Recovery Plan
For Lake Ozette Sockeye Salmon
(*Oncorhynchus nerka*)

Photo by: Mike Young

May 4, 2009
NOAA's National Marine Fisheries Service
Northwest Regional Office
Salmon Recovery Division

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The recovery plan can be downloaded via the Internet at:

http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/Lake-Ozette-Plan.cfm

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INTRODUCTION

This is a Recovery Plan for the protection and restoration of Lake Ozette sockeye salmon. Lake Ozette sockeye were listed as a threatened species under the Endangered Species Act (ESA) in 1999. The ESA requires the National Marine Fisheries Service (NMFS) to develop recovery plans for all listed salmon species; therefore, this recovery plan was developed to comply with the law.

The plan includes a proposal for actions that may voluntarily be taken to stop the downward trend of the species and return it to a healthy, naturally self-sustaining condition.

Lake Ozette, its perimeter shore, and most of the Ozette River, which forms the outlet of the lake, are included in the 922,651-acre Olympic National Park (ONP). This plan complements, recognizes, and works within the authorities of the ONP, as well as Clallam County, the Forest Practices Habitat Conservation Plan (FPHCP), the Washington Department of Natural Resources (DNR) Habitat Conservation Plan (HCP), and tribal trust and treaty rights. The plan does not augment or supersede these or other authorities.

Why Lake Ozette sockeye?

- Lake Ozette sockeye salmon are a species listed under the Endangered Species Act because they are in danger of becoming extinct, and they are found nowhere else.
- Their numbers have dramatically declined from historical levels.

What about other species of fish in the lake?

Other fish species will also benefit from improvements to the freshwater habitat for sockeye.

NMFS, a branch of the National Oceanic and Atmospheric Administration (NOAA) has directed preparation of this recovery plan. NMFS, also called NOAA Fisheries, is the Federal agency charged with stewardship of the nation's marine resources, and NMFS has the responsibility for listing and delisting salmon species under the ESA. For purposes of this summary, the acronym NMFS will be used for the agency that directed this recovery plan.

NMFS prepared this recovery plan with the active participation of the Lake Ozette Steering Committee, a group made up of local citizens, landowners, biologists, and representatives of several county, state, tribal, and Federal entities (listed in Appendix A). The Steering Committee met 18 times over the last three and a half years to discuss and comment on all aspects of successive drafts of this recovery plan. Additionally, NMFS met with various groups and agencies with interests in this planning effort, including the Lake Ozette basin property owners (see Appendix C), timber companies, tribal representatives, Clallam County Commissioners and staff, and Olympic National Park. Input and comments from all of these meetings were considered, evaluated, and, where appropriate, incorporated into the Recovery Plan. Additionally, NMFS solicited public comments on the plan and incorporated these comments as appropriate. The plan's content, however, remains the responsibility of NMFS.

Although the ESA requires NMFS to develop recovery plans, NMFS will rely, to a great extent, on local citizens and jurisdictions to voluntarily implement actions the plan recommends or proposes. In many cases, the plan simply acknowledges and recommends coordinating the pre-existing, ongoing recovery efforts and pre-existing laws or regulations that are expected to benefit the species and its environment, such as the ongoing resource management and habitat restoration activities of Olympic National Park, Washington Department of Fish and Wildlife, and the Makah and Quileute Tribes. Some of the ongoing actions that are integrated into the plan are required under other, separate resource management regulatory processes, such as implementation of forest practices habitat conservation plans, Clallam County road maintenance, operation of the sockeye hatcheries, and regulation of fisheries that may affect sockeye. In addition, Olympic National Park might implement recommended actions on properties for which it is responsible. Other regulatory authorities might enact regulations based on the recommendations in this plan, such as Clallam County for land use issues, or Washington Department of Fish and Wildlife and the Tribes for harvest issues and water quality standards. This recovery plan is not an end in itself. After it is adopted, further work will be needed on such important questions as who will do what, the specific costs, the funding sources that may be available, the time frame for various actions, and what opportunities will be provided for public and agency input and involvement. Work will start on an implementation plan for Lake Ozette sockeye recovery later in 2009.

Why a recovery plan?

Because the ESA requires NMFS to develop recovery plans for all listed species as a means by which to organize and coordinate recovery of the species.

Is this plan voluntary or required?

NMFS is required to make a plan. Implementing the recovery actions is voluntary. The plan is not a law and it is not a regulation; it's just a roadmap, guidance, and resource for people and organizations willing to take action to help the fish.

What does "recovered" mean?

Biological recovery for a salmon species means that it is naturally self-sustaining – enough fish spawn in the wild and return year after year so they are likely to persist in the long run, defined as the next 100 years. The species also has to be resilient enough to survive catastrophic changes in the environment, including natural events such as floods, earthquakes, storms, and decreases in ocean productivity.

- In terms of protection, recovery means the threats that caused the species to decline have been abated.
- In terms of the ESA, recovery means the sockeye no longer needs the protection of the Act and can be taken off the list.
- In terms of social and cultural values, recovery means sufficient abundance for the fish to be self-sustaining and also to allow sustainable harvest.

GOALS

In general, the goal of this plan is for the Lake Ozette sockeye population to reach the point that it no longer needs the protection of the Act and can be delisted. The delisting decision must be based on the best available science. Biological recovery for a salmon species (the basis for delisting) means that it is naturally self-sustaining – enough fish spawn in the wild and return year after year so they are likely to persist in the long run, defined as the next 100 years. The species also has to be resilient enough to survive catastrophic changes in the environment, including natural events, such as floods, earthquakes, storms, and changes in ocean productivity.

A recovery plan can have "broad-sense" goals that may go beyond the requirements for delisting to acknowledge social, cultural, or economic values regarding the listed species. NMFS and the Lake Ozette Steering Committee crafted the following vision statement describing desirable future conditions for the Lake Ozette sockeye and its human and biological setting:

The naturally spawning Lake Ozette sockeye population is sufficiently abundant, productive, and diverse (in terms of life histories and geographic distribution) to provide significant ecological, cultural, social, and economic benefits. Protection and restoration of ecosystems have sustained processes necessary to maintain sockeye as well as other salmon, steelhead, cutthroat trout, and other native fish and wildlife species. Community livability, economic well-being, and treaty-reserved fishing rights have benefited by balancing salmon recovery with management of local forest and fishery economies.

This plan has undergone public comment processes and has been adopted by NMFS. The groups involved in voluntarily implementing the plan's recommendations may consider this vision statement and accept, reject or modify it as they wish.

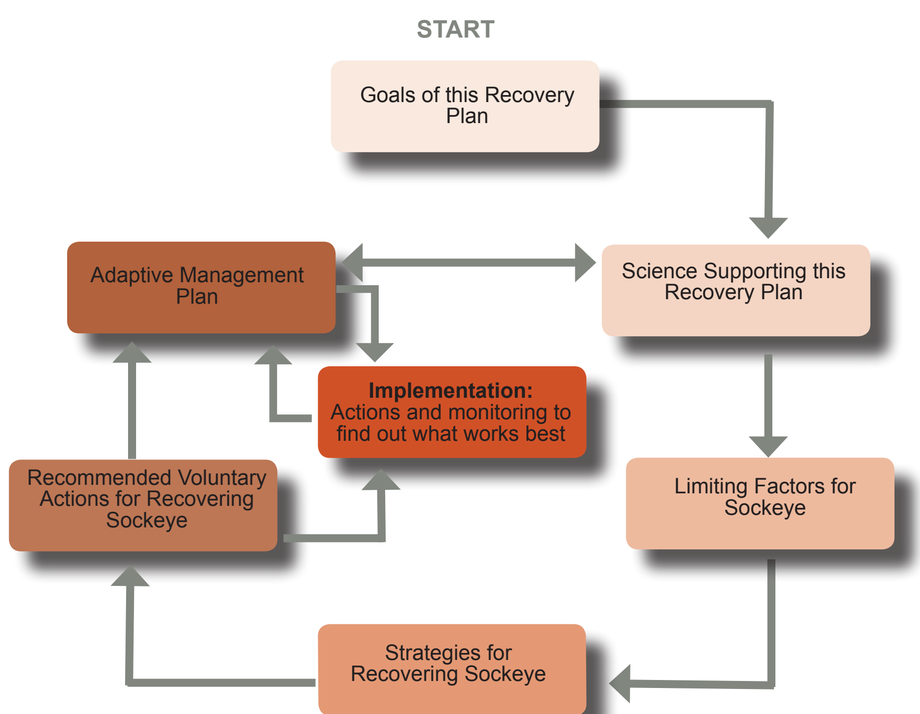
What's the goal of this recovery plan?

