population	Range of Anticipated Total Exploitation Rates	Most Likely Total Exploitation Rate	NMFS-derived Rebuilding Exploitation Rate	Difference in Percentage Points [1]		
				Low End of Range	Most Likely	High End of Range
Duwamish-Green River	49 to 63%	63%	53%	-2%	+10%	+10%

[1] A positive number within the difference in percentage point column indicates that the corresponding anticipated exploitation rate exceeds the NMFS-derived rebuilding exploitation rate.

The co-managers' escapement goal of 5,800 fish for the Duwamish-Green River population have been successfully achieved by the co-managers annually since 1995 (see Table 6). Modeling of the Green River Management Unit indicates that with the implementation of the proposed RMP from May 1, 2005 through April 30, 2010, the escapement goal of 5,800 fish is likely to be continually achieved. The co-managers' escapement goal of 5,800 fish for the Duwamish- Green River population is above the NMFS-derived viable threshold for this population of 5,523 fish (see Table 8). With the level of escapement anticipated to continue to exceed the NMFS-derived viable threshold, the level of risk to the Duwamish-Green River population that is associated with the anticipated range of exploitation rates under the implementation of the RMP is consistent with NMFS' standards.

In summary for those management units for which NMFS has derived rebuilding exploitation rates, a portion of, or the entire range of the anticipated total exploitation rates under the implementation of the RMP exceeds the NMFS-derived rebuilding exploitation rate for three populations (Lower Sauk River, Lower Skagit River, and the Skykomish River populations) and the two populations within the Nooksack Management Unit (North Fork Nooksack River and South Fork Nooksack River populations). In these populations, there is a decreased probability that the populations will rebuild within 25 years and/or an increase in the probability that the population will fall below their critical thresholds during that same 25-year period, when compared to the NMFS-derived rebuilding exploitation rates as the standard. Additional discussion on the identified elevated level of risk to these populations under the implementation of the RMP, in regards to the likelihood of survival and recovery of the ESU, will be provided in Section (b)(4)(i)(D).

Management Units for which NMFS-derived Rebuilding Exploitation Rate standards are not available:

The following analysis addresses the eight management units for which NMFS has not yet derived a rebuilding exploitation rate. The RMP has identified escapement objectives or maximum exploitation rates for each of these management units. These eight management units are the Lake Washington, Puyallup, White River, Nisqually, Skokomish, Mid-Hood Canal, Dungeness, and Elwha Management Units. In these management units, adequate data were not available to assess current productivity of the population(s) or NMFS has not yet completed an analysis of an appropriate rebuilding exploitation rate.

The order of the management units to be evaluated will be based on how the management unit is proposed to be managed, as outlined below. The co-managers propose to manage the Nisqually and the Skokomish Management Units in-season for escapement objectives. The RMP proposes that two management units be managed based on a pre-terminal SUS rebuilding exploitation rate (Lake Washington and Mid-Hood Canal Management Units), two management units by a SUS rebuilding exploitation rate (Dungeness, and Elwha Management Units), and two management units based on a total rebuilding exploitation rate (Puyallup and White River Management Units).

Nisqually Management Unit - The Nisqually Management Unit contains one population, the Nisqually River population (Category 2). The natural component of the Nisqually River population has exhibited an increasing escapement trend (see Table 9). Analysis of habitat capacity by the co-managers, using the Ecosystems Diagnosis and Treatment methodology (NCRT 2001 as cited in the RMP) suggests that optimum productivity under current habitat conditions is achieved by an escapement of 1,100 fish (see page 170 of the RMP).

The 1999 to 2002 average escapement of 1,318 for the Nisqually River population has been above the co-managers' escapement goal of 1,100 fish (see Table 8). Since listing, the co-managers have successfully achieved the escapement goal of 1,100 fish in the Nisqually River in all but one year (see Table 6). In 2001, the estimated natural spawning escapement in the Nisqually River was 1,079 fish, only slightly below the escapement goal.

The co-managers propose to manage the Nisqually Management Unit's terminal area fisheries based on an in-season run-size abundance update, which is designed to achieve the escapement goal of 1,100 fish (see pages 170 and 171 of the RMP). When the in-season run-size abundance estimate indicates that the RMP's upper management threshold of 1,100 fish will not be achieved with scheduled or proposed terminal area fisheries, the co-managers will constrain the fisheries with the objective of increasing abundance to a level at or above the escapement objective. The modeled anticipated range of total exploitation rates for the Nisqually Management Unit under the implementation of the RMP are the highest of any management unit, 64 to 76 percent. The most likely exploitation within this range is 76 percent (see Table 14).

Modeling of the Nisqually Management Unit indicates that the co-managers will continue to achieve the escapement goal of 1,100 fish under the implementation of the RMP. Based on the current abundance status, the increasing escapement trend for the Nisqually River population and the anticipated level of escapement under the implementation of the RMP, the level of risk to the Nisqually River population due to the anticipated range of total exploitation rates is consistent with NMFS' standards.

Skokomish Management Unit – The Skokomish Management Unit contains one population, the Skokomish River population (Category 2). The 1999 to 2002 average natural spawning escapement of 1,483 fish for the Skokomish River population has been below the RMP's escapement goal of 1,650 fish, but above the RMP's low abundance threshold of 800 fish (see

Table 2). Since listing, the natural component of the Skokomish River population has exhibited an increasing escapement trend (see Table 9).

The co-managers propose to manage the Skokomish Management Unit by applying a 15 percent pre-terminal SUS rebuilding exploitation rate and a 12 percent pre-terminal SUS critical exploitation rate ceiling (see Table 2). The Skokomish Management Unit upper management threshold is 3,650 fish. The upper escapement objective represents a spawner requirement for 1,650 in-stream natural spawners (HCSMP 1985) and 2,000 spawners required for the maintenance of hatchery production.

If the returning abundance is insufficient to achieve the upper escapement goal of 3,650 fish, as described above, or if the naturally spawning component of Skokomish River population is expected to fall below 1,200 spawners, additional terminal fishery management measures will be applied by the co-managers, with the objective of meeting or exceeding the 1,200 in-stream natural spawners (see page 175 of the RMP). The types of additional terminal management measures the co-managers will consider are provided on page 175 of the RMP. Since 1996, the annual natural escapement into the Skokomish River has exceeded 1,200 fish (see Table 6).

The anticipated range of total exploitation rates for the Skokomish Management Unit under the implementation of the RMP is 45 to 63 percent. The most likely total exploitation rate within this range is 63 percent (see Table 14). Modeling of the Skokomish Management Unit also indicates the returning abundance will be insufficient to achieve the upper escapement goal of 3,650 fish, but that the co-managers will continue to meet or exceed the lower in-stream natural spawner escapement goal of 1,200 fish under the implementation of the RMP. The RMP's escapement goal of 1,200 fish is similar to the VSP generic guidance of 1,250 fish for a viable threshold for this population.

Based on the current status, the increasing escapement trend of the population, and the anticipated level of escapement under the implementation of the RMP, the level of risk to the Skokomish River population due to the anticipated range of exploitation rates under the implementation of the RMP is consistent with NMFS' standards.

Lake Washington Management Unit - The Lake Washington Management Unit contains two populations; the Cedar River (Category 1) and the Sammamish River (Category 2). The 1999 to 2002 average escapement is 385 for the Cedar River population and 373 for the Sammamish River population (see Table 8). Since 1998, the natural escapements for both of these populations has exceeded the VSP generic guidance of 200 fish, but are well below the VSP-derived guidance for a viable threshold of 1,250 fish. Since listing, the escapement for the Cedar River population is considered stable, while the Sammamish River population is considered increasing (see Table 9).

The co-managers propose to manage the Lake Washington Management Unit by applying a 15 percent pre-terminal SUS rebuilding exploitation rate and a 12 percent pre-terminal SUS critical exploitation rate ceiling (see Table 2). The terminal area fisheries for sockeye and coho salmon will be managed "to minimize incidental impact[s] on chinook [salmon]" as long as the Cedar River population remains below the RMP's upper management threshold of 1,200 fish (see page

155 of the RMP). Appendix C: Minimum Fisheries Regime of the RMP presents the terminal conservation management measures the co-managers will impose if the Cedar River population falls below its low abundance threshold of 200 fish. These terminal conservation management measures include non-retention in recreational fisheries, no directed fisheries, and the reduction in incidental impacts by other fisheries through time and area restrictions (see pages 204 and 205 of the RMP). The Cedar River and Sammamish River populations share the same terminal fisheries. Terminal conservation management measures directed at migrating fish returning to the Cedar River will also benefit fish returning to the Sammamish River.

The anticipated range of total exploitation rates for the Lake Washington Management Unit under the implementation of the RMP is 31 to 38 percent. The most likely total exploitation rate within this range is 35 percent (see Table 14). Modeling of the Lake Washington Management Unit indicates that the co-managers will continue to meet or exceed the critical threshold of 200 natural spawners for each of these two populations under the implementation of the RMP. The range of anticipated escapements for both the Cedar River and the Sammamish River under the implementation of the RMP is 214 to 305 fish each (see Table 3). The most likely escapement for both populations within this range is 295 fish each (see Table 5).

However, as mentioned earlier, the escapement estimates for the Cedar River are based on an expansion of the observed live count of fish. Expansions of the Cedar River redd counts suggests that the expansion of the Cedar River live count may be a conservative estimate of the total escapement (P. Hage, Muckleshoot Tribe, e-mail to S. Bishop, NMFS, February 10, 2004). Additionally, escapement estimates presented in Table 6 for the Sammamish River population do not include escapement into the Upper Cottage Lake or Issaquah Creeks. Therefore, although the escapement information present in Table 6 is believed to be representative of this population’s abundance trend, the escapement estimates are to be considered a conservative estimate of the total Sammamish River population’s escapement.

The range of anticipated escapements in each watershed, although conservative estimates, suggest that escapement will be well below the VSP-derived viable threshold of 1,250 fish and perhaps approaching the VSP-derived critical threshold of 200 fish. Concerns do exist that these two populations may fall below their critical thresholds. Additional discussions on the increased concern for these populations, in regards to the likelihood of survival and recovery of the ESU, will be provided in the following section, Section (b)(4)(i)(D).

Mid-Hood Canal Management Unit - The Mid-Hood Canal Management Unit includes chinook salmon spawning aggregations in the Hamma Hamma, Duckabush, and the Dosewallips Rivers. The Mid-Hood Canal rivers population is classified as a Category 2 population (see Table 7). The 1999 to 2002 average escapement of 404 for the Mid-Hood Canal Management Unit is slightly above the co-managers’ low abundance threshold of 400 fish, but well below the viable threshold of 1,250 fish derived from VSP guidance (see Table 9). Since listing, the Mid-Hood Canal rivers population has exhibited an increasing escapement trend (see Table 9), although trends in individual spawning aggregates of the population are varied (see Table 12).

The co-managers propose to manage the Mid-Hood Canal Management Unit by applying a 15 percent pre-terminal SUS rebuilding exploitation rate and a 12 percent pre-terminal SUS critical exploitation rate ceiling (see Table 2). Additionally, the co-managers propose that when the Mid-Hood Canal Management Unit's upper management threshold of 750 spawners is not expected to be met, that all extreme terminal (freshwater) fisheries that are likely to impact adult spawners of these "sub-populations" will be closed (see page 180 of the RMP).

If escapement is projected to fall below the Mid-Hood Canal Management Unit's low abundance threshold of 400 fish, the co-managers will implement "further conservation measures" in pre-terminal and terminal fisheries to reduce mortality (see page 180 of the RMP). These terminal conservation management measures include non-retention, or even closures of recreational fisheries, no directed fisheries, and the reduction in incidental impacts in other fisheries by the use of time and area restrictions (see pages 207 and 208 of the RMP). The anticipated range of the total exploitation rates for the Mid-Hood Canal Management Unit, including those from Canadian fisheries, under the implementation of the RMP is 26 to 34 percent. The most likely total exploitation rate within this range is 32 percent (see Table 14).

Terminal-area harvest impacts have been virtually eliminated for the Mid-Hood Canal rivers chinook salmon population, particularly when abundance is below the RMP's low abundance threshold. It is anticipated that the pre-terminal SUS fisheries, with a most likely exploitation rate of 12 percent, will account for most of the exploitation rate for the entire SUS of 13 percent (see Table 5). The impacts in pre-terminal SUS fisheries is limited to no more than a 15 percent exploitation rate when the anticipated escapement abundance exceeds the RMP's low abundance threshold. When the anticipated abundance is less than the RMP's low abundance threshold, the impacts in pre-terminal SUS fisheries is reduced to no more than 12 percent.

Since 1990, escapements to the natural spawning areas in Mid-Hood Canal have exceeded the RMP's low abundance threshold of 400 fish for this management unit in only two years (see Table 6). Estimated escapements were 762 fish and 438 fish in 1999 and 2000, respectively. In 2002, the natural escapement into the Mid-Hood Canal Management Unit of 95 spawners is well below the VSP guidance for a critical threshold of 200 fish.

The range of anticipated aggregate spawning escapements into the rivers of the Mid-Hood Canal Management Unit under the implementation of the RMP is 344 to 531 fish (see Table 3). The most likely escapement within in this range is 504 fish (see Table 5). As mentioned earlier, the co-managers, in cooperation with NMFS, have modeled escapement results under a no Puget Sound fishery alternative. The most likely escapement under the "no fishery" scenario is 527 fish. Under the "no fishery" alternative, when compared to the proposed RMP, the most likely resultant escapement into the Mid-Hood Canal population would increase by only 23 fish, from 504 to 527 fish.

Simulation modeling of the Mid-Hood Canal Management Unit indicates that the co-managers will continue to meet or exceed the critical threshold of 200 natural spawners during the implementation of the RMP from May 1, 2005 through April 2010. However, given that the range of anticipated escapements approaches the VSP-derived critical threshold of 200 fish, and issues regarding the spatial distribution of the escapement discussed earlier (see pages 40 to 42), concerns do exist for Mid-Hood Canal rivers population. Additional discussion on the increased concern for the Mid-Hood Canal rivers population in regards to the likelihood of survival and recovery of the ESU will be provided in the following section, Section (b)(4)(i)(D).

Dungeness Management Unit - The Dungeness Management Unit contains one population, the Dungeness River population (Category 1). The 1999 to 2002 average escapement of 345 fish for Dungeness River population has been above the VSP-derived critical threshold of 200 fish, but below the RMP's low abundance threshold of 500 fish (see Table 9). Since listing, the Dungeness River population has exhibited an increasing escapement trend (see Table 9).

The co-managers propose to manage the Dungeness Management Unit by applying a 10 percent SUS rebuilding exploitation rate and a 6 percent SUS critical exploitation rate ceiling (see Table 2). The RMP's SUS rebuilding exploitation rate and the SUS critical exploitation rate ceiling do not include impacts in Alaska and Canadian fisheries. In recent years, Alaska and Canadian fisheries have accounted for the vast majority of the impacts on the Dungeness Management Unit. Although there are no estimates for the Dungeness Management Unit, in the adjacent Elwha Management Unit, it is estimated that the Alaska and Canadian harvests represented, on average (1993 to 1997), 75 percent of the total impacts (16.2 percent in Alaska plus 58.8 percent in Canada, see page 185 of the RMP). A similar Alaska and Canadian harvest distribution is likely for the Dungeness River population.

The co-managers' stated management objective in the RMP for the Dungeness Management Unit is "to stabilize escapement and recruitment, as well as to restore the natural-origin recruit population basis through supplementation and fishery restrictions" (see page 182 of the RMP). The co-managers, in cooperation with federal agencies and private-sector conservation groups, have implemented a supplementation program to rehabilitate chinook salmon runs in the Dungeness River. Chinook salmon from the hatchery program on the Dungeness River are listed under the ESA. The primary goal of the supplementation and fishery control program is to increase the number of fish spawning naturally in the river, while maintaining the generic characteristics of the existing stock.

Simulation modeling indicates the range of total exploitation rates that may be anticipated for the Dungeness Management Unit under the implementation of the RMP is 22 to 29 percent. The most likely total exploitation rate within this range is 27 percent (see Table 14). However, the anticipated SUS exploitation rate for the entire SUS fishery affecting this population is most likely only 5 percent (see Table 5). The range of anticipated escapements to the Dungeness River resulting from the implementation of the RMP is 231 to 356 fish (see Table 3). The most likely escapement within this range is 336 fish (see Table 5). The anticipated escapement range is below the RMP's low abundance threshold of 500 fish, and approaches the VSP-derived critical threshold of 200 fish for this population.

Simulation modeling of the Dungeness Management Unit indicates that the VSP-derived critical threshold of 200 natural spawners will continue to be met or exceeded under the implementation of the RMP from May 1, 2005 through April 2010. However, given that the range of anticipated escapements approaches the critical threshold of 200 fish and falls below the RMP's low abundance threshold of 500 fish, concerns do exist for this population. Benefits to this population by reductions in SUS fishery-related impacts are limited. The anticipated SUS exploitation rate on this population is very low, at 5 percent. Additional discussion on the increased concern for this population in regards to the likelihood of survival and recovery of the ESU will be provided in Section (b)(4)(i)(D).