The primary goal is to be able to "delist" the sockeye – improve its status so that it is naturally self sustaining and no longer threatened with extinction.

What's delisting? Who makes the decision?

Under the Endangered Species Act (ESA) of 1973, listing and delisting of marine species, including salmon, are the responsibility of the National Marine Fisheries Service (NMFS). If a fish or other species is listed as threatened or endangered, legal requirements to protect it come into play. When NMFS decides through scientific review that the species is doing well enough to survive without ESA protection, NMFS will "delist" it. This decision must be based primarily on the best available science concerning the current status of the species and its prospects for long-term survival.

Figure S-1: Recovery Plan Process Schematic



TECHNICAL BASIS

NMFS-Appointed Technical Recovery Team

NMFS appointed teams of scientists with expertise in salmon species to provide scientific support for recovery planning in the Northwest. These technical recovery teams (TRTs) include biologists from NMFS, state, tribal, and local agencies, academic institutions, and private consulting groups. For Lake Ozette sockeye salmon, the scientific team was called the Puget Sound TRT, and it provided two reports: a description of the Lake Ozette sockeye population; and biological recovery criteria for the sockeye. The team also reviewed the draft recovery plan in detail, as well as a scientific document that identified the factors affecting sockeye salmon survival.

TRTs work from a common scientific foundation to ensure that recovery plans are scientifically sound and based on consistent biological principles. All the TRTs use biological principles established by NMFS for salmon recovery planning as a basis of the work they do.

The Lake Ozette sockeye ESU is made up of only one population. Many other salmon ESUs have several component populations spread out over a wide area, and therefore they have more diversity and potential resilience in the face of environmental change. There are five known subpopulations or aggregations of Lake Ozette sockeye, defined in terms of where they spawn—on beaches around the lake or in the tributaries (beach spawning subpopulations include Olsen's Beach and Allen's Beach, while tributary spawning subpopulations include Umbrella Creek, Big River, and Crooked Creek). The non-anadromous, resident sockeye are called kokanee, and they are genetically different enough from anadromous Lake Ozette sockeye to be considered a separate ESU.

What is an "evolutionarily significant unit" (ESU)?

ESUs are defined on the basis of geographic range as well as genetic, behavioral, and other traits.

Formally, an ESU is defined as a group of Pacific salmon or steelhead trout that is (1) substantially reproductively isolated from other groups of the same species and (2) represents an important component of the evolutionary legacy of the species.

All Pacific salmon belong to the family Salmonidae and the genus Oncorhynchus, while sockeye belong to the species *Oncorhynchus nerka*. Lake Ozette sockeye are an evolutionarily significant unit of *O. nerka*.

Most of the time, salmon return to spawn in the streams or lakes where they were born. However, they occasionally "stray" and choose to mate where conditions are right, perhaps in an adjacent stream or lake. The result is that salmon populations that are geographically widespread may have some amount of genetic similarity. They are linked because of straying, and differentiated because of long-term adaptation to different environments. In the Pacific Northwest, NMFS has identified seven sockeye ESUs.

Picture S-1: Lake Ozette (Courtesy of Olympic National Park)

What's a limiting factor?

A limiting factor is any aspect of the environment that affects a species' ability to reproduce, such as predation, water temperature, stream channel structure, or the amount of water in the stream.

What's a hypothesis?

A hypothesis is a statement that can be proved or disproved by further inquiry. It is an invitation to look for more information. A scientific hypothesis is based on some kind of evidence or observation, and it describes either a possible causal relationship or just a relationship of some sort.

It does not matter whether a hypothesis is precise or wildly speculative; the important thing is whether it can be proven or disproven, and how you go about getting the evidence. For example, "I think the moon is made of green cheese" is a hypothesis about the substance of the moon. The question is not where the hypothesis came from but what can be done with it. What's the evidence? How can it be proved or disproved?

An example of a hypothesis for Lake Ozette sockeye recovery planning:
High stream temperatures weaken juvenile and adult sockeye salmon migrating to or from the lake and result in higher mortality.

Limiting Factors Analysis

Technical information about Lake Ozette sockeye recovery is incorporated in a biological research paper, the Lake Ozette Sockeye Limiting Factors Analysis (Haggerty et al. 2009), prepared for NMFS in cooperation with the Lake Ozette Sockeye Steering Committee. The Limiting Factors Analysis, or LFA, is an exhaustive study of all the available published information as well as field biology and unpublished or historical records on Lake Ozette sockeye. The authors, with the guidance of the Steering Committee, made a series of hypotheses about past and current factors that limit the sockeye's survival and reproduction. These hypotheses are based on specific information about the Lake Ozette sockeye, their life cycle, and their environment, as well as general knowledge about anadromous fish and freshwater ecosystems.

The LFA contains hypotheses about limiting factors that affect all Lake Ozette sockeye, both lake beach and tributary spawners. Chapter 4 in the Recovery Plan summarizes the limiting factors hypotheses. It is anticipated that these hypotheses can be tested as part of implementing the recovery program. Actions that are taken to address these limiting factors should be monitored and the results evaluated to see whether they support and confirm or disprove the hypotheses. Then recovery strategies and actions can be adjusted accordingly. The Puget Sound TRT and scientists at NMFS Northwest Fisheries Science Center have reviewed the LFA. Their comments have been evaluated and, as appropriate, incorporated.

For example, one hypothesis is that water quality is a limiting factor for Lake Ozette sockeye. Specifically, it is possible that high water temperatures and high sediment concentrations in the tributaries either weaken or kill enough sockeye and their eggs to make a difference in their rate of reproduction. The evidence that water quality is a limiting factor for Lake Ozette sockeye is described in Chapter 4, Section 4.2.2.1 of the recovery plan, under the heading, "Rationale."

The color graphic on the following page illustrates the relative importance of a wide range of potential limiting factors for the beach spawning Lake Ozette sockeye aggregation, showing the life history stage affected. For example, the thick red arrow at about 2 o'clock on **Figure S-2** indicates that spawning habitat quality has a large effect on the fish in the stage of egg incubation and emergence from the gravel. Two other thick red arrows show that predation can have a large effect on both the juvenile fish rearing in the lake and adults returning to spawn. A fourth indicates the importance of factors that affect survival in the ocean. The plan includes similar graphics showing limiting factors for the tributary spawning aggregation as well as one for factors that affect the entire population.

Figure S-2: Beach spawning sockeye life history stages and hypothesized limiting factors

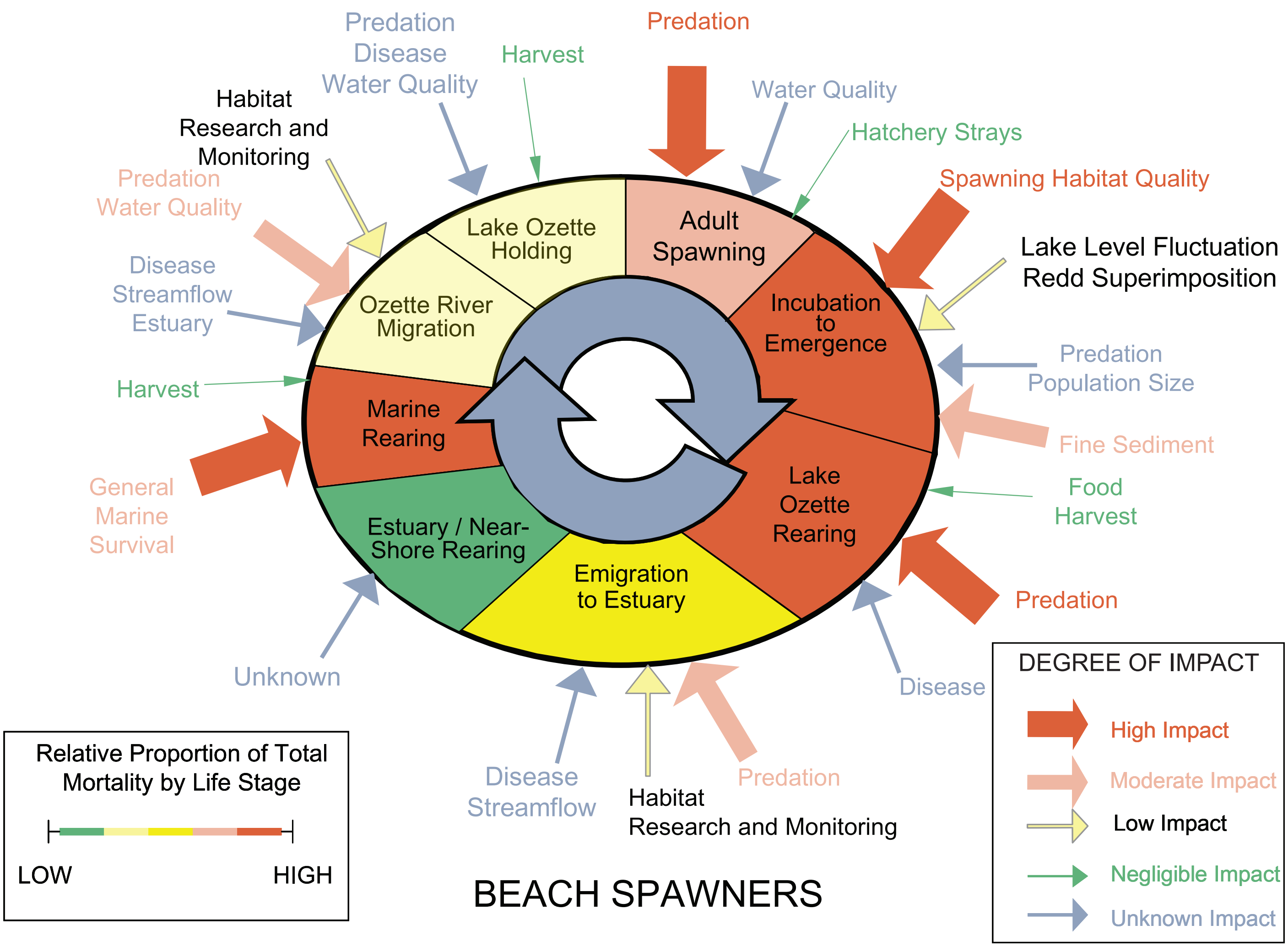


Table S-1: Summary of limiting factors hypotheses (modified from table 4.1 in Lake Ozette Sockeye Salmon Recovery Plan)

Limiting Factor	Population Segment(s) Affected	Degree of Influence of Limiting Factor	Description
Predation	ALL	Key	Changes in relative predator-prey abundances in the Ozette River and Lake Ozette have increased the proportion of juvenile and adult sockeye consumed by predators such as cutthroat trout, northern pikeminnow, largemouth bass, river otters, and harbor seals, and resulted in decreased freshwater survival, as well as an overall decrease in the number of sockeye returning to spawn.
Water Quality	ALL	Contributing	High stream temperatures and low frequency, high intensity turbidity events reduce the fitness of sockeye salmon entering or exiting Lake Ozette and result in decreased survival and productivity.
Streamflow	ALL	Contributing	Reduced streamflows in the Ozette River affect water quality, predation rates and efficiency, and reduce the fitness of migrating and emigrating sockeye.
Habitat	ALL	Contributing	Reduced pool depth, volume, and cover have decreased predator avoidance capabilities and refuge areas for sockeye, increasing predator efficiency and reducing refuge habitat.
Marine Survival	ALL	Contributing	Survival in the marine environment is driven by large-scale climatic processes, which are mostly not controllable. Variability in marine survival rates for sockeye salmon is significant, but not likely a key limiting factor at present. Large-scale changes in marine conditions should be monitored and may be significant in the future.
Estuary	ALL	Unknown	Because little is known about the Ozette River estuary, there is no current hypothesis concerning estuarine conditions as a limiting factor for sockeye. This is an important data gap.
Spawning Habitat	Beach Spawners	Key	Reduced quality and quantity of beach spawning habitat in Lake Ozette has decreased egg to emergence survival, resulting in reduced fry production from the beach spawning aggregations.
Predation	Beach Spawners	Key	Changes in relative predator-prey abundances on Ozette spawning beaches have increased the proportion of adult sockeye, eggs, and newly emerged fry consumed by predators, resulting in decreased freshwater survival.
Water Quality	Beach Spawners	Contributing	Turbidity and suspended sediment concentration (SSC) at Olsen's and Allen's Beaches have a limited effect on sockeye salmon because of the distance of spawning habitat from major sediment sources. However, at historical spawning sites near major tributary outfalls, such as Umbrella Beach, the effects of turbidity and SSC would be expected to be similar to those described for tributary spawners.
Lake Level	Beach Spawners	Contributing	Seasonal lake level changes result in redd dewatering, decreasing egg-to-fry survival rates.

Table S-1 Continued: Summary of limiting factors hypotheses (modified from table 4.1 in Lake Ozette Sockeye Salmon Recovery Plan)