Elwha Management Unit - The Elwha Management Unit contains one population, the Elwha River population (Category 1). The 1999 to 2002 average escapement of 2,009 for the Elwha River population has been above the RMP's low abundance threshold of 1,000 fish. The Elwha River population has exhibited a stable escapement trend since listing (see Table 9).

The co-managers propose to manage the Elwha Management Unit with a 10 percent SUS rebuilding exploitation rate and a 6 percent SUS critical exploitation rate ceiling (see Table 2). The RMP's SUS rebuilding exploitation rate and the SUS critical exploitation rate ceiling do not include impacts in Alaska and Canadian fisheries. Alaska and Canadian fisheries have accounted for the majority of the impacts on the Elwha Management Unit. On average (1993 to 1997), 75 percent of the impacts on the Elwha River population have occurred in Alaska and Canadian fisheries (see page 185 of the RMP).

In the Elwha River, chinook salmon production is limited by two hydroelectric dams which block access at river mile 5 to approximately 70 miles of upstream spawning and rearing habitat (T. Tynan, NMFS, pers. com., to K. Schultz, NMFS, February 18, 2004). Habitat below the dams is also severely degraded because of downstream effects of the dams (N. Lampsakis, Point-No-Point Treaty Council, pers. com., to K. Schultz, NMFS, February 20, 2004). Recovery of this population is dependent upon removal of the two dams, and restoration of access to high quality habitat in the upper Elwha River basin. Chinook salmon produced by the hatchery mitigation program in the Elwha River system are considered essential to the recovery, and are listed under the ESA.

The anticipated range of total exploitation rates for the Elwha Management Unit under the implementation of the RMP is 22 to 30 percent. The most likely total exploitation rate within this range is 27 percent (see Table 14). Similar to the Dungeness Management Unit, the most likely exploitation rate for the SUS fisheries on the Elwha River population is only 5 percent (see Table 5). The resulting range of anticipated escapements to the Elwha River under the implementation of the RMP is 1,395 to 2,125 fish (see Table 3). The range of anticipated escapements is above the RMP's low abundance threshold of 1,000 fish, but below the co-managers' upper management threshold of 2,900 fish.

Based on the current status and stable escapement trend of the population, the anticipated level of escapement under the implementation of the RMP, the hatchery mitigation program initiated on the Elwha River, and consideration of the low anticipated SUS exploitation rate, the level of risk to the Elwha River population due to the anticipated range of exploitation rates under the implementation of the RMP is consistent with NMFS' standard for rebuilding.

Puyallup Management Unit - The Puyallup Management Unit contains one population. The Puyallup River population is classified as a Category 2 population. Hatchery programs introduced out-of-basin origin stocks, primarily of Green River lineage, into the Puyallup River system beginning in 1917 (T. Tynan, NMFS, pers. com., to K. Schultz, NMFS, February 10, 2004). The 1999 to 2002 average escapement of 1,672 fish for Puyallup River population has been well above the RMP's low abundance threshold of 500 fish and above the VSP-derived viable threshold of 1,250 fish (see Table 9). Using the trend in the South Prairie Creek index area as a proxy, the Puyallup River population is considered to have a stable escapement trend (see Table 9).

The co-managers propose to manage the Puyallup Management Unit by applying a 50 percent rebuilding exploitation rate and a 12 percent pre-terminal SUS critical exploitation rate ceiling. The resulting anticipated range of total exploitation rates for the Puyallup Management Unit under the implementation of the RMP is expected to be 49 to 50 percent. The most likely total exploitation rate within this range is 50 percent (see Table 14). The range of anticipated escapements to the Puyallup River under the implementation of the RMP is 1,798 to 2,419 fish (see Table 3). The most likely escapement within this range is 2,419 fish (see Table 5). The range of anticipated escapements for the Puyallup River is above the VSP-derived viable threshold of 1,250 fish.

Based on the current status, the stable escapement trend, and the anticipated level of escapement to remain above the viable threshold, the level of risk to the Puyallup River population due to the anticipated range of exploitation rates under the implementation of the RMP is consistent with NMFS' standard for rebuilding.

White River Management Unit – The White River Management Unit contains one population, the White River population (Category 1). The 1999 to 2002 average escapement of 1,220 fish for White River population has been above the RMP's upper management threshold of 1,000 fish (see Table 9). The White River population has exhibited an increasing escapement trend since listing (see Table 9).

The co-managers propose to manage the White River Management Unit by applying a 20 percent total rebuilding exploitation rate and a 15 percent SUS critical exploitation rate ceiling. The resulting anticipated range of total exploitation rates for the White River Management Unit under the implementation of the RMP is expected to vary little around the RMP's 20 percent rebuilding exploitation rate (see Table 14). The range of anticipated escapements to the White River under the implementation of the RMP is 1,011 to 1,468 fish (see Table 3). The most likely escapement within this range is 1,459 fish (see Table 5). Modeling suggests that escapement will continue to remain above the RMP's upper management threshold of 1,000 fish under the implementation of the RMP.

Based on the current status and increasing escapement trend of the of the population, and the anticipated level of escapement under the implementation of the RMP, the level of risk to the White River population due to the anticipated range of exploitation rates under the implementation of the RMP is consistent with NMFS' standard for rebuilding.

In summary, for those management units where adequate data were not available for NMFS to develop rebuilding exploitation rates, or for those management units where NMFS has yet to develop a rebuilding exploitation rate, there is an increased level of concern for the Cedar River, Sammamish River, Mid-Hood Canal rivers, and Dungeness River populations due to the low escapement anticipated under the implementation of the RMP. Additional discussion on the increased concern for these populations, in regards to the likelihood of survival and recovery of the ESU, will be provided in the following section.

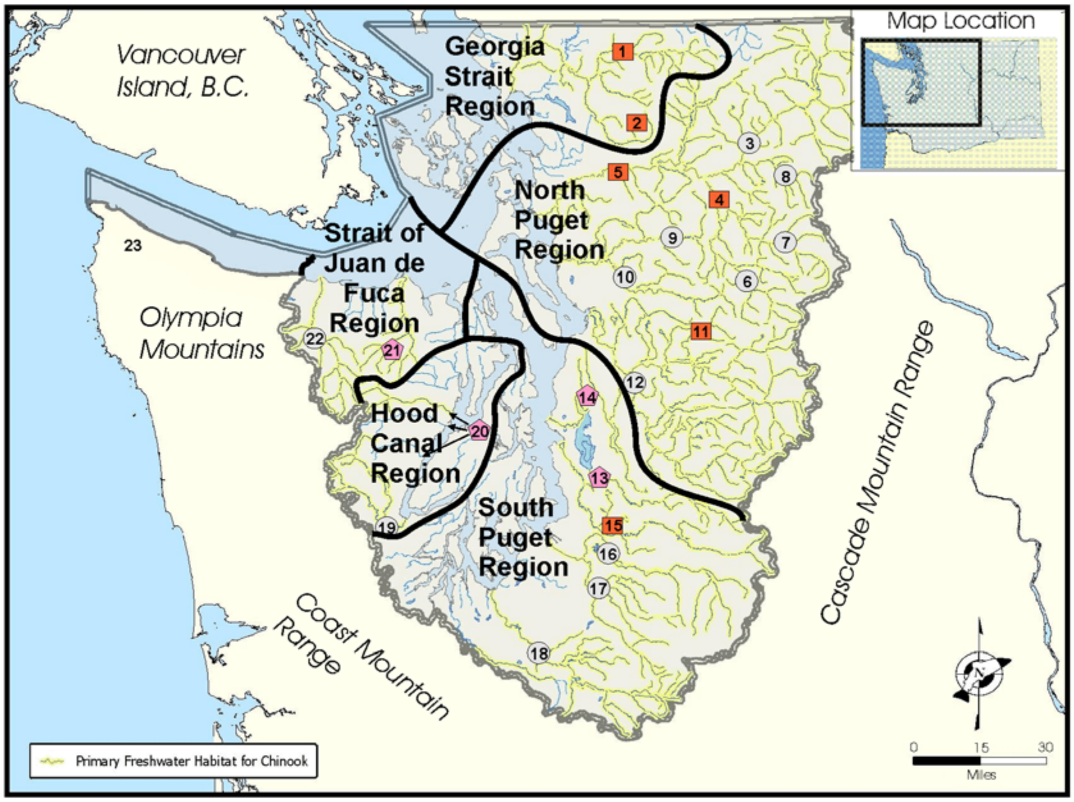
(6) Section (b)(4)(i)(D) Displays a biologically based rationale demonstrating that the harvest management strategy will not appreciably reduce the likelihood of survival and recovery of the Evolutionarily Significant Unit in the wild, over the entire period of time the proposed harvest management strategy affects the population, including effects reasonably certain to occur after the proposed actions cease.

The Puget Sound TRT is in the process of developing recommended recovery biological criteria for listed salmonids in the Puget Sound region. The TRT has prepared a draft document that includes general guidelines for assessing recovery efforts across individual populations within Puget Sound and determining whether they are sufficient for delisting and recovery of the listed ESU (NMFS 2002a). The preliminary delisting and recovery criteria recommendation provided by the TRT (see Chapter 3 in NMFS 2002d) have been used to assist in the evaluation of the harvest management strategy represented by the RMP.

Although component populations contribute fundamentally to the structure and diversity of the ESU, it is the ESU, not an individual population, which is the listed “species” under the ESA. The TRT is charged with identifying the biological characteristics of a recovered ESU as part of developing delisting and recovery criteria. These biological characteristics are based on the collective viability of the individual populations, their characteristics, and their distributions throughout the ESU.

NMFS recognizes that there are various recovery scenarios that may lead to a recovered ESU. Different scenarios of ESU recovery may be based on choosing different degrees of acceptable risk of extinction for different combinations of populations across the ESU. An ESU-wide scenario with all populations at the lower end of the planning range for viability is unlikely to assure persistence and delisting of the ESU (NMFS 2002a). The final ESU-wide scenario for delisting will likely include populations with a range of risk levels, but when considered in the aggregate, the collective risk will be sufficiently low to assure persistence of the ESU.

The geographical distribution of viable populations across the Puget Sound Chinook Salmon ESU is important for the ESU’s recovery (NMFS 2002a). The TRT has identified five geographic regions (Figure 7) within the Puget Sound Chinook Salmon ESU based on similarities in hydrographic, biogeographic, and geologic characteristics, which also correspond to regions where groups of populations could be affected similarly by catastrophes (volcanic events, earthquakes, oil spills, etc.). An ESU with well-distributed viable populations avoids the situation where populations succumb to the same catastrophic risk(s), allows for a greater potential source of diverse populations for recovery in a variety of environments (i.e., greater options for recovery), and will increase the likelihood of the ESU’s survival in response to rapid environmental changes, such as a volcano eruption of Mount Rainier. Geographically diverse populations in different regions also distribute the ecological and ecosystem services provided by salmon across the ESU.



Key: Chinook salmon populations, Puget Sound Comprehensive Chinook Management Plan, 2004.

Nooksack River
1 - North Fork Nooksack River
2 - South Fork Nooksack River

Skagit River
3 - Upper Skagit River
4 - Lower Sauk River
5 - Lower Skagit River
6 - Upper Sauk River
7 - Siuattle River
8 - Upper Cascade River

Stillaguamish River
9 - North Fork Stillaguamish River
10 - South Fork Stillaguamish River

Snohomish River
11 - Skykomish River
12 - Snoqualmie River

Lake Washington
13 - Cedar River
14 - Lake Washington Northern Tributaries

Other Rivers
15 - Duwamish-Green River
16 - White River
17 - Puyallup River
18 - Nisqually River
19 - Skokomish River
20 - Mid-Hood Canal Rivers
21 - Dungeness River
22 - Elwha River
23 - Hoko River (Not within ESU)

Based on NMFS' evaluation, with the implementation of the 2004 RMP:

Populations at low risk with the iimplementation of the RMP.

Populations with an increased level of concern, when compared to NMFS' standards, primarily due to the anticipated escapement approaching the critical threshold.

Populations where the anticipated range of exploitation rates exceeds NMFS-derived rebuilding exploitation rate.

Figure 7. Map of the geographic regions within the Puget Sound Chinook Salmon Evolutionarily Significant Unit (ESU). Based on NMFS' proposed evaluation, identified within the figure are populations are with an increased level of concern, when compared to NMFS' standards and populations where the anticipated range of exploitation rates resulting from the implementation of the RMP exceeds the NMFS-derived rebuilding exploitation rates.

The TRT recommends that an ESU-wide recovery scenario should include at least two to four viable chinook salmon populations in each of the five geographic regions within Puget Sound, depending on the historical biological characteristics and acceptable risk levels for populations within each region (NMFS 2002a). An ESU-wide recovery scenario should also include within each of these geographic regions one or more viable populations from each major genetic and life history group historically present within that geographic region (NMFS 2002a). While changes in harvest alone cannot recover the Puget Sound Chinook Salmon ESU, NMFS can use the preliminary TRT guidance for assistance in evaluating whether the proposed RMP would impede recovery of the ESU.

The following risk assessment is presented in two stages. In the first stage, a potential area of concern or risk is identified by region. In the second stage, the likelihood of that concern or risk occurring is evaluated. The assessment in the second stage also considers the practical influence harvest may have on the potential concern or risk.

Estimated impacts from the fisheries proposed by the RMP will vary by region, consistent with population-specific management objectives specified in the RMP. In prior sections, NMFS evaluated the RMP's impacts on individual populations. Consistent with the TRT's guidance to assess ESU-wide effects, the following is an evaluation of the estimated impacts on the ESU, by region, from the fisheries proposed by the RMP:

Georgia Strait Region – Chinook salmon originating from the Georgia Strait Region are distinct from other Puget Sound chinook salmon in their genetic attributes, life history traits, and habitat characteristics (PSTRT 2003). There are two populations within the Georgia Strait Region: the North Fork Nooksack River and the South Fork Nooksack River populations (see Figure 7). Both populations are designated as Category 1 populations (see Table 7). Straying between the two populations was historically low, as supported by available genetic data, but straying may have increased in recent years (PSTRT 2003). The more recent straying observations may be partially due to an increase in hatchery production. This potential source of straying may have been reduced by the co-managers with the implementation of a 50 percent reduction in on-station hatchery releases from Kendall Creek Hatchery (T. Scott, WDFW, e-mail to K. Schultz, NMFS, March 22, 2004). Habitat differences between the two populations exist, but are subtle (PSTRT 2003).

In previous sections, NMFS has evaluated the RMP's impacts on individual populations and identified an elevated level of risks to the North Fork Nooksack River and South Fork Nooksack River populations, when compared to NMFS' standards. A summary of the risk analysis for these two populations follows. A more detailed analysis of risks to these populations is provided in previous sections.

Nooksack River Populations - The North Fork Nooksack River natural-origin population has exhibited an increasing escapement trend since listing (see Table 9). However, the estimated 1999 to 2002 average escapement of 180 natural-origin spawners for the North Fork Nooksack River population is below the NMFS-derived critical threshold of 200 fish (see Table 8). The South Fork Nooksack River natural-origin population has also exhibited an increasing escapement trend since listing (see Table 9). The 1999 to 2002 average escapement of 249 natural-origin spawners for the South Fork Nooksack River population is slightly above the NMFS-derived critical threshold of 200 fish (see Table 8).

The broodstock used for the Kendall Creek Hatchery program, located on the North Fork Nooksack River, retains the genetic characteristics of the wild population and is considered essential for the survival and recovery of the ESU. When including Kendall Creek hatchery-origin fish, an average aggregate escapement of 3,438 natural spawners in the North Fork Nooksack River has been observed since listing (see Table 10). Adult fish produced by the Kendall Creek Hatchery program and migrating with the natural-origin fish are expected to buffer harvest-induced genetic and demographic risks to the natural-origin North Fork Nooksack River population (see discussion on pages 27 to 30).

Increased escapement of natural-origin fish into the Nooksack River in recent years may be due, in part, to harvest reductions. However, the abundance trend in the natural-origin returns suggests that, although escapement may be stable or even trend upward toward or above the optimum level associated with current habitat condition, natural-origin recruitment will not increase much beyond that level unless constraints limiting marine, freshwater, and estuary survival are alleviated. Augmentation of these natural-origin spawners on the natural spawning areas of the North Fork Nooksack River, with the addition of hatchery-origin spawners, will continue to test the natural production potential of the system at higher escapement levels. The escapement of hatchery-origin fish may also benefit the natural-origin production by capitalizing on favorable survival conditions in some years.

For the Nooksack Management Unit, the anticipated range of total exploitation rates is 20 to 26 percent. The most likely total exploitation rate within this range is 25 percent (see Table 14). Similar to recent years, the largest proportion of the total exploitation rate is expected to be accounted for by the Canadian fisheries (see Table 4). The SUS exploitation rate on the Nooksack River populations is not anticipated to exceed 7 percent under the proposed RMP (see Table 3). Even if the entire SUS exploitation rate on Nooksack River populations of 7 percent was eliminated, the NMFS-derived rebuilding exploitation rate of 12 percent for the Nooksack Management Unit would still not be achieved.