Limiting Factor	Population Segment(s) Affected	Degree of Influence of Limiting Factor	Description
Competition	Beach Spawners	Key	Reduced spawning habitat quality and quantity have increased the competition for suitable habitat at low to moderate spawning escapement levels, resulting in increased redd superimposition and decreased egg-to-fry survival.
Spawning Habitat	Tributary Spawners	Key	Channel simplification and increased sediment production and delivery to streams have decreased the quantity of suitable spawning habitat (i.e., gravel) available to tributary spawning sockeye. Increased levels of fine sediment (<0.85mm) in spawning gravels reduces intra-gravel flow and oxygenation of redds, resulting in decreased egg-to-fry survival.
Channel Stability	Tributary Spawners	Contributing	Decreased channel stability and floodplain alterations have reduced egg-to-fry emergence survival in sockeye tributaries.
Water Quality	Tributary Spawners	Contributing	Elevated turbidity and SSC levels increase stress and reduce sockeye fitness, resulting in increased egg retention rates and pre-spawning mortalities. High levels of turbidity and SSC result in fine sediment deposition in sockeye redds, decreasing egg survival. High levels of turbidity and SSC during the sockeye fry emigration period result in reduced sockeye fry survival, fitness, increased gill abrasion, and altered oxygen uptake.
Predation	Tributary Spawners	Contributing	Predation of sockeye fry by piscivorous fish during emergence, emigration, and dispersal significantly reduces the number of fry rearing in the pelagic zone of the lake. Predation on adult sockeye and eggs in tributaries occurs at low levels and is not likely a significant limiting factor.
Streamflow	Tributary Spawners	Contributing	Natural and anthropogenically influenced streamflow variability (magnitude, frequency, and timing of low and high flows) affects sockeye mortality by: 1) delaying adult migration into tributaries (resulting in more predation, egg retention), 2) limiting where adults spawn in a cross-section (sequestering spawners in areas where egg scour or desiccation is likely), and/or 3) increasing emigrating fry exposure times in tributaries (resulting in exposure to predation or poor water quality).
Holding Pools	Tributary Spawners	Not Currently Limiting	Current holding pool frequency and volume, reduced from historical conditions, appears to be adequate in relation to the current numbers of adult sockeye salmon. However, as the tributary population continues to expand, this factor may begin to exert an influence.

RECOVERY CRITERIA

The ESA requires that recovery plans, to the maximum extent practicable, incorporate objective, measurable criteria which, when met, would result in a determination in accordance with the provisions of the ESA that the species be removed from the Federal List of Endangered and Threatened Wildlife and Plants. These criteria are of two kinds: biological viability criteria and "threats" criteria, which are related to the five listing factors detailed in the ESA (see below).

Biological Viability Criteria

Biologists define "viability" or biological health for salmon populations in terms of four variables or parameters: abundance, productivity or growth rate, spatial structure, and diversity. The Puget Sound TRT recommended the following viability criteria for Lake Ozette sockeye:

Abundance: The number of adult fish on the spawning grounds. *Based on currently available information, the TRT recommended that a viable sockeye population in Lake Ozette should range in abundance between 31,250 and 121,000 adult spawners, over a number of years* (Rawson et al. 2008).

Productivity: The growth rate, which can be measured as the spawner-to-spawner ratio (returns per spawner or recruits per spawner), annual population growth rate, or trends in abundance. Productivity is a measure of a population's ability to sustain itself or to rebound from low numbers. *For the ESU to be viable, the population growth rate would have to be stable or increasing.*

Spatial structure: This refers both to the geographic distribution of individuals in the population and the processes that generate that distribution. *A viable sockeye population in Lake Ozette would include multiple, spatially distinct and persistent spawning aggregations throughout the historical range of the population. A viable sockeye population would therefore have multiple spawning aggregations along the lake beaches, which are the known historical spawning areas. The certainty that the population achieves a viable condition would be further increased if spawning aggregations in one or more tributaries to the lake were also established.*

Diversity: Diversity can be genetic, such as the salmon's instinct to return home to spawn, or traits like appearance, behavior, and life history, which are affected by a combination of genetic and environmental factors. More diverse populations have a better chance of adapting to environmental changes. The Lake Ozette sockeye ESU is made up of only one population, so the diversity within it comes from the various component spawning aggregations and the fundamental difference between the anadromous sockeye salmon and the resident kokanee salmon in Lake Ozette, which is a separate ESU. The TRT says *that a viable Ozette sockeye population would include one or more persistent spawning aggregations from each major genetic and life history group historically present within that population. A viable population of sockeye in Lake Ozette also would maintain the historical genetic diversity and distinctness between anadromous sockeye salmon and kokanee salmon in Lake Ozette.*

Puget Sound Technical Recovery Team Viability Criteria for the Lake Ozette Sockeye Salmon

Abundance: Between 31,250 and 121,000 adult spawners, over a number of years.

Productivity (growth rate)**:** Stable or increasing.

Spatial Structure: Multiple, persistent, and spatially distinct beach spawning aggregations, augmented by tributary spawning aggregations.

Diversity: One or more persistent spawning aggregations from each major genetic and life history group historically present within the population. Maintain the distinctness between Lake Ozette sockeye and kokanee.

"Threats" Criteria

The term "limiting factors" refers to characteristics in the environment that affect a species' survival, such as, for example, high water temperature or lack of spawning gravel. NMFS defines threats as the human activities or natural events that cause the limiting factors, for example, removal of streamside vegetation, which causes loss of shade and, consequently, higher water temperature.

While the term "threats" carries a negative connotation, it does not mean that activities identified as threats are inherently undesirable. They are typically legitimate and necessary human activities that may at times have unintended negative consequences for fish populations—and that can also be managed in a manner that minimizes or eliminates the negative impacts.

The term "threats" also relates directly to the listing factors that are evaluated under ESA section 4(a)(1) when initial determinations are made whether to list species for protection. The listing factors are categories of threats.

Here are the ESA section 4(a)(1) listing factors:

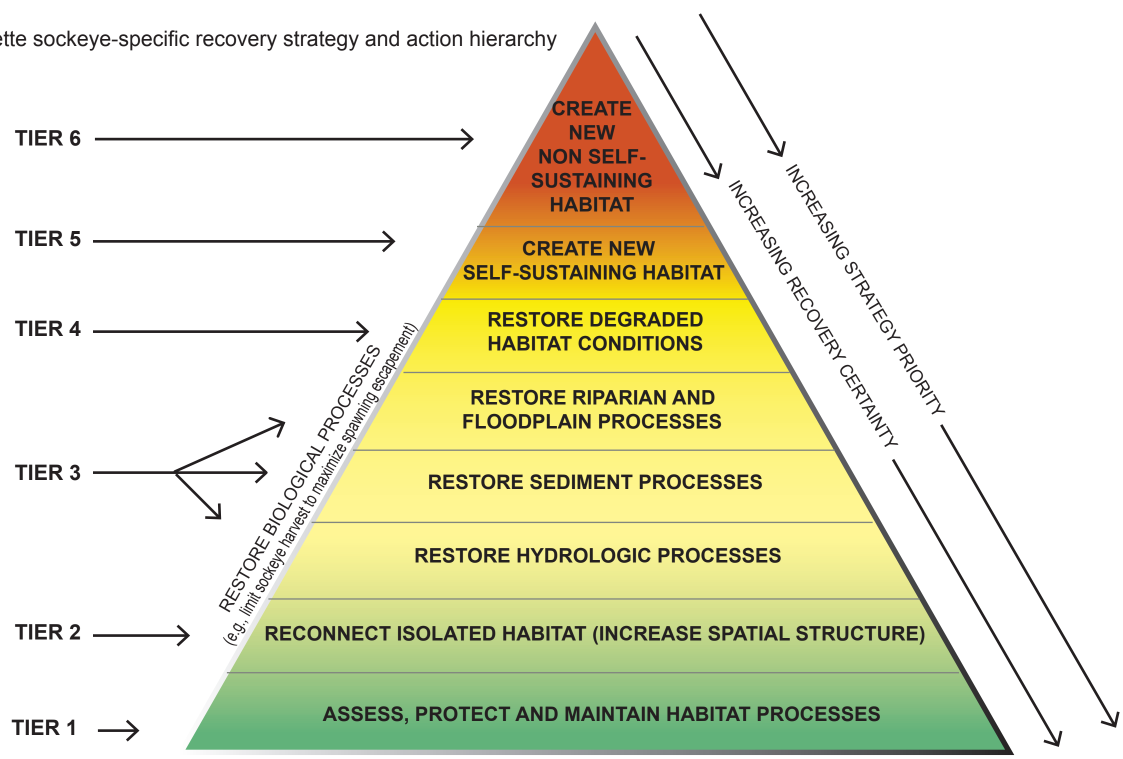
1. Present or threatened destruction, modification, or curtailment of [the species'] habitat or range
2. Over-utilization for commercial, recreational, scientific, or educational purposes
3. Disease or predation
4. Inadequacy of existing regulatory mechanisms
5. Other natural or human-made factors affecting [the species'] continued existence.

The threats criteria define the conditions under which the listing factors, or threats, can be considered to be addressed or mitigated. Threats criteria for measuring recovery of Lake Ozette sockeye are discussed in more detail in Section 3.3.3 of this plan.

RECOVERY STRATEGY

The plan recommends an integrative recovery strategy based on current research about the relationships between watershed processes, land use, and freshwater habitat that incorporates all ecological processes impacting sockeye survival (i.e. habitat degradation, hydrologic process, and predation, among others). This information

Figure S-3: Ozette sockeye-specific recovery strategy and action hierarchy



is then related towhat is known about sockeye mortality by life stage, and to the hypothesized limiting factors. The result is a hierarchy of types of recovery strategies that can form the basis for setting priorities among potential actions. Chapter 6 in the plan explains the recovery strategy. **Figure S-3** illustrates the hierarchy. The recovery strategies are arranged in order of greatest certainty for contributing to recovery, with the most certain, Tier 1, at the base of the pyramid.

The first priority and likely the most effective type of action ("Tier 1" in **Figure S-3**), is to assess, protect, and maintain good quality habitat and the processes that create and maintain it. One example would be to verify the success of current spawning areas and protect them. Another would be to protect forest or streamside areas with conservation easements, where trees could be allowed to grow large, mature, and fall by natural forces.

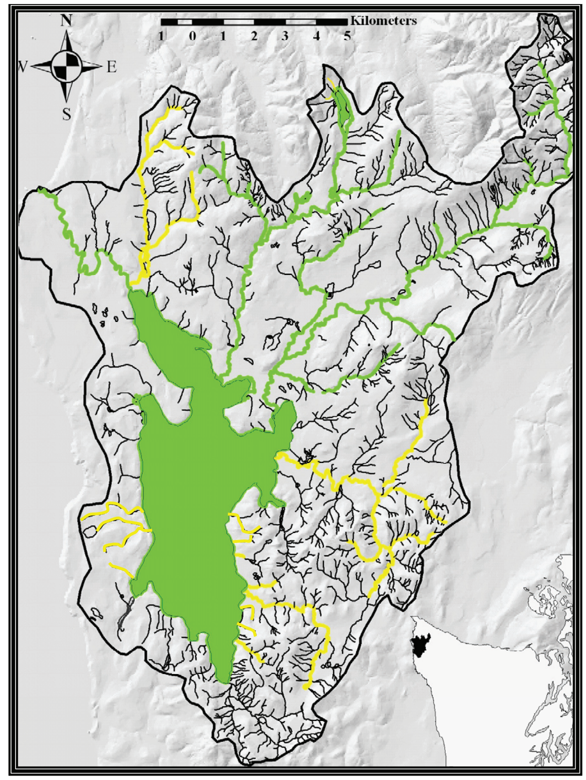
Next in importance and certainty of effectiveness is reconnecting isolated habitat, for example, removing a blockage in the stream, thus allowing salmon more room to spawn and rear.

Third is restoring biological processes of various kinds. This includes a wide range of potential actions, for example: restoring natural predator-prey balance by improving egg-to-fry survival and/or reducing non-native fish species by means of selective fishing; restoring riparian forests along streams and rivers; assessing sources of sediment and reducing sediment production and delivery to streams.

Directly restoring degraded habitat is of lower priority because it is harder, often more costly, and often effective only in the short-term, compared to restoring the processes that create habitat and will continue creating properly functioning habitat over time. However, some direct actions, such as placing large woody debris in carefully chosen areas, will initiate biological processes that are likely to continue naturally.

Creating new habitat is quite a lot harder than working to protect and restore existing habitat; it

Figure S-4: Lake Ozette subbasin prioritization. Green lines depict priority I subbasins, yellow lines depict priority II subbasins, and black lines entering Lake Ozette and the Ozette River depict priority III subbasins



PRIORITY I

- Lake Ozette
- Ozette River
- Umbrella Creek
- Big River

PRIORITY II

- Coal Creek
- Crooked Creek
- Siwash Creek
- Elk Creek
- 20.0073 and 20.0078
- Unnamed West and Eastside Tributaries

PRIORITY III

- Palmquist Creek
- Quinn Creek
- South Creek
- Allen Slough
- 20.0079
- All Other Unnamed Tributaries

is therefore of lowest priority, although in some circumstances it may be the only alternative.

In addition to these priorities, it is important to determine where recovery actions would have the greatest positive impact. The Recovery Plan, with input from the Steering Committee, provides an evaluation of the sub-basins in the Lake Ozette watershed for their importance as sockeye habitat. **Figure S-4** shows the resulting geographic priorities for recovery efforts in the Lake Ozette basin.


Picture S-2: Lake Ozette sockeye salmon in Big River (Photo by Caroline Peterschmidt)

ACTIONS FOR RECOVERY

The plan introduces a series of actions that could be taken to improve prospects for recovery of the Lake Ozette sockeye. This is a key part of the plan, and it is one of the three basic requirements for an ESA recovery plan. Although these actions are to be considered for future implementation, no one is obligated, required, or mandated to follow through on them. The only obligatory actions are those that are already part of local, state, or Federal laws or regulations, or part of an ESA regulatory action under ESA section 7 or section 10, such as the legally binding Habitat Conservation Plans completed between NMFS, timber companies, and the Washington Department of Natural Resources.

Recovery of a healthy, abundant population of Lake Ozette sockeye is likely to happen only if people are willing to work together to achieve it, and if the local people see some benefit to themselves in the results. The proposed recovery actions are designed to address the full range of limiting factors for all life cycle stages of Lake Ozette sockeye salmon and are intended to improve the health and habitat of these fish. Implementation of selected actions described in the plan is the next step in effectively moving toward recovery of this species. Stakeholders will be involved in developing an Implementation Schedule and selecting future projects.

It is important to recognize that it will be easier to obtain focus and funding for sockeye recovery with an approved recovery plan. Still, there are several more steps to be taken before deciding whether to implement each of the proposed recovery actions:

- Develop project budgets and seek funding.
- Get permits from authorizing agencies.
- Communicate with those potentially affected.
- Evaluate potential social and economic effects of proposed actions.
- Coordinate actions with Olympic National Park, the Tribes, Washington Department of Fish and Wildlife, Clallam County, and other appropriate entities.

The proposed actions are in six categories:

- Fisheries management
- Habitat-related actions
- Hatchery supplementation
- Predation-related actions
- Research, monitoring and adaptive management
- Public education and outreach

Fisheries Management

Short-term actions

1. Continue current Olympic National Park, Washington Department of Fish and Wildlife, and tribal fishing regulations that prohibit directed harvest and retention of Lake Ozette sockeye salmon in recreational and tribal commercial fisheries. Conduct population status and impact reviews and employ strict criteria to ensure that any future tribal ceremonial and subsistence fisheries do not compromise recovery.

What is the Forest Practices Habitat Conservation Plan?