NMFS has evaluated the elevated risks to the Nooksack Management Unit associated with the SUS fisheries proposed in the RMP, using the NMFS-derived rebuilding exploitation rate as the standard for comparison. With the modeled Canadian fisheries, and assuming 2003 abundance, a 7 percent SUS fishery exploitation rate for the Nooksack River populations would lead to a 6 percentage point decrease in the probability of rebuilt populations in 25 years under current conditions. Modeling also suggests that the application of a 7 percent SUS fishery exploitation rate would result in a 14 percentage point increase in the probability that the populations will fall below the critical level during that same 25-year period (see Table 16).

Similar to recent years, it is likely that the vast majority of the SUS fishery harvest impacts on the Nooksack Management Unit populations under the RMP would occur in treaty Indian fisheries. Since 2001, the majority of the SUS harvest on the Nooksack Management Unit has occurred in tribal fisheries. In recognition of tribal management authority and the Federal government’s trust responsibility to the tribes, NMFS is committed to considering their judgment and expertise regarding the conservation of trust resources. Consistent with this commitment and as a matter of policy, NMFS has sought, where there is appropriate tribal management, to work with tribal managers to provide limited tribal fishery opportunities, so long as the risk to the population remains within acceptable limits.

Trends in the escapement of natural-origin Nooksack early chinook salmon populations are increasing. The additional contributions of hatchery origin spawners to the natural spawning areas are anticipated to reduce catastrophic and demographic risks to the North Fork Nooksack population. In addition, the Kendall Creek hatchery-origin chinook salmon share the ecological and genetic characteristics of the natural origin spawners. Information suggests that past harvest constraints have had limited effect on increasing the escapement of returning natural-origin fish. The magnitude of Canadian harvest is expected to significantly exceed the NMFS-derived rebuilding exploitation rate for the Nooksack River populations. However, the SUS exploitation rate on the Nooksack River populations is not anticipated to exceed 7 percent. NMFS considers the tribes' management authority, judgment, and expertise regarding conservation of trust resources. Taking all these factors into account, NMFS concludes that the implementation of the RMP from May 1, 2005 through April 30, 2010, will adequately protect chinook salmon populations in the Georgia Straight Region.

North Puget Sound Region – The largest river systems in Puget Sound are found within the North Puget Sound Region. There are ten chinook salmon populations delineated by the TRT within the North Puget Sound Region (see Figure 7). NMFS has determined that the proposed RMP will contribute to the rebuilding of seven of the ten populations (70 percent) within this region. NMFS has identified a potential elevated level of risk under the RMP for three of these ten populations, as assessed through a comparison of likely exploitation rate ranges for these populations under the RMP with their NMFS-derived rebuilding exploitation rates. These three populations are the lower Sauk River and lower Skagit River populations in the Skagit Summer/Fall Management Unit, and the Skykomish River population in the Snohomish Management Unit. A summary of the risk analysis for these three populations follows, but a more detailed analysis is provided in previous sections.

Lower Skagit River Population: The lower Skagit River population is classified as a Category 1 population (see Table 7). The population has shown an increasing escapement trend since listing (see Table 9). The 1999 to 2002 average escapement of 2,944 fish has been above the NMFS-derived viable threshold of 2,182 fish for the lower Skagit River population (see Table 8). The anticipated escapement under the implementation of the RMP for the lower Skagit River population is 1,182 fish (see Table 5). This level of escapement is well above the NMFS-derived critical threshold of 251 fish for the lower Skagit River population.

The anticipated total exploitation rate under the implementation of the RMP for the lower Skagit River population would range between 48 and 56 percent. The most likely total exploitation rate within this range would be 55 percent (see Table 14). The upper end of the range of anticipated total exploitation rates exceeds the NMFS-derived rebuilding exploitation rate of 49 percent for this population. Similar to recent years, it is anticipated that Canadian fisheries will account for the substantial portion of the anticipated total exploitation rate on this population under the implementation of the RMP (see Table 4).

The anticipated range of exploitation rates for the SUS fisheries for the lower Skagit River population is 16 to 18 percent (see Table 3). The most likely exploitation rate for the SUS fisheries within this range is 16 percent (see Table 5). Through modeling, NMFS assessed the increased risk to the lower Skagit River population associated with the SUS fisheries proposed in the RMP. With the modeled Canadian fisheries and abundance similar to 2003 levels, a 16 percent SUS exploitation rate would result in a 26 percentage point decrease in the probability of a rebuilt population in 25 years under current conditions. This modeling also indicates that there is no change in the probability that the population will fall below the critical level during that same 25-year period (see Table 16).

Lower Sauk River Population: The lower Sauk River chinook salmon population is classified as a Category 1 population (see Table 7). The population has exhibited an increasing escapement trend since listing (see Table 9). The 1999 to 2002 average escapement of 721 fish has been above the NMFS-derived viable threshold of 681 fish for the lower Sauk River population (see Table 8). The most likely escapement resulting from the implementation of the RMP for the lower Sauk River population is 588 fish (see Table 5). This level of escapement is above the NMFS-derived critical threshold of 200 fish defined for the for the lower Sauk River population (see Table 8).

Total exploitation rates on the lower Sauk River population under the implementation of the RMP on the lower Sauk River population are expected to range between 48 and 56 percent. The most likely total exploitation rate within this range is 55 percent (see Table 14). The upper end of the range of anticipated total exploitation rates exceeds the NMFS-derived rebuilding exploitation rate for this population of 51 percent. A lack of data prevented NMFS from determining the level of increased risk for to the lower Sauk River population in the event that the total exploitation rate exceeds the NMFS-derived rebuilding exploitation rate. The effects of the implementation of the RMP on the lower Sauk River population are assumed to be similar to those identified for the lower Skagit River population as discussed above.

Skykomish River Population: The Skykomish River chinook salmon population is classified as a Category 1 population (see Table 7). The population has exhibited an increasing escapement trend since listing (see Table 9). The 1999 to 2002 average escapement of 2,118 fish for the Skykomish River population has been above the NMFS-derived critical threshold of 1,650 fish, but below the NMFS-derived viable threshold of 3,500 fish (see Table 8). The estimated escapement for the Skykomish River population that is most likely to result from the implementation of the RMP is 2,385 fish (see Table 5).

The total exploitation rate of 22 percent that is most likely to result from the implementation of the RMP would exceed the NMFS-derived rebuilding exploitation rate for the Skykomish River population by 5 percentage points (see Table 19). The anticipated harvest impacts on the populations within the Snohomish Management Unit include those from Canadian fisheries (see Table 4). The management of Canadian fisheries is outside the jurisdiction of the co-managers. However, the co-managers do have jurisdiction over fisheries occurring within the SUS areas. For the Snohomish Management Unit, the anticipated range of exploitation rates for the SUS fisheries is 13 to 14 percent (see Table 3). The most likely exploitation rate within in this range is 13 percent (see Table 5).

Through modeling, NMFS identified the increased level of risk that may be associated with the SUS fisheries exploitation rates proposed in the RMP, when compared to the NMFS-derived rebuilding exploitation rate. Under the mostly likely scenario, a 13 percent SUS exploitation rate for the Skykomish River population will result in a 14 percentage point decrease in the probability of a rebuilt population in 25 years under current conditions. Modeling also suggests that the implementation of the RMP will result in a 3 percentage point increase in the probability that the population will fall below the critical level during that same 25-year period (see Table 16).

The TRT recommends that any ESU-wide recovery scenario include at least two to four viable chinook salmon populations in each of the five geographic regions within Puget Sound, depending on the historical biological characteristics and acceptable risk levels for populations within each region. NMFS' assessment is that the RMP will contribute to rebuilding for seven of the ten populations within the North Puget Sound Region. The life history and run timing characteristics of the three populations identified as having an elevated level of risk for rebuilding (the lower Sauk River, the lower Skagit River, and the Skykomish River populations), are similar to the seven other populations in the region (see Table 7). Two of these three "at risk" populations are currently above their identified viable thresholds, and all three populations have an increasing trend in escapement since listing. Therefore, NMFS concludes that the RMP's management objectives are adequately protective of the geographic distribution, life history characteristics, and diversity of populations within the North Puget Sound Region of the ESU.

South Puget Sound Region – There are six populations delineated by the Puget Sound TRT within the South Puget Sound Region (see Figure 7). Genetically, most of the present spawning aggregations in the South Puget Sound Region are similar, likely reflecting the extensive influence of transplanted stock hatchery releases, primarily from the Green River population (PSTRT 2003). The TRT found that life history and genetic variations were not useful in determining populations within the South Puget Sound Region. Most chinook salmon in the South Puget Sound Region have similar life history traits.

In the previous sections, NMFS found that the proposed RMP is anticipated to contribute to the stabilization or rebuilding of all populations within this region[11]. However, NMFS has identified a concern for two South Puget Sound Region populations due primarily to anticipated low abundance under the implementation of the RMP from May 1, 2005 through April 2010. A summary of the concerns for these two populations follows, but a more detailed analysis is provided in previous sections.

Cedar River and Sammamish River Populations: The Lake Washington Management Unit includes two populations; the Cedar River (Category 1) and the Sammamish River (Category 2) populations. The 1999 to 2002 four-year average escapements of 385 fish for the Cedar River population and 373 fish for the Sammamish River population are above the identified critical thresholds. The four-year average escapement of 385 fish for the Cedar River population is

[11] With the level of escapement for the Duwamish-Green River population anticipated to continue to exceed the NMFS-derived viable threshold, the level of risk to this population associated with the implementation of the RMP is consistent with NMFS' standards.

below the RMP's upper management threshold for the population of 1,200 fish (see Table 8). The RMP proposes no upper management threshold for the Sammamish River population (see discussion on pages 32 to 33).

Since listing, the trend in escapement to the Cedar River has been stable, while the escapement to the Sammamish River population has exhibited an increasing trend (see Table 9). However, it is noted that the total escapement estimates for the Cedar River, as presented in Table 6, are based on an expansion of a live fish counts. Expansions of redd counts in the Cedar River suggest that this historical expansion of the live counts may be a conservative estimate of the total escapement. Additionally, the escapement estimates for the Sammamish River population do not include escapement into the Upper Cottage Lake or Issaquah Creeks. Therefore, although the escapement information used in this evaluation is believed to be representative of trends, the escapement estimates are considered a conservative estimate of the total escapement. A direct comparison of the Cedar River and Sammamish River escapements with the VSP generic guidance for a critical threshold of 200 fish should be considered conservative, as the total escapements for these two systems are likely greater than those depicted in Table 6.

Since 1998, the estimated natural escapement levels for both populations within the Lake Washington Management Unit have exceeded the VSP generic guidance for a critical threshold of 200 fish, but have remained well below the guidance for a viable threshold of 1,250 fish. Escapements into the Cedar River and the Sammamish River tributaries resulting from the implementation of the RMP are anticipated to range from 214 to 305 fish each (see Table 3). The most likely escapement for each population within this range is 295 fish (see Table 5).

Harvest impact modeling for the Lake Washington Management Unit indicates that the co-managers will continue to meet or exceed the critical threshold of 200 natural spawners for both populations within the management unit under the implementation of the RMP. However, given that the range of anticipated escapements approaches the critical thresholds for each population, and considering the volatility in escapement observed for these populations in the past, NMFS is concerned that these populations could experience very low abundance in the next several years, below the critical thresholds. However, there is a substantial contribution of stray hatchery-origin fish to the natural escapement in the Sammamish River tributaries. The Sammamish River population (Category 2 population) is not genetically distinct from these straying hatchery-origin fish. These hatchery-origin fish may lessen demographic concerns that may arise regarding low escapement for that population.

In previous sections of this document, NMFS has expressed concern for the Sammamish River population because the RMP provides no low abundance threshold for managing harvest impacts on the population. The co-managers propose that protective measures imposed to safeguard the Cedar River population, which include management constraints that would be applied when the population falls below its low abundance threshold, will also incidentally benefit the Sammamish River population. The co-managers' argument is compelling because the Cedar River and Sammamish River populations are both affected by the same terminal area fisheries. NMFS agrees that it is reasonable to expect that terminal conservation management measures directed at migrating fish returning to the Cedar River would also benefit fish returning to the Sammamish River.

Limiting factors to chinook salmon survival and productivity in the Lake Washington basin are being addressed by improving fish passage conditions at the Ballard Locks, and restoration of anadromous fish access to 17 miles of the Cedar River above the Landsburg Dam. While these improvements will likely enhance spatial structure and productivity, there remain highly altered conditions in the Lake Washington basin and at the Ballard Locks that are daunting to juvenile salmon survival and emigration, and adult immigration.

The TRT recommends that an ESU-wide recovery scenario should include at least two to four viable chinook salmon populations in each of five geographic regions within Puget Sound, depending on the historical biological characteristics and acceptable risk levels for populations within each region. Despite potential risks that the Cedar River and Sammamish River populations may experience under the harvest management plan from May 1, 2005 through April 2010, the RMP is still expected to provide sufficient protection for four of the six populations in the South Puget Sound Region. The concerns for the Cedar River and Sammamish River populations do not represent much risk to the region. Identifying these two populations as a concern is considered a precautionary approach, as information suggests that the escapements estimated for these systems are likely conservative. NMFS believes that the RMP's management objectives are adequately protective of the geographic distribution, life history characteristics, and genetic diversity of the populations within the South Puget Sound Region of the ESU.

Hood Canal Region – Primarily because of their geographic isolation from other basins of the ESU, the TRT concluded that chinook salmon spawning historically in Hood Canal streams were independent from other chinook salmon spawning aggregations in the Puget Sound region (PSTRT 2003). There are two populations within the Hood Canal Region: the Skokomish River and the Mid-Hood Canal rivers populations (see Figure 7). Both populations are classified as a Category 2 population (see Table 7). Watersheds harboring Category 2 chinook salmon populations are areas where indigenous populations of the species are believed to no longer exist, but where sustainable wild populations existed historically and wild production remains self-sustaining at present and where habitat could still support such populations.

In a previous section, NMFS has identified potential concern for harvest impacts on the spatial structure of the Mid-Hood Canal rivers population. This concern is heightened because of the low abundance in two of the individual rivers. A summary of the concerns for the Mid-Hood Canal rivers population follows, but a more detailed analysis is provided in previous sections.

Mid-Hood Canal Rivers Population: The 1999 to 2002 average escapement of 404 fish for the Mid-Hood Canal rivers population is only slightly above the RMP's low abundance threshold of 400 fish for the population (see Table 9). The Mid-Hood Canal rivers population has exhibited an increasing escapement trend since the time of listing (see Table 9). However, low levels of escapements in the Mid-Hood Canal Management Unit are anticipated to continue under the implementation of the RMP. The range of anticipated spawning escapements into the rivers of the Mid-Hood Canal Management Unit under the implementation of the RMP from May 1, 2005 through April 2010 is expected to range from is 344 to 531 fish (see Table 3). The most likely escapement within this range is 504 fish (see Table 5).

The Mid-Hood Canal rivers population includes spawning aggregations in the Hamma Hamma, Duckabush, and the Dosewallips Rivers. Most harvest impacts on this population occur in mixed stock areas outside of the Hood Canal region. The effects of these mixed stock fisheries on the three components of the population are variable and unpredictable. It is therefore difficult for the co-managers to impose differential harvest effects on the individual spawning aggregate components in order to adjust spawning distribution among the rivers. In 2002, the natural escapement of 95 spawners into the Mid-Hood Canal Management Unit fell well below the VSP guidance for a critical threshold of 200 fish for this population. Total annual spawning escapements below 40 fish have been observed in recent years in each of the Duckabush and Dosewallips Rivers.

For the Mid-Hood Canal Management Unit, the anticipated range of total exploitation rates that would result from the implementation of the RMP is 26 to 34 percent. The most likely total exploitation rate within this range is 32 percent (see Table 14). Similar to the more northern chinook salmon management units discussed above, Canadian fisheries are expected to account for a substantial proportion of the total exploitation rate on this population (see Table 4). The most likely SUS exploitation rate anticipated under the implementation of the RMP is 13 percent.

Escapement into the individual systems has varied, with the spawning aggregation in the Hamma Hamma River representing the majority of the total Mid-Hood Canal rivers population abundance in recent years (see Table 6). Adult returns resulting from the WDFW-administered Hamma Hamma River supplementation program, which relies partially on broodstock returning to the river, has likely contributed substantially to the Mid-Hood Canal rivers population’s increasing abundance trend (see Table 12).

The hatchery-origin adult fish that are progeny of broodstock collected from the Hamma Hamma River may buffer demographic risks to the Mid-Hood Canal rivers population in the short term, particularly to the component of the population spawning in the Hamma Hamma River. The general characteristics of the Mid-Hood Canal rivers population, including life history and run timing, are also found in the Skokomish River population (see Figure 7), the only other population within the region. Genetically similar stocks are also sustained by several hatchery facilities in the Hood Canal area and in hatcheries in the South Puget Sound Region where the Green River-lineage are naturally or artificially sustained.

As mentioned in a previous section, the co-managers, in cooperation with NMFS, have modeled escapement results under a no Puget Sound fishery alternative. The most likely escapement for this management unit under the “no fishery” scenario is 527 fish. With no Puget Sound fisheries, anticipated escapement into the Mid-Hood Canal rivers population would only increase by 23 fish, spread among the three component natural spawning rivers. Given the observed proportions of recent year escapements into the individual river systems comprising the Mid-Hood Canal Management Unit (see Table 12), the most likely increase in escapement into the Duckabush and Dosewallips Rivers will be only three and two fish, respectively. Based on modeling, further decreases in the proposed SUS fisheries-related impacts would have little effect on the persistence of the spawning aggregations in the Dosewallips and Duckabush Rivers.