The Forest Practices Habitat Conservation Plan (FPHCP) is a set of legal agreements, under ESA section 10, between the US Fish and Wildlife Service, NMFS, the State of Washington, and private timberland owners, that sets out forest practices necessary to protect the survival and recovery of fish and aquatic species in the State of Washington. The FPHCP is based on the Forests and Fish Report, which was developed by county, state, and federal entities, certain Washington Tribes, and professional forestry associations, and represents some five years of intensive negotiations among stakeholders to reach an agreement that all could live with. NMFS found implementation of the FPHCP "consistent with the long-term survival and recovery of covered species," including Lake Ozette sockeye, but the FPHCP is not a recovery plan; it is an agreement that permits a certain level of harm to ESA-listed species ("incidental take," as it is called in the ESA), on the assumption that overall conditions will improve if the rules are followed.

2. Adjust current recreational fishing regulations to promote and maximize the removal of non-native fish species to reduce predation on juvenile sockeye.
3. Continue current marine area fishing regimes, which likely have no substantial impacts on Lake Ozette sockeye. Continue to monitor these fisheries.

Long-term actions

1. As abundance increases, conduct population status and impact reviews and employ strict criteria to ensure that any future directed and/or incidental harvest of sockeye in freshwater, estuarine and nearshore marine areas will not compromise recovery, including any future tribal commercial, ceremonial and subsistence, or all-citizen recreational fisheries.
2. Continue regulating other marine fisheries to minimize incidental impacts on Lake Ozette sockeye.

Habitat-Related Actions

Habitat-related actions for sockeye recovery are discussed in several categories: programmatic actions, which are landscape-scale management programs implemented through many site-specific actions; project-level actions for habitat protection, restoration or enhancement; near-stream and floodplain restoration; spawning habitat restoration; and voluntary conservation easements and land acquisitions from willing sellers.

Programmatic actions

The recovery plan recommends implementing the various existing plans and regulations that have provisions to protect and improve fish habitat (see details in Section 7.2.1).

1. Forest Practices Habitat Conservation Plan
2. Washington Department of Natural Resources State Land Habitat Conservation Plan
3. Clallam County Critical Areas Ordinance and Storm Water Management Plan
4. Clallam County Road Maintenance Plan
5. Olympic National Park General Management Plan
6. Olympic Coast National Marine Sanctuary Management Plan
7. Washington State Department of Fish and Wildlife Hydraulic Code
8. Washington State Department of Ecology water quality and quantity regulatory requirements

Habitat protection, restoration, and/or enhancement projects

1. ***Broad-scale sediment reduction projects:*** The following actions may be carried out voluntarily by any landowners.
- Quantitatively assess sediment production impacts from logging (gully creation, debris flows, landslides), road building, removal of large woody debris, and other land use activities.
- Reduce or eliminate land use-related sediment.
- Where willing landowners and funding exist, purchase land from sellers and manage land to recover watershed processes and ecosystem function to improve sockeye habitat.

- Develop voluntary, comprehensive "green" forestry programs at the landscape scale that promote ecosystem function and watershed process recovery.
- Reconnect floodplains in high-priority subbasins by reintroducing large woody debris to all tributaries to improve floodplain connectivity and sediment deposition/storage.
- Plant or under-plant conifer forests in fields and disturbed hardwood zones next to streams to increase bank rooting strength, increase channel complexity, and aid in sediment storage/deposition.
- Eradicate non-native plants (knotweed, for example) next to streams and replace with native species more effective at protecting soil and banks.

2. *Broad-scale hydrologic restoration projects:* These projects would affect basic watershed and stream processes such as runoff and erosion, streamflow, stream channel structure, and flooding. The first step is to do extensive research to find out where natural hydrologic functions can be improved. Then, construct a hydrologic model to help identify potential projects and set priorities. Potential actions might include road decommissioning, installing road cross-drains and appropriately sized culverts, and placement of large wood. All this would have to be agreed upon, including consideration of public input and coordination with Olympic National Park.

3. *Large woody debris (LWD) placement projects:* The plan proposes ***considering*** a series of broad-scale recommendations and site-specific projects because large wood in the tributaries has many benefits for salmon.

   The following LWD actions are proposed because they address limiting factors, respond to recommendations in research studies (i.e., Herrera 2005), and provide scientifically based actions to improve sockeye viability. These actions are recommended for consideration when developing the Implementation Schedule.

Actions should be selected after careful consideration of both the biological needs of sockeye salmon and the social and economic needs of residents in the Ozette watershed, in coordination with the appropriate entities and stakeholders. During the implementation phase of the recovery plan, all proposed actions will be further defined, options analyzed, costs identified or refined, permitting needs identified, social and economic effects analyzed, and decisions made in coordination with relevant permitting agencies and stakeholders.

Why is large woody debris (LWD) important to salmon?

Large woody debris means big chunks of wood, such as root wads or trees fallen into or across the channel.

- In all forested rivers and streams, LWD plays a key role in shaping the channel.
- It creates pools and hiding places, providing salmon with protection from predators.
- It helps filter sediment to provide clean gravel for spawning.
- It provides organic matter to feed the small invertebrates that salmon feed on.

LWD can benefit landowners, too.

- Streams with adequate riparian vegetation and LWD on banks and in the channel are more resilient to catastrophic floods and help maintain a stable, healthy channel.

Where would LWD be placed?

The plan recommends placing LWD in a variety of creeks and rivers. In key sockeye habitat areas such as Umbrella Creek and in the lower reach of the Ozette River, LWD can be placed relatively freely without significant constraints from private property. In areas with more human constraints such as upper Ozette River and Big River, LWD projects need to be more carefully evaluated and engineered, to make sure that habitat benefits accrue while potential damages to local property are foreseen, prevented, or can be mitigated.

As recommended in the two existing detailed LWD studies on the Ozette River, no LWD would be placed in the upper portion of the Ozette River without additional public input and scientific analysis of the potential direct and indirect impacts on lake properties.

a. Lower Ozette River

Relates to Hypothesis 1 (in Chapter 6 of the Plan): Predation by marine mammals in the Lower Ozette River is a limiting factor for Lake Ozette sockeye.

- Placing LWD structures in the lower Ozette River would help prevent or hinder harbor seal migration into the lake.
- LWD would provide cover for migrating salmon and help to reduce predation.
- LWD placement in this river area would not lead to changes in the level of Lake Ozette.

b. Upper 1.3 miles of Ozette River

Throughout the last century, and particularly in the last 60 or 70 years, LWD was removed from the Ozette River in the belief that it helped fish or would reduce flooding. LWD removal, in combination with other factors, has affected water quality (Hypothesis 2), Ozette River streamflow (Hypothesis 3), and Ozette River habitat conditions such as pool depth, pool volume, and cover (Hypothesis 4). It has also contributed to lower average lake levels and resulted in increased vegetation along the lake shore (Hypothesis 6). Historically, LWD was also removed from portions of the lake shoreline. This removal affected the shoreline hydraulics. Water turbulence around shoreline wood cleanses gravel locally and helps prevent vegetation from taking hold. Without wood, vegetation can more effectively colonize bare soil and trap fine sediment, which reduces potential spawning habitat for sockeye.

Picture S-3: Floodplain connectivity in the Lake Ozette watershed

Adding LWD in the upper 1.3 miles of Ozette River would help to restore natural flow patterns and maintain a natural range of lake levels in order to improve beach spawning habitat.

What is floodplain connectivity?

Floodplains are the relatively low-lying lands alongside rivers and streams that are occasionally inundated during high flows and floods. Floodplain connectivity refers to the ability of the stream to periodically overflow its banks. Although we call this "flooding" and perceive it as something to avoid, especially when houses and roads are at stake, it is flooding that makes the soil fertile, replenishes wetlands with nutrients, seeds, and organic matter, and enriches the rivers and streams for the fish and other aquatic life. Upstream floodplains can also diminish the force of the floodwaters and prevent more extensive flooding downstream.

However, for this area, the plan recommends an extensive list of studies, modeling, and analysis of potential impacts on property before proceeding with any large wood placement.

The plan recommends the following steps:

- Determine the effect of different wood loading scenarios on property and infrastructure.
- Identify a range of LWD placement options, including no LWD placement, and evaluate the effect of LWD placement on lake level.
- Identify current flood hazards and potential flood risks around the lake.
- Refine hydrologic model.
- Identify a range of options for large wood placement.
- Identify potential projects to be evaluated based on balancing the biological needs of sockeye with the social and economic effects on local residents.
- Survey existing beach spawning areas to analyze results of hydrologic modeling and figure out what would be good for the fish.

- Evaluate and select restoration sites.
- Develop a shoreline vegetation plan.
- Analyze the social and economic effects of each potential project.

c. *Umbrella Creek*

Fish habitat and LWD conditions in the main Ozette tributaries (e.g., Umbrella, Big, Crooked) were thoroughly monitored and measured in 1999 and 2000. Researchers found that there are areas where there is not very much LWD, the stream channel is unstable, and there is little suitable spawning gravel. The plan recommends considering reintroducing LWD to key tributary channel segments of sockeye Critical Habitat with the intent to stabilize the channel and restore spawning gravels.

Near-stream and floodplain restoration projects

The plan includes extensive detail concerning the near-stream zones around Lake Ozette and its tributaries, and recommends many potential actions that would improve fish habitat by improving natural near-stream zone and floodplain processes—too many to list in a short summary. These should be considered for implementation, with appropriate study and weighing of landowner concerns. Types of actions recommended:

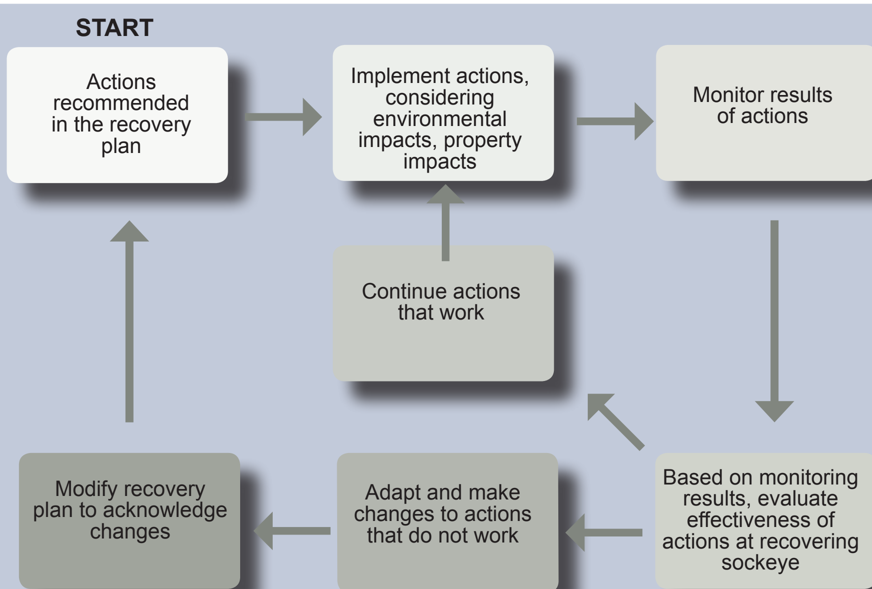
- Eliminate non-native plant species.
- Plant trees near streams where feasible.
- Reintroduce large wood where it would improve floodplain connectivity, sediment storage, water retention, and peak flow attenuation.
- Relocate roads where they affect floodplain connectivity or near-stream processes.

Spawning habitat restoration/enhancement projects

- Restore beach spawning habitat at Umbrella Beach, then try to reintroduce sockeye there.
- Identify other potential sockeye beach spawning habitats and attempt reintroducing sockeye salmon in conjunction with habitat enhancement projects such as:
  → placing downed trees on spawning beaches to promote gravel storage and sorting, mobilization and transport of fine sediment, and increased hyporheic flow
  → mechanical improvements of beach spawning areas
- Place LWD as appropriate in critical habitat for sockeye spawning, such as Umbrella Creek.
- Develop a shoreline habitat restoration plan, including vegetation clearing and beach restoration actions at selected shoreline project sites and flood protection in areas that were identified as flood-prone. Involve volunteers to carry out actions as part of public education and outreach.

What is Adaptive Management?

Adaptive management is the process of adjusting management actions and/or directions based on new information. The new information comes from monitoring the results of actions and evaluating their effects. Then the recovery actions can be continued or changed to be more effective.



Voluntary conservation easements and land acquisition from willing sellers

Habitat for sockeye salmon can be protected and maintained through market-driven transfer of development rights for conservation. One way to do this is through conservation easements. Conservation easements provide greater flexibility than land acquisition, because the property owner can remain on the land while limiting future development in exchange for tax benefits and cash payments. Protective easements remain in place even if the property is sold. Purchase from willing sellers by a land trust or other suitable organization is another way to provide long-term protection for habitat. It is important to have a management plan for any such property to ensure habitat goals are met.

Hatchery Supplementation

The plan recommends continuing hatchery supplementation and related research as described in the Makah Tribe's Lake Ozette Sockeye Salmon Hatchery and Genetic Management Plan, which NMFS approved under the ESA in 2003.

The purpose of the hatchery plan is to establish natural, self-sustaining sockeye salmon spawning aggregations in two major Lake Ozette tributaries (Umbrella Creek and Big River), using broodstock from adult returns to Umbrella Creek that were derived from indigenous Lake Ozette stock. Supplementation is to continue until 2012, the equivalent of three salmon generations, with appropriate monitoring and evaluation to determine the success of the program and to support a decision to either terminate or continue using hatchery supplementation to aid recovery of the Lake Ozette sockeye.

Predation-Related Actions

- Create an incentive program, as appropriate within National Park Service regulations, to encourage or require lethal take of large-mouth bass and other non-native fish species, with a goal of reducing or eliminating non-native fish species.

What or who are the "co-managers?"

Consistent with Federal Court Order (United States v. Washington 1974), Northwest Indian tribes and the State of Washington (through the Washington Department of Fish and Wildlife) are "co-managers" in regulating salmon harvest. The tribes have court-affirmed, legally enforceable treaty rights reserving to them a share of the salmon harvest. For the purposes of this plan, other entities have been identified, as they have shared jurisdiction for certain resource management actions identified in the plan. These other entities are: the National Marine Fisheries Service, the U.S. Fish and Wildlife Service, and the National Park Service.

The Treaty of Neah Bay (1855) and the Treaty of Olympia (1856) identify lands ceded to the federal government by the Makah and Quileute Tribes, respectively. The Tribes share a common boundary of their ceded lands, described in both treaties. The treaties reserved to the Tribes the right of fishing "at all usual and accustomed grounds and stations." This right was reaffirmed by the Boldt Decision in 1974 (U.S. v. Washington, 384 F. Supp. 312, 362).

- Work with NMFS and other appropriate agencies to study impacts of marine mammals and river otters on sockeye salmon, particularly on beach spawning grounds. Based on this information, develop a NMFS- and ONP-sanctioned plan to address these impacts through a variety of predator control measures being tested and used in the NMFS Northwest Region.
- Working in coordination with NMFS, ONP, the Tribes, and Washington Department of Fish and Wildlife, analyze the impacts of seals and sea lions on sockeye salmon and identify options to minimize these impacts, including reinstating ceremonial and subsistence hunting of seals and sea lions in Tribal Usual and Accustomed hunting and fishing areas.
- Modify sockeye adult enumeration techniques at the Ozette River weir to reduce any predation mortality on adult and juvenile sockeye.
- Implement research and monitoring actions proposed in Chapter 8 to analyze fishing regulations, predator-prey interactions, and predation at all life stages for beach spawners.