The TRT recommends that an ESU-wide recovery scenario should include at least two to four viable chinook salmon populations in each of five geographic regions within Puget Sound, depending on the historical biological characteristics and acceptable risk levels for populations within each region. NMFS concludes the RMP's management objectives are adequately protective of the geographic, life history, and diversity of the populations within the Hood Canal Region of the ESU. This recommended determination takes into consideration that the hatchery-origin production may buffer demographic risks associated with the RMP to the Mid-Hood Canal rivers population. Additionally, the genetic similarity between the Mid-Hood Canal rivers population and populations within the Skokomish River and the South Puget Sound Region, which could serve as reserves, was also a factor. However, the primary reasons for the recommendation are the total abundance status of the population, the increasing escapement trend observed for the population, the annual monitoring and evaluation actions outlined in the RMP (discussed later in this document), and the likelihood that further decrease in the SUS fisheries-related impacts would have limited beneficial effects.

Strait of Juan de Fuca Region - The TRT delineated two populations within the Strait of Juan de Fuca Region: the Dungeness River and the Elwha River populations (see Figure 7). Both populations are classified as Category 1 populations (see Table 7). Although the TRT identified only two historically extant populations within the Strait of Juan de Fuca Region, important components of the historical diversity within the Strait of Juan de Fuca Region may have been lost (PSTRT 2003).

Genetically, the chinook salmon in the Elwha River are very distinct from other Puget Sound populations (see Figure 5a in PSTRT 2003). Chinook salmon in the Dungeness River are also genetically distinct from other populations in Puget Sound and appear intermediate in their characteristics between eastern Puget Sound and the Elwha River populations (PSTRT 2003). Habitat differences also exist between the Dungeness and Elwha River basins and other Puget Sound watersheds (PSTRT 2003).

In previous sections, NMFS found that the RMP provides sufficient protection for the Elwha River population. However, NMFS has identified a heightened level of concern for the Dungeness River population, primarily because of the current status of the populations, the annual anticipated escapement resulting from the implementation of the RMP is expected to approach the VSP-derived critical threshold of 200 for the population. A summary of the risk analysis for the Dungeness River population follows, but a more detailed analysis is provided in previous sections.

Dungeness River Population: Since listing, the average escapements of 345 fish for the Dungeness River population has been above the VSP generic guidance for a critical threshold of 200 fish for this population, but below the RMP's low abundance threshold of 500 fish. The Dungeness River population has exhibited an increasing escapement trend since listing (see Table 9). Modeling of the Dungeness Management Unit indicates that the co-managers would continue to meet or exceed the critical threshold of 200 natural spawners under the implementation of the RMP from May 1, 2005 through April 2010. The range of escapements to the Dungeness River under the implementation of the RMP is expected to be 231 to 356 fish (see Table 3). The most likely escapement within this range is 336 fish (see Table 5). The range of anticipated escapements is below the RMP's low abundance threshold of 500 fish and approaches the VSP generic guidance for a critical threshold of 200 fish for this population.

The co-managers, in cooperation with federal agencies and private-sector conservation groups, have implemented a captive brood stock program to rehabilitate chinook salmon runs in the Dungeness River. Juvenile and adult fish produced through the hatchery program on the Dungeness River are listed with the natural-origin fish under the ESA. The primary goal of the supplementation and an associated fishery restriction program is to increase the number of fish spawning naturally in the river, while maintaining the generic characteristics of the existing broodstock.

Although there are no fishery harvest distribution estimates for the Dungeness Management Unit, in the adjacent Elwha Management Unit, it is estimated that the Alaskan and Canadian harvests have represented, on average, almost 80 percent of the total fishery impacts. A similar Alaskan and Canadian harvest distribution is assumed for the Dungeness River population. Through modeling, the estimated range of exploitation rates that may be anticipated for the Dungeness Management Unit under the implementation of the RMP from May 1, 2005 through April 2010 is 22 to 29 percent. The most likely total exploitation rate within this range is 27 percent (see Table 14). However, the anticipated SUS exploitation rate for this population is very small; the SUS fisheries exploitation rate on this population is most likely to be 5 percent (see Table 5).

The co-managers will review the status of populations within the ESU annually. The co-managers, in cooperation with NMFS, will use this information to assess whether impacts on listed fish are as expected. When a population is anticipated to fall below its low abundance threshold, the co-managers have committed to consider additional actions when application of the RMP is not sufficiently protective in a given year, and when such additional actions would benefit the stocks.

NMFS concludes that the RMP would provide sufficient protection for the Strait of Juan de Fuca Region populations. This recommended determination takes into consideration that the conservation hatchery program operating in the Dungeness River buffers the demographic risk to the Dungeness River population. This recommended determination also considers the status and increasing escapement trend of the populations within this region, annual monitoring and evaluation outlined in the RMP (which will be discussed more later in this evaluation), the small anticipated SUS exploitation rate of less than five percent, and the likelihood that any further decrease in the SUS fisheries-related impacts would have limited beneficial effects on these populations. As discussed above and in previous sections, NMFS finds that the RMP's management objectives would be adequately protective of the geographic distribution, life history characteristics, and genetic diversity of populations within the Strait of Juan de Fuca Region of the ESU.

ESU Summary - The Puget Sound Chinook Salmon ESU, not the component, individual populations, is the primary focus of NMFS' evaluation of the impacts of the RMP under the ESA. In conducting this evaluation, NMFS takes into account the recommendations of the TRT, which is charged with identifying the biological characteristics of a recovered ESU as part of developing delisting and recovery criteria. As noted earlier, the TRT's preliminary recommendation is that any ESU-wide recovery scenario should include at least two to four viable chinook salmon populations in each of five geographic regions within Puget Sound, depending on the historical biological characteristics and acceptable risk levels for populations within each region. Biological criteria outlined in the ESA 4(d) Rule, NMFS' other mandates under the Endangered Species Act, and federal trust responsibilities to treaty Indian tribes will also be considered in developing NMFS' evaluation and resultant determination for the RMP.

NMFS concludes that the implementation of the RMP from May 1, 2005 through April 30, 2010, will adequately protect chinook salmon populations in the Georgia Straight Region based primarily on the increasing trends of the natural-origin populations, the additional contributions of hatchery-origin spawners to the natural spawning areas, and the low anticipated SUS exploitation rate. Additionally, NMFS' conclusion is based on information suggesting that past harvest constraints have had limited effect on increasing escapement of returning natural-origin fish, when compared with the return of hatchery-origin fish, and taking into consideration NMFS' treaty trust responsibility.

NMFS has determined that implementation of the proposed RMP will contribute to rebuilding for seven of the ten populations within the North Puget Sound Region. The life history and run timing characteristics of the three populations identified as having an elevated level of risk for rebuilding, are represented by the seven other populations in the region. Escapements for two of three "at risk" populations are currently above their identified viable thresholds, and all three populations have shown an increasing trend in escapement since listing. Therefore, NMFS concludes that the RMP's management objectives would be adequately protective of the geographic distribution, life history characteristics, and genetic diversity of the populations within the North Puget Sound Region of the ESU.

Through its evaluation, NMFS expects that the proposed RMP would contribute to the stabilization or rebuilding of all populations within the South Puget Sound Region. Specific harvest impacts identified for the two populations within the region, the Cedar River and Sammamish River populations, do not rise to a level that might represent a substantial risk to chinook salmon population rebuilding and recovery in the region when all populations are considered. Highlighting harvest impact concerns for these two populations is considered precautionary. Therefore, NMFS concludes that the RMP's management objectives are adequately protective of the geographic distribution, life history characteristics, and genetic diversity of the populations within the South Puget Sound Region of the ESU.

The RMP's management objectives are adequately protective of the geographic distribution, life history traits, and genetic diversity of the populations within the Hood Canal Region of the ESU. This conclusion is based on the production of the hatchery-origin fish that share the ecological and genetic traits of the natural-origin population, the status and increasing escapement trends of the two component populations, the annual monitoring and evaluation actions applied in the RMP to track population status and harvest impacts, the likelihood that further decrease in the SUS fisheries-related impacts would have limited effects on the persistence of the Mid-Hood Canal rivers population within this region, and the genetic similarity between the Mid-Hood

Canal rivers population and populations within the Skokomish River and the South Puget Sound Region.

NMFS concludes that the RMP will also provide adequate protection for chinook salmon originating from the Strait of Juan de Fuca Region. This recommended determination is based on the status and increasing escapement trends of the populations, the annual monitoring and evaluation actions outlined in the RMP, the low anticipated SUS exploitation rates, the likelihood that any further decrease in the SUS fisheries-related impacts would have limited beneficial effects on the persistence of these two populations, and on consideration that the hatchery-origin fish produced for conservation purposes in the two watersheds within this region share the ecological and genetic traits of the natural-origin populations.

Based on these conclusions and the analysis presented in previous sections, NMFS finds that the RMP’s management objectives, in combination with other ongoing habitat and hatchery efforts, would provide adequate protection for each of the five regions of the ESU. NMFS finds that the RMP’s management objectives adequately address the biological criteria outline in the ESA 4(d) Rule. Therefore, the NMFS Northwest Region, Sustainable Fisheries Division concludes that implementation of the RMP from May 1, 2005 through April 2010 would not appreciably reduce the likelihood of survival and recovery of the Puget Sound Chinook Salmon ESU in the wild**.**

(7) Section (b)(4)(i)(E) Includes effective (a) monitoring and (b) evaluation programs to assess compliance, effectiveness, and parameter validation *(Minimum requirement: collect catch and effort data, information on escapements, and information on biological characteristics, such as age, fecundity, size and sex data, and migration timing*).

The Puget Sound Indian Tribes and the WDFW, independently and jointly conduct a variety of research and monitoring programs. Chapter 7 of the RMP (starting on page 55) describes these monitoring programs which are used to assess effectiveness of the management actions in achieving the management objectives of the RMP and to validate the assumptions used in deriving the objectives. Information from research and monitoring programs will be used in conjunction with the performance indicators to assess the effectiveness of the RMP and revise management objectives and actions accordingly.

Chinook salmon harvest in all fisheries, including incidental catch and fishing effort, is monitored by the co-managers. Commercial catches within the Puget Sound Action Area are recorded on sales receipts (‘tickets’), copies of which are sent to the WDFW and tribal agencies and recorded in a jointly-maintained database. A preliminary summary of catch and effort is available four months after the season, although a final, error-checked record may require a year or more to develop.

For Puget Sound fishing areas, recreational harvest is estimated from either creel census or from a sample of catch record cards obtained from anglers. The recreational fishery baseline sampling program provides auxiliary estimates of species composition, effort, and catch-per-unit-effort (CPUE) to the Salmon Catch Record Card System. The baseline sampling program is geographically stratified among the marine catch areas in Puget Sound. The objective of the sampling program is to sample 120 fish per stratum for estimation of species composition, and 100 boats per stratum for the estimation of CPUE.

Catch and effort summaries allow an assessment of the performance of fishery regulations in constraining catch to the desired levels. Time and area constraints, and gear limitations, are imposed by regulations, but with some uncertainty regarding their exact effect on harvest. For many management units, catch is often projected pre-season based on the modeled effect of specific regulations. Post-season comparison of estimated and actual catch allows for the assessment of the true effect of those regulations, and guides their future application or modification.

Incidental mortality in fisheries directed at other species or non-listed chinook salmon has comprised an increasingly large proportion of the total harvest mortality of Puget Sound chinook salmon. Non-landed mortality is accounted for in the RMP. Non-landed mortality is primarily addressed in the RMP's Chapter 4, the section on Non-Landed Fisheries Mortality (starting on page 26 in the RMP) and in Appendix B: Non-landed Mortality Rates of the RMP. Non-landed mortality is projected by averaging levels estimated across a recent period, either as total chinook salmon landed or as a proportion of the target species catch.

The co-managers estimate chinook salmon escapement from surveys in each river system. Escapement surveys provide information on run timing and population status. A variety of sampling and computational methods are used to calculate escapement, including cumulative redd counts, peak counts of live adults, cumulative carcass counts, and integration under escapement curves drawn from a series of live fish or redd counts. A more detailed description of methods used for Puget Sound systems is included in Appendix E: Puget Sound Chinook Escapement Estimates: Description and Assessment of the RMP.

Catch sampling and escapement surveys also provide biological data on age, length, sex, and size. Depending on the accuracy required of such estimates, more sampling effort may be required by the co-managers than has previously been expended on gathering basic biological data to determine age and sex composition and the effects of fisheries on these biological elements. State and tribal technical staffs are currently focusing attention on the improving design and implementation of these studies.

The performance of the fisheries during the life of the RMP will be assessed to determine the extent to which catch and fishing effort conform to the quotas, ceilings, or projections that were defined in pre-season planning for each fishing area and season. The assessment may lead to further evaluation of the effectiveness of fishing regulations (e.g. time or area constraints, gear restrictions, or bag limits), in future management plans. The causes of discrepancies between expected and actual catch and effort will be identified by the co-managers with a view to changing regulatory measures, and methods for projecting catch and fishing effort, to improve their accuracy.

Assessment of the total return requires accurate estimation of escapement and reconstruction of fishing-related mortality from coded-wire tag data or fishery simulation models. There will a time lag of approximately 18 months, after the conclusion of the fall fisheries, before tag recovery data are available to researchers. Tag recoveries from all intercepting fisheries, including those in Alaska and British Columbia, are required to complete the assessment. Accounting of the harvest fishing-related mortality and escapement for each management unit will enable the calculation of exploitation rates, which may be compared with the pre-season projections and objectives. Ultimately, reconstruction of all cohorts associated with a given brood year enables the calculation of brood-year exploitation rates.

Cohort reconstruction and estimation of exploitation rates from tag recovery data will also provide a means of assessing the accuracy of the fishery simulation models. Models predict unit-specific fishing-related mortality by scaling the abundance of all contributing populations, and the fishing effort anticipated in each area and season, against those in a base period. Tag-based run reconstruction provides an alternative and independent estimate of the total fishing-related mortality and harvest distribution of each management unit or population. The errors detected in the simulation model, whether they be associated with abundance forecasts or computation of harvest, will be quantified and taken into account in developing harvest objectives and fishery planning so that fishery management planning will be robust to those errors.

Cohort reconstruction for each management unit is the fundamental monitor of productivity. As discussed above, the productivity of each management unit or population guides the development and adjustment of exploitation rate objectives. Those objectives must conform to the most recent values and trends in population productivity. However, many management units do not have sufficient data on productivity to detect changes. Periodically, the population/recruit function will be updated, and the exploitation rates and thresholds re-assessed, for each management unit. The tasks involved in monitoring abundance and productivity, and assessing the performance of annual fishing regimes, is mandated by the Puget Sound Salmon Management Plan (PSSMP 1985).

In addition to the monitoring programs discussed in the RMP, there are numerous other ongoing projects funded by other agencies or programs which provide additional information useful for fisheries management. Each year, the Salmon Recovery Funding Board provides funding for projects designed to further salmon recovery. Limiting factor analyses are being conducted for each major watershed within Washington State (WSCC 2000). The results of these analyses will be important for parameter validation and management objective revision as necessary. Data collection and monitoring programs included in Hatchery and Genetic Management Plans implemented within the Puget Sound region will also provide valuable information on stray rates and patterns, and contribution of hatchery fish to escapements.

(8) Section (b)(4)(i)(F) Provides for (a) evaluating monitoring data; and (b) making any revisions of assumptions, management strategies, or objectives that data show are needed.

A description of how WDFW and the PSTT will evaluate the monitoring data and compile a report of the findings can be found in Chapter 7 of the RMP, in the Annual Chinook Management Report section, and in Appendix E: Puget Sound Chinook Escapement Estimates: Description and Assessment of the RMP.

State and tribal technical staff will meet periodically in-season to exchange information and data, achieve consensus on in-season management actions, and prepare post-season reports. Additional meetings and exchanges will occur as needed to develop recommendations for management units' harvest regimes pertinent to the RMP, resolve differences in approach, and review monitoring program results. Data from the monitoring programs form the basis for development and refinement of forecasting and assessment efforts.

The RMP's critical exploitation rate ceilings were established by the co-managers, after policy consideration of the recent fisheries regimes that responded to critical status for some management units. If substantial changes are made to the model, these ceilings may be adjusted in consultation with NMFS (see page 17 of the RMP).

The co-managers will notify NMFS when in-season actions are expected to deviate substantially from preseason expectations, e.g., increase an exploitation rate to a management unit's ceiling rate or reduce the expected escapement level to below the management unit's low abundance threshold (see page 38 of the RMP). The notification will include a description of the change, an assessment of the anticipated fishing mortality resulting from the change, and an explanation of how impacts of the action maintains consistency with the Puget Sound chinook salmon harvest management plan.

The annual post-season review of the management plan is part of the annual pre-season planning process. The post-season review is necessary to permit an assessment of the co-managers' annual management performance in achieving spawning escapement, harvest, and allocation objectives. The co-managers will review each population's status annually and, where needed, identify actions required to improve estimation procedures and correcting bias. As appropriate, measures will be derived to address deleterious effects on size, age or sex selectivity. Such improvements provide greater assurance that management objectives will be achieved in future seasons. The effort builds a remedial response into the pre-season planning process to prevent excessive fishing-related mortality levels relative to the conservation of a management unit.

The annual post-season reports will be completed by mid-February of each year over the term of the RMP (see page 55 of the RMP). A copy will be provided to NMFS. The review of the harvest management plan will include: a fisheries summary; harvest levels; non-landed mortality; estimated escapement; an exploitation rate assessment; and the cohort reconstruction. It will also include consideration of the information developed through the recovery planning efforts of the TRT. Future revisions to the Puget Sound chinook salmon management plan will occur if comprehensive technical review of the available information indicates that a modification would be beneficial to achieving the goals of the RMP. The results of the post-season reports will also be used to shape future fishery management plans in order to increase the effectiveness of the harvest regime and decrease uncertainty. Escapements will be monitored to evaluate whether the exploitation rates have contributed to stabilizing or increasing escapements.

(9) Section (b)(4)(i)(G) Provides for (a) effective enforcement, (b) education, (c) coordination among involved jurisdictions.

The description of the RMP's enforcement and education programs can be found in Chapter 5 - Fisheries and Jurisdictions, starting on page 38 of the RMP. The RMP relies on a pre-season planning process to set the initial harvest regimes (fishing schedules and seasons) for all management units. The setting of the Puget Sound fisheries schedules and seasons occurs concurrently with the planning of the Washington and Oregon coastal fisheries. The pre-season planning process will occur from March through early-April, during the North of Cape Falcon forums. The forum is open to the public, allowing the public access to salmon status information, and providing the public an opportunity to interact with the co-managers.

Regulations enacted during the season will implement guidelines established during the pre-season planning process described above, but may be modified based on in-season assessments of effort, catch, abundance, and escapement. However, in many areas, the co-managers lack the necessary tools to detect in-season deviations from the pre-season forecast in time to adjust regulations. Any in-season modifications will be in accordance with the procedures specified in the Puget Sound Salmon Management Plan (PSSMP 1985) and subsequent court orders.

The WDFW and individual treaty tribes are responsible for regulation of harvest in fisheries under their authority, consistent with the principles and procedures set forth in the Puget Sound Salmon Management Plan. Fisheries will be regulated to achieve sharing and production objectives based on four fundamental elements: (1) acceptably accurate determination of the appropriate exploitation rate, harvest rate, or numbers of fish available for harvest; (2) the ability to evaluate the effects of specific fishing regulations; (3) a means to monitor fishing activity in a sufficient, timely and accurate fashion; and (4) effective regulation of fisheries to meet objectives for spawning escapement and fishery impact limitations.

Commercial fishery regulations are promulgated by WDFW and by each tribe. The co-managers maintain a system for transmitting commercial fishing regulations electronically to all interested parties (including NMFS), in a timely manner, prior to and during all fisheries. Regulations are stored in paper and electronic format by WDFW, each tribe, and the Northwest Indian Fisheries Commission. Commercial fishery regulations for some fisheries are also available through telephone hotlines maintained by WDFW, the Northwest Indian Fisheries Commission, and individual tribes. The WDFW publishes regulations for recreational fisheries in a widely distributed pamphlet. WDFW regulations, and in-season regulation changes, are also published on their website (*www.wa.gov/wdfw*).

Non-tribal commercial and recreational fishery regulations are enforced by the WDFW. The WDFW Enforcement Program currently employs 163 personnel. Of that number, 156 are fully commissioned Fish and Wildlife staff who ensure compliance with licensing and habitat requirements, and enforce prohibitions against the illegal taking or poaching of fish and wildlife (WDFW 2003). The Fish and Wildlife Enforcement Program is primarily responsible for enforcing the Washington State Fish and Wildlife Code. However, officers are also charged with enforcing many other codes as well, and are often called upon to assist their local city/county, and other state law enforcement agencies, and tribal authorities. On average, officers currently make more than 300,000 public contacts annually. The WDFW Enforcement staff also works cooperatively with the United States Fish and Wildlife Service, NMFS Enforcement branch, and the United Sates Coast Guard.

Each tribe exercises authority over enforcement of tribal commercial fishing regulations, whether fisheries occur on or off their reservation. In some cases enforcement is coordinated among several tribes by a single agency (such as the Point No Point Treaty Council, which is entrusted with enforcement authority over Lower Elwha Klallam, Jamestown S'Klallam, and Port Gamble S'Klallam tribal fisheries). Enforcement officers of one tribal agency may be cross-deputized by another tribal agency, where those tribes fish in common areas. Prosecution of violations of tribal regulations occurs through tribal courts and governmental structures.

The co-managers maintain a system for transmitting, cross-indexing and storing fishery regulations affecting harvest of salmon. Both WDFW and the Puget Sound Tribes monitor and enforce compliance with these regulations as part of more extensive enforcement programs. The co-managers' and federal court systems are expected to be sufficient to ensure that enforcement is followed through with appropriate prosecution of violators.

The PSTT and WDFW have direct management authority over fisheries harvesting Puget Sound chinook salmon in Puget Sound. The Pacific Salmon Commission, Pacific Fishery Management Council, and North of Falcon meetings will provide the forums for coordination among jurisdictions impacting Puget Sound chinook salmon populations. The fishery regimes developed each year as an outcome of these planning forums account for fishing-related mortality in all fisheries in the United States and Canada. They also help to ensure that fisheries are consistent with the management objectives and approach described in the RMP. The RMP's rebuilding exploitation rate objectives for the Puget Sound chinook salmon management units will be submitted to the Pacific Fishery Management Council for inclusion into the federal management plan for West Coast ocean salmon fisheries. Fishing-related mortality of Puget Sound chinook salmon in Alaska and Canadian fisheries is constrained by the terms of the Pacific Salmon Treaty agreement (PST 1999).

Both the Pacific Fishery Management Council and North of Falcon fishery planning processes are open to the public. The Council takes public comment and input throughout its development of fishing regimes for the ocean fisheries off Washington, Oregon and California. Representatives from the commercial and recreational fishing constituencies are active participants in the North of Falcon planning process. Public notification of fishery regulations is achieved through press releases, regulation pamphlets, telephone hotlines, and Federal Register notices. The WDFW has recently implemented a more aggressive campaign to increase public involvement and education through expanded public meetings, and greater access to information through use of the Internet.

(10) Section (b)(4)(i)(H) Includes restrictions on resident and anadromous species fisheries that minimize any take of listed species, including time, size, gear, and area restrictions.

The RMP's rebuilding exploitation rates, upper management thresholds, low abundance thresholds, and the critical exploitation rate ceilings are the primary elements of the harvest plan.

Time, size, gear and area and retention restrictions are all among the actions taken to ensure that salmon fishing-related mortality is consistent with these management objectives. Chinook salmon-directed fisheries in some terminal areas have been closed for years, and in other areas, fisheries on other species and healthy hatchery populations are restricted or delayed to protect naturally spawning chinook salmon.

Actions the co-managers have taken in the past and that will be considered under the RMP to protect listed species include: closures in the April, May, and June recreational fisheries and size limits to protect spring chinook salmon; closed spawning grounds to fishing; and required non-retention of chinook salmon. Both commercial and recreational fisheries have instituted closures around river mouths where chinook salmon concentrate before moving upstream.

Juvenile yearling life stage spring chinook salmon are not typically vulnerable to being caught in the fisheries subject to the RMP because of the juvenile's feeding habits and small size. Juvenile chinook salmon are rarely caught in any Puget Sound fishery. Nets are the primary commercial gear used in Puget Sound and the mesh is generally too large to ensnare juveniles.

Recreational fisheries in areas throughout Puget Sound have regulations that will reduce the potential mortality of juvenile chinook salmon. These regulations include the use of barbless hooks, minimum size requirements, and catch-and-release-only fishing. Puget Sound freshwater salmon recreational fisheries are concentrated during the period of adult return (July, August, September, and October), typically well after the majority of juveniles have emigrated from freshwater.

(11) Section (b)(4)(i)(I) Is consistent with other plans and conditions established within any Federal court proceeding with continuing jurisdiction over tribal harvest allocations.

The RMP explicitly states in its general principles that it will comply with the requirements of *U.S. v. Washington, U.S. v. Oregon,* other applicable federal court orders, and the Pacific Salmon Treaty (see page 4 of the RMP).

Recommended Determination:

The co-managers' RMP for Puget Sound fisheries potentially affecting listed Puget Sound chinook salmon from May 1, 2004, through April 30, 2010 has been evaluated, pursuant to 50 CFR 223.209 (Tribal Rule) and the government-to government processes therein.

NMFS Northwest Region's Sustainable Fisheries Division recommends that the National Marine Fisheries Service determine under 50 CFR 223.203(b)(6) that:

(i) implementing and enforcing the RMP will not appreciably reduce the likelihood of survival and recovery of the Puget Sound Chinook Salmon ESU; and

(ii) the RMP will be implemented and enforced within the parameters set forth in *United States v. Washington* or *United States v. Oregon*.

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Appendix A

Model Results: Implementation of the RMP

Appendix A1. Anticipated exploitation rates and escapements for Puget Sound chinook salmon by management unit under the RMP, FRAM run number 30P3.

Abundance: 30 Percent Reduction of 2003
Canadian: 2003 Level

Management Unit	Population [1]	Anticipated Total Exploitation Rate	Anticipated SUS Exploitation Rate	Anticipated Pre-terminal SUS Exploitation Rate	Anticipated Escapement	Aspects of the Minimum Fisheries Regime Imposed [2]
Nooksack	Natural-Origin Spawner:	20%	7%	3%	278	Yes
	North Fork Nooksack	-	-	-	125	
	South Fork Nooksack	-	-	-	153	
Skagit Summer/ Fall [3]	Natural Spawners:	49%	18%	9%	8,003	No
	Upper Skagit River	-	-	-	6,743	
	Lower Sauk River	-	-	-	428	
	Lower Skagit River	-	-	-	861	
Skagit Spring	Natural Spawners:	23%	14%	12%	1,331	No
	Upper Sauk River	-	-	-	493	
	Suiattle River	-	-	-	448	
	Upper Cascade River	-	-	-	389	
Stillaguamish	Natural-Origin Spawners:	17%	12%	10%	1,620	No
	N.F. Stillaguamish River	-	-	-	1,321	
	S.F. Stillaguamish River	-	-	-	299	
Snohomish	Natural-Origin Spawners:	20%	14%	11%	3,543	Yes
	Skykomish River	-	-	-	1,724	
	Snoqualmie River	-	-	-	1,819	
Lake Washington	Natural Spawners:	33%	23%	9%	446	No
	Cedar River	-	-	-	223	
	Sammamish River	-	-	-	223	
Green	Natural Spawners:					No

	Duwamish-Green River	49%	39%	9%	5,801	
White	Natural Spawners: White River	20%	19%	8%	1,011	No
Puyallup	Natural Spawners: Puyallup River	50%	39%	9%	1,798	No
Nisqually	Natural Spawners: Nisqually River	64%	56%	24%	1,119	No
Skokomish	Natural Spawners: Skokomish River	45%	31%	12%	1,239	Yes
Mid-Hood Canal	Natural Spawners: Mid-Hood Canal Rivers	26%	12%	12%	367	Yes
Dungeness	Natural Spawners: Dungeness River	22%	5%	4%	245	No
Elwha	Natural Spawners: Elwha River	23%	5%	4%	1,480	No

[1] A natural-origin spawner (NOR) is any naturally spawning salmon that has spent essentially all of its life-cycle in the wild and whose parents spawned in the wild. Unless other wise note, exploitation rate and escapement are natural spawners. Natural spawner is any naturally spawning salmon (hatchery plus natural-origin).

[2] A general description of these minimal fisheries, as proposed by the co-managers, is outlined in Appendix C: Minimum Fisheries Regime of the RMP.

[3] Based on Skagit Summer/Fall Management Unit modeling, which assumes 2003 fisheries and abundance. Anomalous age structure and the presence of pink salmon fisheries in 2003 make the estimates of exploitation rates used in this modeling a likely overestimate of the harvest impacts. The SUS exploitation rates are more likely to be similar to recent rears, 6 to 18 percent exploitation rates.

Appendix A2. Anticipated exploitation rates and escapements for Puget Sound chinook salmon by management unit under the RMP, FRAM run number 30M2.

Abundance: 30 Percent Reduction of 2003
Canadian: Maximum allowed under Pacific Salmon Treaty

Management Unit	Population [1]	Anticipated Total Exploitation Rate	Anticipated SUS Exploitation Rate	Anticipated Pre-terminal SUS Exploitation Rate	Anticipated Escapement	Aspects of the Minimum Fisheries Regime Imposed [2]
Nooksack	Natural-Origin Spawner:	26%	7%	2%	252	Yes
	North Fork Nooksack	-	-	-	113	
	South Fork Nooksack	-	-	-	139	
Skagit Summer/Fall [3]	Natural Spawners:	56%	16%	8%	7,551	Yes
	Upper Skagit River	-	-	-	6,339	
	Lower Sauk River	-	-	-	403	
	Lower Skagit River	-	-	-	809	
Skagit Spring	Natural Spawners:	28%	15%	13%	1,270	No
	Upper Sauk River	-	-	-	470	
	Suiattle River	-	-	-	428	
	Upper Cascade River	-	-	-	371	
Stillaguamish	Natural-Origin Spawners:	20%	12%	11%	1,584	No
	N.F. Stillaguamish River	-	-	-	1,291	
	S.F. Stillaguamish River	-	-	-	293	
Snohomish	Natural-Origin Spawners:	23%	14%	12%	3,399	Yes
	Skykomish River	-	-	-	1,654	
	Snoqualmie River	-	-	-	1,745	
Lake Washington	Natural Spawners:	38%	22%	9%	428	No
	Cedar River	-	-	-	214	
	Sammamish River	-	-	-	214	
Green	Natural Spawners:					

	Duwamish-Green River	51%	36%	9%	5,802	No
White	Natural Spawners: White River	20%	17%	9%	1,011	No
Puyallup	Natural Spawners: Puyallup River	50%	35%	9%	1,834	No
Nisqually	Natural Spawners: Nisqually River	66%	53%	25%	1,109	No
Skokomish	Natural Spawners: Skokomish River	48%	26%	12%	1,225	Yes
Mid-Hood Canal	Natural Spawners: Mid-Hood Canal Rivers	34%	12%	12%	344	Yes
Dungeness	Natural Spawners: Dungeness River	29%	5%	5%	231	Yes
Elwha	Natural Spawners: Elwha River	30%	5%	4%	1,395	No

[1] A natural-origin spawner (NOR) is any naturally spawning salmon that has spent essentially all of its life-cycle in the wild and whose parents spawned in the wild. Unless other wise note, exploitation rate and escapement are natural spawners. Natural spawner is any naturally spawning salmon (hatchery plus natural-origin).

[2] A general description of these minimal fisheries, as proposed by the co-managers, is outlined in Appendix C: Minimum Fisheries Regime of the RMP.

[3] Based on Skagit Summer/Fall Management Unit modeling, which assumes 2003 fisheries and abundance. Anomalous age structure and the presence of pink salmon fisheries in 2003 make the estimates of exploitation rates used in this modeling a likely overestimate of the harvest impacts. The SUS exploitation rates are more likely to be similar to recent rears, 6 to 18 percent exploitation rates.

Appendix A3. Anticipated exploitation rates and escapements for Puget Sound chinook salmon by management unit under the RMP, FRAM run number AEQ1.

Abundance: 2003 Level
Canadian: 2003 Level

Management Unit	Population [1]	Anticipated Total Exploitation Rate	Anticipated SUS Exploitation Rate	Anticipated Pre-terminal SUS Exploitation Rate	Anticipated Escapement	Aspects of the Minimum Fisheries Regime Imposed [2]
Nooksack	Natural-Origin Spawner: North Fork Nooksack South Fork Nooksack	20% - -	7% - -	3% - -	388 174 214	Yes
Skagit Summer/Fall [3]	Natural Spawners: Upper Skagit River Lower Sauk River Lower Skagit River	48% - - -	18% - - -	9% - - -	11,633 9,765 620 1,247	No
Skagit Spring	Natural Spawners: Upper Sauk River Suiattle River Upper Cascade River	23% - - -	14% - - -	13% - - -	1,921 711 647 562	No
Stillaguamish	Natural-Origin Spawners: N.F. Stillaguamish River S.F. Stillaguamish River	17% - -	11% - -	10% - -	2,322 1,893 429	No
Snohomish	Natural-Origin Spawners: Skykomish River Snoqualmie River	19% - -	14% - -	11% - -	5,073 2,468 2,604	No
Lake Washington	Natural Spawners: Cedar River Sammamish River	31% - -	20% - -	10% - -	610 305 305	No
Green	Natural Spawners:					

	Duwamish-Green River	62%	51%	10%	5,819	No
White	Natural Spawners: White River	20%	19%	9%	1,468	No
Puyallup	Natural Spawners: Puyallup River	49%	39%	10%	2,392	No
Nisqually	Natural Spawners: Nisqually River	76%	68%	26%	1,106	No
Skokomish	Natural Spawners: Skokomish River	63%	50%	13%	1,211	Yes
Mid-Hood Canal	Natural Spawners: Mid-Hood Canal Rivers	26%	13%	13%	531	No
Dungeness	Natural Spawners: Dungeness River	22%	5%	5%	352	Yes
Elwha	Natural Spawners: Elwha River	22%	5%	5%	2,125	No

[1] A natural-origin spawner (NOR) is any naturally spawning salmon that has spent essentially all of its life-cycle in the wild and whose parents spawned in the wild. Unless other wise note, exploitation rate and escapement are natural spawners. Natural spawner is any naturally spawning salmon (hatchery plus natural-origin).

[2] A general description of these minimal fisheries, as proposed by the co-managers, is outlined in Appendix C: Minimum Fisheries Regime of the RMP.

[3] Based on Skagit Summer/Fall Management Unit modeling, which assumes 2003 fisheries and abundance. Anomalous age structure and the presence of pink salmon fisheries in 2003 make the estimates of exploitation rates used in this modeling a likely overestimate of the harvest impacts. The SUS exploitation rates are more likely to be similar to recent rears, 6 to 18 percent exploitation rates.

Appendix A4. Anticipated exploitation rates and escapements for Puget Sound chinook salmon by management unit under the RMP, FRAM run number 03m2.

Abundance: 2003 Level
Canadian: Maximum allowed under Pacific Salmon Treaty

Management Unit	Population [1]	Anticipated Total Exploitation Rate	Anticipated SUS Exploitation Rate	Anticipated Pre-terminal SUS Exploitation Rate	Anticipated Escapement	Aspects of the Minimum Fisheries Regime Imposed [2]
Nooksack	Natural-Origin Spawner:	25%	7%	2%	365	Yes
	North Fork Nooksack	-	-	-	164	
	South Fork Nooksack	-	-	-	201	
Skagit Summer/Fall [3]	Natural Spawners:	55%	16%	8%	11,029	Yes
	Upper Skagit River	-	-	-	9,258	
	Lower Sauk River	-	-	-	588	
	Lower Skagit River	-	-	-	1,182	
Skagit Spring	Natural Spawners:	27%	14%	13%	1,845	No
	Upper Sauk River	-	-	-	683	
	Suiattle River	-	-	-	621	
	Upper Cascade River	-	-	-	539	
Stillaguamish	Natural-Origin Spawners:	19%	11%	10%	2,281	No
	N.F. Stillaguamish River	-	-	-	1,860	
	S.F. Stillaguamish River	-	-	-	421	
Snohomish	Natural-Origin Spawners:	22%	13%	11%	4,901	Yes
	Skykomish River	-	-	-	2,385	
	Snoqualmie River	-	-	-	2,516	
Lake Washington	Natural Spawners:	35%	20%	10%	588	No
	Cedar River	-	-	-	294	
	Sammamish River	-	-	-	294	
Green	Natural Spawners:					

	Duwamish-Green River	63%	47%	10%	5,816	No
White	Natural Spawners: White River	20%	18%	9%	1,459	No
Puyallup	Natural Spawners: Puyallup River	50%	35%	10%	2,419	No
Nisqually	Natural Spawners: Nisqually River	76%	65%	26%	1,126	No
Skokomish	Natural Spawners: Skokomish River	63%	44%	12%	1,237	Yes
Mid-Hood Canal	Natural Spawners: Mid-Hood Canal Rivers	32%	13%	12%	504	No
Dungeness	Natural Spawners: Dungeness River	27%	5%	4%	336	Yes
Elwha	Natural Spawners: Elwha River	28%	5%	4%	2,031	No

[1] A natural-origin spawner (NOR) is any naturally spawning salmon that has spent essentially all of its life-cycle in the wild and whose parents spawned in the wild. Unless other wise note, exploitation rate and escapement are natural spawners. Natural spawner is any naturally spawning salmon (hatchery plus natural-origin).

[2] A general description of these minimal fisheries, as proposed by the co-managers, is outlined in Appendix C: Minimum Fisheries Regime of the RMP.

[3] Based on Skagit Summer/Fall Management Unit modeling, which assumes 2003 fisheries and abundance. Anomalous age structure and the presence of pink salmon fisheries in 2003 make the estimates of exploitation rates used in this modeling a likely overestimate of the harvest impacts. The SUS exploitation rates are more likely to be similar to recent rears, 6 to 18 percent exploitation rates.

Public Comments and Responses

Public Comments and Responses

On March 18, 2004, the Puget Sound Treaty Tribes (PSTT) and the Washington Department of Fish and Wildlife (WDFW) provided a jointly developed resource management plan to National Marine Fisheries Service (NMFS), Northwest Regional Office. The resource management plan, titled the "Puget Sound Comprehensive Chinook Management Plan: Harvest Management Component," dated March 1, 2004 (hereafter referred to as the RMP), provides the framework through which the tribal and state jurisdictions would jointly manage all salmon and gillnet steelhead fisheries that may impact listed chinook salmon within the greater Puget Sound area. The co-managers proposed that the RMP remain in effect for six years, from May 1, 2004 through April 30, 2010.

NMFS published a notice in the *Federal Register* announcing the availability of its Proposed Evaluation and Pending Determination (PEPD) on the RMP for public review and comment on April 15, 2004 (69 FR 19975). The comment period closed on May 17, 2004. Three commenters provided comments to NMFS on the PEPD during this public comment period. NMFS has reviewed the comments received and discussed the substantive issues with the co-managers. Several of the comments were addressed and reflected in NMFS' final Evaluation and Recommended Determination (ERD). The co-managers made no modifications to the RMP based on public comments received on NMFS' PEPD.

Comments received from the public in response to the NMFS announcement of the PEPD for review are summarized as follows:

On Tuesday, May11, 2004, NMFS received e-mail comments from Mr. Robert Hayman of the Skagit River System Cooperative. The comments were submitted in the form of electronic versions of three documents: "NMFSFinalE&DComments504.doc"; "BYExplRateCalcs2004 PopStatFix 404.xls"; and "SkgtSFCkProjectn4E&D404.xls". Under the implementation of the RMP, the projected range of exploitation rates for the Skagit summer/fall chinook salmon management unit was estimated to be 48 to 56 percent (Table 3 in the PEPD). The PEPD qualified this projection by stating that this range of exploitation rates probably overestimates the actual rates under the RMP. Mr. Hayman agreed with this assessment and requested that his three documents be included as part of the public record on the PEPD "so that they are available if further elaboration is needed about the Evaluation and Determination's assessment of Skagit summer/fall chinook." No change to the PEPD was necessary.

On Tuesday, May11, 2004, NMFS received comments from Mr. Sam Wright. Mr. Wright commented that the Final Environmental Impact Statement (FEIS) should be completed prior to soliciting public review comments on the PEPD. Mr. Wright's comments were primarily directed at the Draft Environmental Impact Statement (DEIS). The comments addressed the alternatives of the DEIS and proposed an additional alternative, which he referred to as Alternative 1A. He asked that these comments on the DEIS be incorporated by reference. Mr. Wright provided no other direct comments on the PEPD. The discussion on the various alternatives is not directly applicable to the PEPD. Mr. Wright's comments pertaining to the DEIS will be addressed in the FEIS process.

On Monday, May 17, 2004, through e-mail, NMFS received comments on the PEPD from the Washington Trout (WT). The commenter recommends that NMFS substantively revise the PEPD before a final determination is developed. The structure of the WT's comments was presented in nine identified sections. These sections were: Introduction; Minimum Fishery Regime; Management Objectives and Indicators; Recovery Exploitation Rates; Upper Management Thresholds; Low Abundance Thresholds; Critical Exploitation Rate Ceiling; Critical Exploitation Rate Ceiling; and Other Issues of Concern. In responding to the WT's comments, NMFS will use a similar structure.

Response to Comments

"Introduction" Comments:

Comment 1 **–** In the introduction section, the commenter requested that the PEPD: (1) provide a detailed explanation of key terms and concepts employed in the RMP. The commenter stated that the PEPD employs important legalistic and technical-biological terms and concepts without ever attempting to explain them; (2) provide a detailed and critical description and assessment of the key assumptions made by the RMP; (3) clearly describe and characterize the several kinds of risk that the harvest regime may pose to populations of the listed Evolutionarily Significant Unit (ESU) and to the ESU as a whole; (4) characterize relevant and critical uncertainties with methods used in the PEPD; (5) evaluate whether the proposed fishery regime(s) is(are) described in sufficient detail to permit a clear assessment of the extent to which the regime is risk-averse to potential impacts on populations of the listed ESU; (6) clearly describe and explain the extent to which the proposed harvest regime is risk-averse to harmful impacts on individual populations of the listed ESU and the ESU as a whole; and, (7) require the RMP to employ clearly articulated impact-threshold targets to be attained (or to be avoided), with clearly articulated management actions that will be taken in response when critical thresholds are not attained (or not avoided), and clear time frames for taking corrective actions and for achieving the desired targets of the corrective actions.

Response: NMFS found these comments too general in nature and lacking necessary specifics to properly respond. NMFS assumes, given that that these comments were in the "introduction" section, that many of these comments will be addressed by responding to the more specific comments that followed in other sections. For a general response, as required in section (b)(6)(iii) of the Endangered Species Act of 1973 (ESA) section 4(d) rule for listed Puget Sound chinook salmon (referred hereafter as the ESA 4(d) Rule), the RMP, in NMFS' opinion, must adequately address eleven criteria under section (b)(4)(i) in Limit 4. The criteria under Limit 4 section (b)(4)(i) are summarized in Table 1, page 3 of the PEPD. Compliance with these criteria does not necessarily require the most conservative response. The RMP proposes implementation of restrictions to the fishery-related mortality to each Puget Sound chinook salmon population or management unit. The RMP's restrictions to the cumulative fishery-related mortality are expressed as: (1) a rebuilding exploitation rate; (2) an upper management threshold; (3) a low abundance threshold; and (4) a critical exploitation rate ceiling (Table 2 of the PEPD). For select management units, Appendix A: Management Unit Status Profiles of the RMP describes how these thresholds or exploitation rate limits were derived. NMFS did not necessarily evaluate the RMP's definition of terms or the assumptions the co-managers used in developing the RMP's mortality limits. In the PEPD, NMFS compared the proposed RMP's mortality limits, regardless of their basis, to the NMFS-derived critical and viable threshold standards. NMFS used the best data available to estimate these critical and viable thresholds for each population. The PEPD also evaluated the effects of implementing the RMP's mortality limits. The co-managers, in cooperation with NMFS, modeled the anticipated impacts of implementing the proposed RMP's mortality limits. The modeling used risk-averse assumptions in determining potential impacts and the resultant escapement. The modeling assumed the fishing regime under the RMP would closely resemble that planned for 2003, and modeled those fishing regulations for the southern United States (SUS). The modeling also assumed a range of intercepting fisheries to include the highest Canadian harvest allowed under the 1999 Pacific Salmon Treaty (PST) agreement, as well as those in 2003. The modeled range of Puget Sound chinook salmon abundance was bounded by the 2003 forecast abundance and a 30 percent reduction from that level for all populations. The anticipated results of implementing the RMP were compared against the criteria outlined under Limit 6 of the ESA 4(d) Rule. NMFS' approach in its evaluation is conservative, and takes into consideration the uncertainty of the data. Through its evaluation of the RMP, NMFS Northwest Region's Sustainable Fisheries Division concluded that the RMP adequately addressed all the criteria outlined in the ESA 4(d) Rule, including implementing and enforcing the RMP, and would not appreciably reduce the likelihood of survival and recovery of the Puget Sound Chinook Salmon ESU. Information provided in the PEPD, along with the information included and available by reference, provides the reviewer the information necessary to evaluate NMFS' risk criteria used to reach this conclusion.

Comment 2: The commenter expressed concern regarding the PEPD's conclusion that the RMP "would not appreciably reduce the likelihood of survival and recovery of the Puget Sound Chinook Salmon ESU." The commenter believes that this finding reflects an opaque standard, open to any number of subjective interpretations, including the most minimal.

Response: This language in question in the PEPD is taken directly from section (b)(6)(i) of the ESA 4(d) Rule. The ESA 4(d) Rule states that "...the [take] prohibitions of paragraph (a) of this section relating to threatened species of salmonids .... do not apply to actions undertaken in compliance with a resource management plan .... provided that: (i) The Secretary has determined .... that implementing and enforcing the joint tribal/state plan will not appreciably reduce the likelihood of survival and recovery of affected threatened ESUs" (50 C.F.R. 223.203(b)(6)). Some of the criteria outlined in the ESA 4(d) Rule require NMFS to evaluate the RMP's impacts on individual populations. One of the criteria for Limit 6 of the ESA 4(d) Rule is that harvest actions that impact populations at or above their viable thresholds must maintain the population or management unit at or above that level. Overall, along with other on-going habitat and hatchery programs, the results of harvest actions since the ESA listing of the Puget Sound Chinook Salmon ESU appear to be maintaining these populations above the viable threshold levels as required by the ESA 4(d) Rule. Another criterion for Limit 6 of the ESA 4(d) Rule is that fishing-related mortality on populations above critical levels, but not at viable levels (as demonstrated with a high degree of confidence), must not appreciably slow achievement to viable function. The criterion for populations at or below their critical thresholds is that fishing-related mortality on the population must not appreciably increase genetic and demographic risks facing the population, and does not preclude achievement of viable functions, unless the RMP demonstrates the likelihood of survival and recovery of the entire ESU in the wild would not be appreciably reduced by greater risks to an individual population. Only one population in the ESU, the North Fork Nooksack River population, is considered to be below its critical threshold (see Table 9 of the PEPD). For the North Fork Nooksack River population, NMFS concludes that the RMP does not appreciably increase genetic and demographic risks facing this population, as required by the ESA 4(d) Rule, for a population below their critical level. However, the ESU, not the individual populations within the ESU, is the listed entity under the ESA. Through its evaluation of the RMP, NMFS Northwest Region's Sustainable Fisheries Division concluded that the RMP would not appreciably reduce the likelihood of survival and recovery of the Puget Sound Chinook Salmon ESU.

"Minimum Fishery Regime" Comments:

Comment 3: The commenter believes that the PEPD introduces factors that appear to be extra-biological mitigation for various and specific anticipated risks to the ESU imposed by the RMP, including what appears to be consideration of the need for a fair distribution of the burden of conservation. The commenter suggests that the relationship of the RMP to Canadian and Alaskan fisheries appears to be NMFS' most explicit attempt in the PEPD to distribute the conservation burden fairly.

Response: As required in section (b)(6)(iii) of the ESA 4(d) Rule, the RMP must adequately address eleven criteria under section (b)(4)(i) in Limit 4. How the conservation burden was distributed among the various sections is not one of the eleven criteria used to evaluate the RMP under the ESA 4(d) Rule. However, to provide the reviewer a better understanding of the RMP, the PEPD did present the co-managers' perspective on certain aspects of the RMP. From the co-managers' perspective, the Minimum Fishery Regime proposed in the RMP addresses conservation concerns "while still allowing a reasonable harvest of non-listed salmon" (page 17 of the RMP). The PEPD (page 5) incorrectly alludes that it is the co-managers' perspective that the RMP represents a fair distribution of the burden of conservation. Reference to the co-manager's perspective that the RMP represents a fair distribution of the burden of conservation was removed from the ERD. However, NMFS did not evaluate the co-managers' perspective of the minimum fisheries regime. NMFS evaluated the effects of the proposed action, in this case the implementation of Puget Sound fisheries under the abundance and non-SUS fisheries anticipated in the next five years. In evaluating the effects of the action, Canadian impacts are considered in the baseline.

Comment 4: The commenter believes that the recognition of tribal treaty rights would mandate the acceptance of a base level of fisheries that must always be allowed, under any circumstance. It was of concern to the commenter that the RMP would propose that there was no conceivable circumstance potentially faced by the ESU that would warrant the complete restriction of fishery impacts on an individual management unit.

Response: Similar to recent years, it is likely that the vast majority of the SUS fishery harvest impacts on the Nooksack Management Unit populations under the RMP would occur in treaty Indian fisheries. Since 2001, the majority of the SUS harvest on the Nooksack Management Unit has occurred in tribal fisheries. In recognition of tribal management authority and the Federal government's trust responsibility to the tribes, NMFS is committed to considering their judgment and expertise regarding the conservation of trust resources. Consistent with this commitment and as a matter of policy, NMFS has sought, where there is appropriate tribal management, to work with tribal managers to provide limited tribal fishery opportunities, so long as the risk to the population remains within acceptable limits. NMFS evaluated the RMP based on what is likely to occur over the next five fishing seasons, May 1, 2005 to April 30, 2010, the remaining duration of the RMP. To approve the RMP under the ESA 4(d) Rule, NMFS must conclude that the RMP adequately address the criteria outlined in the ESA 4(d) Rule, including the criterion that implementing the RMP will not appreciably reduce the likelihood of survival and recovery of the Evolutionarily Significant Unit in the wild, over the entire period of time the proposed harvest management strategy affects the population. Compliance with these criteria does not necessarily require the most conservative response. In the PEPD, the anticipated results of implementing the RMP were compared against the criteria outlined under Limit 6 of the ESA 4(d) Rule. Through its evaluation of the RMP, NMFS Northwest Region's Sustainable Fisheries Division concluded that the RMP adequately addressed all the criteria outlined in the ESA 4(d) Rule, including implementation and that enforcing the RMP would not appreciably reduce the likelihood of survival and recovery of the Puget Sound Chinook Salmon ESU. The "complete restriction of fishery impacts on an individual management unit" was not necessary to meet the criteria outlined under Limit 6 of the ESA 4(d) Rule. If impacts under the implementation of the RMP are greater than expected, NMFS can withdraw the ESA 4(d) Rule determination or ask the co-managers to adjust fisheries to reduce impacts.]

Comment 5: The commenter suggests that the minimum fisheries regime proposed in the RMP will not result in significant reductions in either the total exploitation impacts experienced by management units, or the SUS [southern United States] or pre-terminal SUS exploitation rates. The commenter believes that this inadequacy conflicts with the RMP's characterization of the minimum fisheries regime as "extraordinary fisheries conservation measures" designed to "minimize" impacts on management units from fisheries.

Response: NMFS did not evaluate the RMP's characterization of the minimum fisheries regime. The anticipated results of implementing the RMP, not the RMP's characterization of the minimum fisheries regime, were compared against the criteria outlined under Limit 6 of the ESA 4(d) Rule. Compliance with these criteria does not necessarily require the most conservative response. The RMP proposes implementation of restrictions to the fishery-related mortality to each Puget Sound chinook salmon population or management unit. The RMP's limits to the cumulative fishery-related mortality are expressed as: (1) a rebuilding exploitation rate; (2) an upper management threshold; (3) a low abundance threshold; and (4) a critical exploitation rate ceiling (Table 2 of the PEPD). The co-managers, in cooperation with NMFS, modeled the anticipated impacts of implementing the RMP, which uses these four harvest mortality limits in combination to manage the fisheries. Table 3 of the PEPD provides the anticipated range of exploitation rates and anticipated escapements for Puget Sound chinook salmon under the implementation of the RMP. In addition, in the RMP, the co-managers also presented data that suggest that significant reductions in the exploitation rate in some systems have not resulted in substantially higher returns of natural-origin chinook salmon. Although, this has not been conclusively demonstrated for many populations, it is suggestive that habitat, not fishery-related mortality, may be the limiting factor on production in some systems.

Comment 6: The commenter states that the description of the various SUS exploitation rates is confusing. As an example, the commenter suggests that a comparison of Table 2 with Table 5 fails to clarify what, if any, the changes in fishery regimes would occur under the minimum fishery regime.

Response: For most management units, the RMP's critical exploitation rate ceiling imposes an upper limit on southern United States (SUS) exploitation rates when spawning escapement for a management unit is projected to fall below its low abundance threshold *or* if Canadian fisheries make it difficult or impossible to achieve the RMP's rebuilding exploitation rate. The co-managers define "impossible" if the northern fisheries by themselves impose an exploitation rate above the rebuilding exploitation rate or reduce abundance so that either the upper management threshold or the low abundance threshold could not be achieved even with zero SUS fishing. The co-managers define "difficult" if, in order to achieve a total exploitation rate less than the rebuilding exploitation rate, or escapement above the upper management threshold, SUS fisheries directed at abundant un-listed chinook and other species would have to be constrained (W. Beattie, NWIFC, e-mail to K. Schultz, NMFS, August 6, 2004). The RMP provides a general description of the fisheries that will represent the lowest level of fishing mortality on listed chinook salmon proposed by the co-managers. A general description of these minimal fisheries is outlined in Appendix C: Minimum Fisheries Regime of the RMP. In modeling the fisheries, instances where the RMP's critical exploitation rate ceiling was imposed on a management unit can be identified by reviewing the anticipated escapement or exploitation rates. If the anticipated escapement was below the RMP's low abundance threshold or if the exploitation rate was greater than the RMP's rebuilding exploitation rate, then the modeling exercise imposed the RMP's critical exploitation rate ceiling. Table 2 in the PEPD are the RMP's management objectives (rebuilding exploitation rate, upper management threshold, low abundance thresholds, and the critical exploitation rate ceiling), by management units and populations. Table 2 in the PEPD shows the change in the exploitation rate under the RMP's rebuilding exploitation rate and the exploitation rate under the minimum fishery regime, the critical exploitation rate ceiling. Table 5 in the PEPD are the most likely total exploitation rates, southern United States (SUS) exploitation rates, and escapements within the modeled forecasts under the implementation of the RMP by Puget Sound chinook salmon management unit or population. To assist the reader, a column was added to Table 5 of the ERD and to the tables in Appendix A of the ERD that identify the management units in which the RMP's critical exploitation rate ceiling for that management unit was implemented during modeling.

Comment 7: The commenter stated that under the RMP's minimum fishery regime, additional conservation measures on the SUS fisheries may be considered by the co-managers "where analysis can demonstrate that additional conservation measures in fisheries would contribute substantially to recovery of a management unit…". The commenter suggests that the RMP and the PEPD make no attempt to define or identify what would constitute a "substantial" contribution to recovery.

Response: The co-managers propose that where analysis can demonstrate that additional conservation measures in fisheries would contribute substantially to recovery of a management unit, the co-managers may, at their discretion, and in concert with other specific habitat and enhancement actions, implement them (see page 34 of the RMP). The need to define or identify what would constitute a substantial contribution to recovery is not needed to evaluate the RMP under Limit 6 of the ESA 4(d) Rule. The co-managers, in cooperation with NMFS, have modeled the anticipated impacts of the implementation of the RMP. Appendix A of the PEPD contains the model run results. The analysis of the anticipated results of implementing the RMP, without the inclusion of these possible additional conservation measures in fisheries, was evaluated against the criteria under Limit 6 of the ESA 4(d) Rule. If the actual escapement outcome during the next five years is below that modeled, NMFS will meet with the co-managers to discuss possible additional management actions the co-managers may take. Additionally, NMFS may reconsider revoking the ESA 4(d) determination. However, the co-managers have instituted additional management measures under low abundance conditions in the past to decrease fishery impacts. The demonstrated willingness of the co-managers to constrain fisheries over the past 15 years, without certainty of substantial benefit to the ESU, gives NMFS some confidence in their future response to a population with a declining status.

Comment 8: Table 2 of the PEPD summarizes the relationship between the various management objectives and exploitation rates for each management unit. The commenter believes that Table 2 is confusing and potentially misleading. In Table 2, some of the RERs [rebuilding exploitation rates] are expressed as pre-terminal SUS and SUS rates, without clearly identifying that the rate does not include impacts from Canadian and Alaskan Fisheries.

Response: The categorization of the exploitation rates within the Table 2 of the PEPD is clearly identified as either total, southern United States (SUS), or pre-terminal southern United States (PT SUS). Additionally, Footnote 2 of Table 2 of the PEPD reads, in part, as follows: "The SUS fishery includes all fisheries south of the border with Canada that may harvest listed Puget Sound chinook salmon. The SUS fishery includes both pre-terminal SUS and terminal SUS fisheries. The co-managers define a pre-terminal fishery as a “fishery that harvests significant numbers of fish from more than one region of origin” (page 65 of the RMP). The co-managers define a terminal fishery as a “fishery, usually operating in an area adjacent to or in the mouth of a river, which harvests primarily fish from the local region of origin, but may include more than one management unit” (page 65 of the RMP). The terminal SUS fisheries will vary by management unit and may occur in freshwater and marine areas.” A similar description of the categorization of the exploitation rates can be found within the main body of the PEPD, on page 7.

Comment 9: The commenter suggested that the RMP’s critical exploitation rate ceilings are “driven by policy considerations” and not by biological (i.e., conservation) considerations. The commenter believes that these “policy considerations” are not described in the RMP and that their legal basis is not explicitly described, explained, and/or justified.

Response: Although the RMP’s critical exploitation rate ceilings were primarily based on policy concerns, biological and conservation considerations were also taken into account by the co-managers in developing the ceilings. All other harvest mortality limits in the RMP (rebuilding exploitation rates, upper management thresholds, and low abundance thresholds) were derived using biological consideration rather than policy-driven parameters. NMFS compared the proposed RMP’s mortality limits, regardless of their basis, to the NMFS-derived standards. NMFS’ evaluation focused on the effects of implementing the RMP’s mortality limits. The co-managers, in cooperation with NMFS, modeled the anticipated impacts of implementing the RMP. A description of the co-managers’ policy considerations used to develop the RMP’s critical exploitation rate ceilings was not needed to evaluate the impacts of the RMP under Limit 6 of the ESA 4(d) Rule. In recognition of tribal management authority and the Federal government’s trust responsibility to the tribes, NMFS is committed to considering their judgment and expertise regarding the conservation of trust resources. Consistent with this commitment and as a matter of policy, NMFS has sought, where there is appropriate tribal management, to work with tribal managers to provide limited tribal fishery opportunities, so long as the risk to the population remains within acceptable limits.

“Management Objectives and Indicators” Comments:

Comment 10: The commenter states that the RMP proposes to manage harvest on the basis of the status of individual populations. The commenter suggests that the substance of the proposed regime overstates the extent to which the RMP is supportive of recovery within five management units: Nooksack, Skagit Summer/Fall chinook, Skagit spring chinook, Stillaguamish, and Snohomish. The commenter believes that in none of these four [five] management units is the maximum (“recovery”) exploitation rate based directly upon an estimate of the maximum allowable rate sustainable by the weakest component stock. The commenter believes that this reliance on management unit rates contradicts the claim by the RMP and the PEPD that the RMP proposes a harvest management regime in which exploitation rates are restricted by the weakest component population.

Response: For most management units with multiple populations, the objectives in the RMP are based on the management for the weakest component (e.g. see Appendix A: Management Unit Status Profile of the RMP for the Snohomish Management Unit). In NMFS' evaluation of the RMP, the management unit's anticipated exploitation rate was applied to all populations within that management unit. When available, the anticipated exploitation rates on individual populations were compared to the corresponding population-specific NMFS-derived rebuilding exploitation rates. NMFS also derived a rebuilding exploitation rate for the Nooksack Management Unit, which contains two populations, because data was insufficient to develop a population-specific rebuilding exploitation rates. In this case, the anticipated exploitation rates for the Nooksack Management Unit were compared to the corresponding management unit-specific NMFS-derived rebuilding exploitation rate. Additionally, the anticipated population-specific escapements were compared to NMFS-derived critical and viable thresholds or to the generic guidance provided by the Viable Salmonid Populations document (VSP) (NMFS 2000b as cited in the PEPD). This approach evaluates the anticipated impacts of the RMP on weakest component population within each management unit. Results showed that the NMFS-derived rebuilding exploitation rates for the weakest population within a given management units were generally met and often below the NMFS-derived rebuilding exploitation rates. However, it also needs to be noted that although populations contribute fundamentally to the structure and diversity of the ESU, it is the ESU, not an individual population, which is the listed entity under the ESA.

"Recovery Exploitation Rates" Comments:

Comment 11: The commenter stated that the PEPD inappropriately references the draft RAP [risk assessment procedure] document of May 30, 2000. The commenter suggested that the method described in this citation was superceded by a method described in a document titled "Viable Risk Assessment Procedure". The commenter indicated that the latter document employed a harvest model more suitable for population viability modeling needed to assess harvest impacts on listed salmon populations.

Response: The method outlined in NMFS' document titled "A risk assessment procedure for evaluating harvest mortality of Pacific salmonids," dated May 30, 2000, is commonly referred to as the RAP model. Subsequent updates and improvements to the original RAP model resulted in the current model, known as the Viable Risk Assessment Procedure (VRAP) model. The VRAP model is what NMFS used to derive the rebuilding exploitation rates to evaluate the RMP. Unlike the RAP model, the VRAP model lacks complete documentation. However, the method used by NMFS to derive the rebuilding exploitation rates using the VRAP model are accurately described in NMFS' RAP document, as cited in the PEPD. The ERD was modified to make this clearer to the reader.

Comment 12: The commenter challenges the PEPD's assertion that harvest at or below NMFS-derived RERs "will not appreciably reduce the likelihood of rebuilding that population, assuming current environmental conditions based on specific risk criteria". The commenter suggests that no details are provided by NMFS regarding assumptions and calculations in support of this finding. Consequently, the commenter believes that it is impossible for the reviewer to know what "specific risk criteria" were employed, and to thereby judge the appropriateness of NMFS' finding.

Response: As stated on page 25 in the PEPD, NMFS-derived rebuilding exploitation rates were developed by using a simulation model to identify an exploitation rate for an individual population that meets specific criteria related to both survival and recovery, given the specified thresholds and estimated spawner/recruit parameters. The simulation used the population-specific threshold levels to identify an exploitation rate that met the following criteria: (a) the percentage of escapements less than the critical threshold value increase by less than five percentage points relative to no fishing, *and either* (b) the escapement at the end of the 25-year simulation exceeded the viable threshold at least 80 percent of the time *or* (c) the percentage of escapements less than the viable escapement threshold at the end of the 25-year simulation differed from the no-fishing baseline by less than 10 percentage points. The PEPD references Appendix C: Technical Methods - Derivation of Chinook Management Objectives and Fishery Impact Modeling Methods of the draft environmental impact statement (DEIS) on the proposed determination for a detailed explanation of rebuilding exploitation rate derivation. The PEPD also references NMFS' RAP modeling document, cited as NMFS 2000a, for additional information on how NMFS derived these rebuilding exploitation rates. Information provided in the PEPD, along with the information included and available by reference, provides the reviewer the information necessary to ability to evaluate NMFS' risk criteria.

"Upper Management Thresholds" Comments:

Comment 13: The commenter suggests that there is little real data available to the co-managers or NMFS on which to base firm, robust estimates of the current carrying capacity. The commenter stated that any estimate of a critical management threshold such as the MSH [maximum sustainable harvest] escapement level will inevitably be extremely uncertain. The commenter believes that it is extremely risky to employ such an uncertain point estimate as a management target, without at least acknowledging the uncertainty, which in practical terms should mean adjusting the target in a conservative direction relative to the risks associated with the uncertainty. The commenter believes that the PEPD fails to raise or discuss any critical considerations of these kinds about the approach taken by the RMP for estimating these escapement reference points and employing them in the proposed harvest management regime.

Response: In the PEPD, NMFS used the best estimate of the level of escapement that produces maximum sustainable yield (MSY) of the system. This level of escapement was referred to as the viable threshold in the evaluation. NMFS completed a comprehensive analysis to derive viable thresholds for a subset of Puget Sound chinook salmon populations (Table 8 of the PEPD). These viable thresholds are based on a spawner-recruit analysis of recent years' catch and escapement data and include environmental variants. NMFS used these viable thresholds to determine the NMFS-derived rebuilding exploitation rates. The NMFS-derived rebuilding exploitation rates were set so that escapement would meet or exceed the viable threshold at least 80 percent of the time at the end of 25 years. By using at least 80 percent, one would on average obtain an escapement level greater than the MSY. During this fishery impact simulation modeling, NMFS assumed low marine survival rates for the salmon populations, which is conservative and risk adverse. Additionally, the RMP's rebuilding exploitation rates or escapement goals may be modified in response to the most current information about the productivity and status of populations, or in response to better information about management error. There is also uncertainty in the risk analysis simulation about actual exploitation rates beyond the duration of the RMP. The NMFS-derived rebuilding exploitation rates are based on simulations over a more conservative 25-year period, whereas the RMP's duration is for a much shorter duration. In other words, NMFS compared the RMP to NMFS' standards which were developed on simulations assuming fish would be harvested at a given rate over a 25 years period. NMFS' approach in evaluating the RMP is conservative and considers the uncertainty of the data and simulation outcomes.

Comment 14: The commenter suggests that the impact of past (over-) harvest on aggregate stocks (management units) is not taken into consideration in the estimation of stock-recruitment relationships.

Response: Development of data with which to manage Puget Sound chinook salmon has been an ongoing effort. Work towards a comprehensive approach to Puget Sound salmon harvest began in the late 1980s. A comprehensive chinook salmon management plan was implemented initially in 1997 by the co-managers. Revisions to the management framework have been made in subsequent years as new information became available. Subsequent Puget Sound chinook salmon escapements indicate that the reduced exploitation rates and other harvest management actions resulting from the implementation of these harvest plans have contributed to the stabilization and increase in Puget Sound chinook salmon escapement. The RMP has replaced the old escapement goals with rebuilding exploitation rates for several management units, and changed the escapement goals for others. However, the role of past harvest in current condition of the resource is not the primary consideration of the PEPD. The focus of the NMFS' evaluation is whether implementing and enforcing the proposed action will not appreciably reduce the likelihood of survival and recovery of the Puget Sound Chinook Salmon ESU over a range of possible abundance and fishing conditions anticipated in the next five years. In the PEPD, NMFS evaluated the RMP's response to low abundance and concluded that implementing and enforcing the RMP would not appreciably reduce the likelihood of survival and recovery of the Puget Sound Chinook Salmon ESU.

Comment 15: The commenter states that the RMP establishes upper management thresholds for populations or management units using methods such as "standard spawner-recruit calculations…, empirical observations of relative escapement levels and catches, or Monte Carlo simulations that buffer for error and variability…". The commenter suggests that the RMP's harvest thresholds, derived through these simulations, are not appropriately risk-averse.

Response: The co-managers' method in establishing the RMP's upper management thresholds is risk-averse by acknowledging and attempting to account for known uncertainties. Many of the RMP's upper management thresholds were derived when sufficient data was available to use the classic spawner-recruit functions, augmented by incorporating environmental covariates. In addition, the spawner-recruit functions are fit by applying deviates from predicted calendar year escapements to observed escapements rather than the deviates of the estimated returns to predicted returns. Additionally, in the PEPD, NMFS compared the RMP's upper management thresholds to the NMFS-derived or VSP-derived viable thresholds and found that they were similarly conservative and risk-averse.

Comment 16: The commenter believes that the NMFS should not accept a 20 percent probability of *not* attaining a viable threshold within four to eight chinook generations.

Response: The NMFS-derived rebuilding exploitation rates were set to result in attainment of the viable threshold in at least 80 percent of the simulation runs by the end of 25 years (see response to Comment 13). NMFS' use of 25 years is conservative, as four to eight generations (number of generations in 25 years) is not a very long time to expect a population to respond to a change. Additionally, by using at least 80 percent as a condition, one would on average obtain an escapement level greater than this floor. NMFS' use of an 80 percent chance of achieving the viable threshold is reasonable. This approach is conservative considering uncertainty of the data and simulations.

Comment 17: The commenter believes that inability to detect a difference between harvest and no harvest regimes should not suffice as a justification for harvesting [declining] stocks.

Response: One of the criteria that must be adequately addressed to approve the RMP under the ESA 4(d) Rule is that NMFS must conclude that implementing the RMP will *not appreciably reduce* the likelihood of survival and recovery of Puget Sound Chinook Salmon ESU (emphasis added). In its evaluation, NMFS estimated the impacts on the populations within the Puget Sound Chinook Salmon ESU under a no-harvest regime and compares those results to the impacts associated with implementing the RMP. This comparison is necessary to assess whether or not implementation of the RMP will appreciably reduce the likelihood of survival and recovery of affected threatened ESU than if the action did not occur. NMFS-derived rebuilding exploitation rates were developed by using a simulation model to identify an exploitation rate for an individual population that meets specific criteria related to both survival and recovery, given the specified thresholds and estimated spawner/recruit parameters. The simulation used the population-specific threshold levels to identify an exploitation rate that met certain conditions (see response to Comment 12). One of those conditions is whether the percentage of escapements less than the critical threshold value increase by less than five percentage points relative to the baseline. The baseline assumes no salmon fisheries. This approach recognizes that a population may improve or decline irrespective of the proposed action being evaluated. In situations where freshwater or estuarine survival is severely compromised by degraded habitat, even the total elimination of the harvest may not improve the population's productivity or status. If the risk assessment concludes that the percentage probability of escapements falling below the critical threshold will increase by less than five percentage points relative to the baseline, then it is reasonable to conclude that implementing the RMP will not appreciably reduce the likelihood of survival of Puget Sound Chinook Salmon ESU. The focus of NMFS' evaluation is on whether the difference is appreciable between the impacts associated with the implementation of the RMP and those that would still occur under the baseline.

Comment 18: The commenter believes that the PEPD relies upon questionable and controversial estimates of current habitat capacity to justify estimates of upper management thresholds.

Response: NMFS uses the best data available and continues to encourage the co-managers to improve and expand their data collection. Habitat capacity estimation is accomplished using several methods, and comparisons between results from the different methods are made to help evaluate the RMP. See response to Comment 19.

Comment 19: The commenter suggests that the PEPD relies on Ecosystem Diagnosis and Treatment (EDT) modeling estimates of spawner-recruit functions to argue that "further harvest constraint will not, by itself, effect an increase above the asymptote associated with current productivity, until habitat conditions improve." The commenter believes that the EDT model has received very critical reviews from the Salmon Recovery Science Review Panel and from the Columbia Basin Independent Science Advisory Panel.

Response: Calculating a rebuilding exploitation rate ideally requires knowledge of a spawner-recruit relationship based on escapement, age composition, coded-wire tag distribution, environmental parameters, and management error. These types of data are available for several management units (Table 8 of the PEPD). For populations with insufficient data to develop a spawner-recruit relationship, generic guidance from the VSP paper or, when available, analyses of habitat capacity (such as the EDT methodology) have been used to assist NMFS in evaluating the RMP's proposed thresholds. NMFS uses the best scientific data available in this evaluation. Habitat capacity is difficult to measure and estimation is now accomplished by several different methods. NMFS acknowledge that all models have strengths and weaknesses. NMFS has made appropriate comparisons of the models and their outputs to help evaluate the RMP's upper management thresholds.

"Low Abundance Thresholds" Comments:

Comment 20: The commenter states that the RMP defines a low abundance threshold as "a spawning escapement level, set intentionally above the point of biological instability, which triggers extraordinary fisheries conservation measures" to minimize fishery related impacts and increase spawning escapement. The commenter believes that the RMP's claim that the low abundance thresholds are set above the point of biological instability is misleading.

Response: As required in section (b)(6)(iii) of the ESA 4(d) Rule, the RMP must adequately address eleven criteria under section (b)(4)(i) in Limit 4. The analysis of the anticipated results of implementing the RMP, not the RMP's characterization, was compared against the criteria defined under Limit 6 of the ESA 4(d) Rule (see response to Comment 5). After taking into account uncertainty, the critical threshold is defined as a point under current conditions below which: (1) depensatory processes are likely to reduce the population below replacement; (2) the population is at risk from inbreeding depression or fixation of deleterious mutations; or (3) productivity variation due to demographic stochasticity becomes a substantial source of risk (see page 15 of NMFS 2000b as cited in the PEPD). NMFS-derived critical thresholds ranged from 200 to 1,650 fish. These critical thresholds may be revised as additional information becomes available on how an individual population responds to low abundance. NMFS finds that the RMP's low abundance thresholds are generally set at or above what are considered to be critical thresholds (point of biological instability) for the chinook populations based on a survey of the literature and population-specific assessments. However, NMFS recognizes these thresholds are likely to vary over time as habitat conditions change.

Comment 21: The commenter believes that the SUS exploitation rates will generally increase when the minimum fishery regime [equating to the RMP's critical exploitation rate ceiling] is triggered. This might occur under circumstances when total abundances are low enough that escapements are projected to be below a population or management unit's low abundance threshold. This outcome is relative to the circumstance when the regime is triggered due to the total RER being exceeded even though escapements are expected to be above the low abundance threshold.

Response: For most management units, the RMP's critical exploitation rate ceiling imposes an upper limit on SUS exploitation rates when spawning escapement for a management unit is projected to fall below its low abundance threshold *or* if Canadian fisheries make it difficult or impossible to achieve the RMP's rebuilding exploitation rate. Modeling exercises by the co-managers demonstrate the potential for imposing the RMP's critical exploitation rate ceiling for several management units for the duration of the RMP (see response to Comment 6). The proposed critical exploitation rates are ceilings that are not to be exceeded. The commenter suggests the SUS exploitation rates will be increased to meet the ceiling when the RMP's critical exploitation rate ceiling is imposed. This is not NMFS' understanding of the co-managers' plans for implementing the RMP, nor was this outcome used as an assumption in how the fisheries were modeled. During modeling, if the SUS fisheries' impacts were already below the RMP's critical exploitation rate ceiling, the co-managers in modeling future fisheries did not increase the impacts of the SUS fisheries to reach this ceiling. If impacts under the implementation of the RMP are greater than expected, NMFS can withdraw the ESA 4(d) Rule determination or ask the co-managers to adjust the fisheries' impacts.

Comment 22: The biological importance of the low abundance thresholds was also of concern to the commenter. The commenter suggested that neither the RMP nor the PEPD clearly define the "point of biological instability" [critical threshold] or provide a clear quantitative explanation of how the proposed low abundance threshold levels are determined. The commenter further suggested that the PEPD does not provide any evidence that the RMP's low abundance thresholds are set far enough above putative points of biological instability to provide a precautionary and properly risk-averse margin of safety when they are crossed from above.

Response: See response to Comment 20.

Comment 23: The commenter stated that the RMP defines the point of instability as "that level of abundance (i.e., spawning escapement) that incurs substantial risk to genetic integrity, or exposes the population to depensatory mortality factors." The commenter believes that with other critical terms employed in the RMP and the PEPD, no explanation is provided or even attempted regarding what is meant by a "substantial" risk or how such a level of risk is determined.

Response: NMFS did not evaluate the RMP's definition of the point of instability. NMFS' evaluation focused on the effects of implementing the RMP's mortality limits, regardless of their basis. In the PEPD, NMFS compared the RMP's low abundance thresholds against NMFS-derived or VSP-derived critical thresholds threshold (see response to Comment 20 for NMFS' definition of a critical threshold). The co-managers' basis in the development of the RMP's low abundance thresholds was not needed to make this comparison. In the PEPD, NMFS concludes that the RMP's low abundance thresholds are generally set at or above what are defined as, or considered to be, the critical thresholds.

"Critical Exploitation Rate Ceiling" Comments:

Comment 24: The commenter expressed concern that the application of an exploitation-rate ceiling in response to crossing a critical-abundance threshold from above would be based on policy objectives rather than biological considerations.

Response: See responses to Comments 9 and 21.

Comment 25: The commenter expressed concern about an apparent disconnect between the descriptions of the Critical ER [exploitation rate] Ceilings and their apparent actual effects on impact rates. The commenter suggested that no discussion is offered in the PEPD on how a minimally acceptable level of access was determined, who determined it, or why.

Response: The RMP does include discussion on how a minimally acceptable level of access was determined. See responses to Comments 5 and 21.

Comment 26: The commenter suggested that the association of the Critical ER Ceilings with RERs and the low abundance thresholds creates the implication of a two-tiered harvest regime for each MU [management unit], with separate impact-rate schedules above and below the thresholds. However, there is little indication that the provisions of the RMP would necessarily affect any significant difference in overall impacts on an MU, no matter what level of abundance it reaches, or whether or not Critical ER Ceilings are imposed.

Response: See response to Comment 5 and 21.

"Other Issues of Concern" Comments:

Comment 27: The commenter believes that the range of variability in chinook salmon productivity is not fully considered. The commenter suggests that the PEPD uncritically accepts the likely range of abundances of adult chinook returns under the six-year RMP implementation period chosen by the co-managers for their modeling of the impacts of implementing the RMP. The commenter believes that the PEPD fails to require that the co-managers adopt more risk-averse modeling assumptions in estimating the likely impacts on listed chinook of the implementation of the RMP.

Response: As mentioned earlier, Table 3 of the PEPD provides the anticipated range of exploitation rates and anticipated escapements for Puget Sound chinook salmon under the implementation of the RMP. Two variables were used in the modeling of the future fisheries to provide these anticipated ranges of exploitation rates and anticipated escapements. These modeling variables were abundance of returning salmon and impacts associated with the level of Canadian fisheries. The modeled salmon abundance in 2003 was used to estimate the upper end of the annual abundance returns under the implementation of the RMP. A 30 percent reduction in the 2003 abundance was used to represent the lower range of modeled returns. This range of modeled abundance is similar to the variation in observed abundance for the ESU recently. However, this range is considered conservative given the increasing escapement trend in recent years. Given the general trend of stable to increasing abundance, it is likely that if the actual abundance in the next five years falls outside this range, the actual abundance would most likely be greater. Under the implementation of the RMP, it is unclear if Canadian conservation actions will continue or if impacts will increase to maximum levels allowed under the Pacific Salmon Treaty. In modeling the Canadian fisheries, the impacts similar to fisheries in 2003 were used to represent the lower range of anticipated impacts. Maximum harvest levels allowed under the Pacific Salmon Treaty were modeled to represent the upper range of impacts associated with Canadian fisheries. Fisheries can not go above this level under the terms of the Pacific Salmon Treaty. The evaluation used the modeling based on the maximum harvest levels under the Pacific Salmon Treaty as the most likely to occur within this range. Canadian impacts, under the agreement of the Pacific Salmon Treaty, may not be greater than the level assumed as the most likely to occur. The range of abundance was chosen by NMFS in consultation with the co-managers and based on an examination of abundance and survival conditions over the past ten years.

Comment 28: The commenter believes negative impacts of hatchery chinook salmon on natural-origin chinook salmon are ignored, misinterpreted, or inappropriately accepted. The commenter expressed that the Kendall Creek Hatchery is currently operating without ESA take authorization. The commenter suggests that the PEPD's assertions that the Kendall Creek hatchery population "retains the genetic characteristics of the wild population," or that hatchery production at Kendall Creek "buffers genetic and demographic risks" to wild NF [North Fork] Nooksack River chinook salmon are precisely the assertions that NMFS has yet to make any determination over.

Response: In its recent proposed revision of the Puget Sound chinook salmon ESA listing, NMFS has proposed that the Kendal Creek Hatchery population be determined to be part of the Puget Sound Chinook Salmon ESU. 69 Fed. Reg. 33102, 33129 (June 14, 2004). NMFS has proposed the Kendall Creek Hatchery chinook population conservation-directed program may provide substantial benefits to VSP parameters for the North Fork Nooksack River spring chinook salmon population (see section 6.2.1 of the Salmonid Hatchery Inventory and Effects Evaluation Report, An Evaluation of the Effects of Artificial Propagation on the Status and Likelihood of Extinction of West Coast Salmon and Steelhead Under the Federal Endangered Species Act, as posted on the NMFS, NWR's web-site at: http://www.nwr.noaa.gov/1srd/Prop_Determins/Inv_Effects_Rpt/6_PSoundChinook.pdf, as accessed on December 15, 2004). The North Fork Nooksack River spring chinook salmon population is a unique population that will likely be considered important for recovery of the Puget Sound Chinook Salmon ESU to a viable level. The program likely benefits the abundance, diversity, and spatial structure of the North Fork Nooksack River population. NMFS and the co-managers recognize that the Kendall Creek hatchery-origin fish spawning in the South Fork Nooksack River are a risk, not a benefit to the South Fork Nooksack River population. This was one of the reasons that the co-managers reduced the Kendall Creek early chinook salmon hatchery production by 50 percent in 2003 (W. Beattie, NWIFC, e-mail to K. Schultz, NMFS, August 6, 2004). However, the Kendall Creek Hatchery, and the other chinook hatchery programs in Puget Sound are currently under review by NMFS for our evaluation and determination under limit 6 of the ESA 4(d) Rule. Therefore, this finding regarding the Kendall Creek Hatchery chinook population is considered preliminary. The ERD was modified to reflect that the Puget Sound hatchery programs are being reviewed by a separate Limit 6 determination of the ESA 4(d) Rule.

Comment 29: The commenter believes that the RMP lacks clarity in describing how it recognizes "Viable" and "Critical" concepts.

Response: See response to Comment 20 for NMFS' definition of a critical threshold, which is consistent with the VSP paper for a critical threshold. The regulations in the ESA 4(d) Rule require that the RMP must use the concepts of "viable" and "critical" thresholds in a manner so that fishery management actions; (1) recognize significant differences in risk associated with viable and critical population threshold states, and (2) respond accordingly to minimize long-term risks to population persistence. The RMP defines its own upper management and low abundance thresholds, but these are readily comparable to the NMFS-derived or VSP-derived viable and critical thresholds. The ESA 4(d) Rule also requires that harvest actions that impact populations that are currently at or above their viable thresholds must maintain the population or management unit at or above that level. Fishing-related mortality on populations above critical levels but not at viable levels (as demonstrated with a high degree of confidence) must not appreciably slow rebuilding to viable function. Fishing-related mortality to populations functioning at or below their critical thresholds must not appreciably increase genetic and demographic risks facing the population and must be designed to permit achievement of viable functions, unless the RMP demonstrates the likelihood of survival and recovery of the entire ESU in the wild would not be appreciably reduced by greater risks to an individual population. Table 9 in the PEPD is the post-listing threshold classification and escapement trend since listing for Puget Sound chinook salmon populations. In the PEPD, NMFS found the RMP was responsive to the populations' status, when compared to the critical or viable thresholds, as required by the ESA 4(d) Rule.

Comment 30: The commenter believes that there is a lack of consistency between the PEPD and RMP. The commenter received and reviewed information from WDFW regarding the co-managers' 2004 fishing plan, outlining model predictions of expected impacts and escapements for all management units. The commenter suggested that several of the exploitation-rate and escapement predictions fall well outside the range of likely impacts and escapements described in Table 3 of the PEPD.

Response: NMFS, in cooperation with the co-managers, have modeled the anticipated impacts of the implementation of the RMP. NMFS recognized that in this modeling exercise, conservative assumptions were made and that there was always the possibility that in any individual year the results could be different than the range of possibilities considered. In recent years, the post-season assessment has generally shown that estimated exploitation rates are lower than pre-season projections, with the escapement often higher than predicted pre-season (W. Beattie, NWIFC, e-mail to K. Schultz, NMFS, August 6, 2004). If impacts under the implementation of the RMP are greater than expected, NMFS can withdraw the ESA 4(d) Rule determination or ask the co-managers to adjust fisheries to reduce impacts. Generally, the 2004 pre-season modeled escapement results are within or greater than the range of predicted escapements in the PEPD. This can be, in part, attributed to the use of risk-averse modeling assumptions in modeling impacts and the resultant escapement under the RMP (see response to Comment 27).

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