Public Education and Outreach

- Engage the public as an active partner in implementing and sustaining recovery efforts. Build public awareness, understanding, and support, and provide opportunities for public participation in all aspects of recovery implementation.
- Share information between scientists and the public as recovery projects and monitoring actions are carried out.

RESEARCH, MONITORING, & ADAPTIVE MANAGEMENT

The salmon life cycle is very complex, and there is a lot we do not know about the Lake Ozette sockeye. The recovery plan identifies the many knowledge gaps and uncertainties involved. In some cases, the plan proposes further study as an "action." In other cases, the plan proposes actions that should be beneficial based on general knowledge of how watershed processes work. For example, it is known that excessive suspended sediment can suffocate juvenile or adult fish by clogging their gills, and too much fine sediment can prevent water circulation through the redds (areas where salmon lay their eggs) and kill the eggs. Therefore, reducing sediment in the water is likely to improve sockeye survival.

Because the proposed recovery actions are based on hypotheses about the relationships between fish, human activities, and the environment, the plan also recommends continuously gathering data (monitoring) to find out how things are going. Monitoring is the basis for adaptive management – the ability to change the actions, based on new information, to be more effective over time. Research, monitoring, and adaptive management are built into the plan. It is important to be able to see when recovery actions are making progress and continue them, or to find out that something is not working and decide what to change.

Chapter 8 of the recovery plan lists the research, monitoring, and evaluation needed for long-term, effective decision making regarding Lake Ozette sockeye recovery. In the future, the plan can be changed, and recovery actions can be changed, depending on the results of monitoring. To implement the plan, it will be just as important to find funding for monitoring as for any of the proposed recovery actions.

Upon adoption of this Recovery Plan in 2009, NMFS will develop a detailed adaptive management and monitoring plan, together with an implementation plan, in coordination with the Puget Sound Technical Recovery Team, Lake Ozette Steering Committee, the public, and co-managers.

The plan, in Section 8.2, recommends an extensive list of monitoring and research.

Here are some of the highlights:

- Continue to monitor Ozette River streamflow. Investigate effects of reduced streamflow on run timing and sockeye fitness.
- Continue to collect continuous streamflow (stage and discharge) data on all major tributaries to Lake Ozette (Coal, Umbrella, Big, Crooked and Siwash).
- Continue to collect continuous sediment (turbidity and suspended sediment concentration) data on all major tributaries to Lake Ozette (Coal, Umbrella, Big, Crooked, Siwash).
- Continue and expand Ozette River stream temperature monitoring program.
- Continue and expand on all sockeye population status monitoring.
- Develop and implement a program to monitor and evaluate predator-prey interactions in Lake Ozette and the Ozette River.
- Re-evaluate the impacts of Lake Ozette fishing regulations, especially with regard to cutthroat trout.
- Study the effects of large logjams in the Ozette River. Do they form deep pools with colder water where sockeye take refuge?
- Study predation on adult and juvenile sockeye. Which predators consume more sockeye salmon?
- Study the spawning beaches. How many sockeye spawn each year on each beach?

- How many kokanee (lake-resident fish of the species *O. nerka*) spawn with (migrating) sockeye on the beaches? What effect does this have on the population?

IMPLEMENTATION AND TIME AND COST ESTIMATES

The ESA requires a recovery plan to contain "estimates of the time required and the cost to carry out those measures needed to achieve the plan's goal and to achieve intermediate steps toward that goal." Time and cost estimates are usually presented as part of an implementation schedule that lists the recovery actions and spells out who will do what, within what time frame.

Unlike other ESA-listed salmon in Washington State, the Lake Ozette sockeye ESU has not had a state-designated recovery board (such as the Hood Canal Coordinating Council for Hood Canal summer chum salmon) responsible for developing the recovery plan. Therefore, NMFS is working with the Lake Ozette Steering Committee and other entities such as the newly formed North Pacific Coast Lead Entity and the Washington Coast Sustainable Salmon Partnership to make a plan to identify who should do what, the costs and funding sources, the time frame, and opportunities for public involvement. The implementation schedule, like the recovery plan, is not binding, but it is hoped that the organizations potentially involved will choose to participate because habitat protection and restoration will advance their missions and confer various shared benefits.

A detailed implementation schedule will be produced in 2009 upon adoption of the plan.

NMFS and the Lake Ozette Steering Committee have developed an extensive list of 121 projects to address the recovery of Lake Ozette sockeye salmon. Appendix E of this plan provides cost estimates for actions, where costs are available. Costs for actions that are being implemented as part of ongoing, existing programs are considered "baseline" and are not included in Appendix E as costs to recover sockeye. The overall total cost to implement recovery actions for the first 10 years of this plan is estimated to be about $46 million.

NMFS estimates that recovery of the Lake Ozette sockeye ESU, like recovery for most of the ESA-listed salmon, could take 50 to 100 years. Because many uncertainties exist about how sockeye will respond to recovery actions, the costs and recovery actions in this plan focus on the first 10 years of implementation. Actions and costs will be revised over time as part of adaptive management.

Picture S-4: Lake Ozette sockeye salmon in Big River (Courtesy of Makah Fisheries Management)

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ACRONYMS & ABBREVIATIONS

BFD	bankfull depth
BFW	bankfull width
BIA	Bureau of Indian Affairs
BRT	West Coast Biological Review Team
BY	brood year
cfs	cubic feet per second
cfs/mi^2	cubic feet per second per square mile
CMER	Cooperative Monitoring, Evaluation and Research Committee, established by Washington State Forest Practices Board
CMZ	channel migration zone
CW	channel width
DBH	diameter at breast height
WDNR	Washington State Department of Natural Resources
DOE	Washington State Department of Ecology
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESU	evolutionarily significant unit
FL	fork length
FPHCP	Forest Practices Habitat Conservation Plan
GLO	Government Land Office
HCP	Habitat Conservation Plan
HGMP	Hatchery and Genetic Management Plan
HORs	hatchery-origin recruits
JRMP	Joint Resource Management Plan
LB	left bank
LFA	Lake Ozette Sockeye Limiting Factors Analysis (Haggerty et al. 2009)
LWD	large woody debris
MDN	marine-derived nutrients
MFM	Makah Fisheries Management
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NORs	natural-origin recruits
NWIFC	Northwest Indian Fisheries Commission
ONF	Olympic National Forest
ONP	Olympic National Park
PFMC	Pacific Fishery Management Council
PSTRT	Puget Sound Technical Recovery Team
QNR	Quileute Natural Resources
RB	right bank
RBT	right bank tributary
RM	river mile

RMP Resource Management Plan

RY return year

SASSI Salmon and Steelhead Stock Inventory

SEPA State Environmental Policy Act

SL standard length

SS suspended sediments

SSC suspended sediment concentration

SSHIAP Salmon Steelhead Habitat Inventory and Assessment Project

TFW Timber, Fish, and Wildlife

TL total length

TRT Technical Recovery Team

USCG United States Coast Guard

USFS United States Forest Service

USFWS United States Fish and Wildlife Service

USGS United States Geological Survey

VSP viable salmonid population

WAU Watershed Administrative Unit

WDF Washington Department of Fisheries

WDFW Washington State Department of Fish and Wildlife

WFPB Washington State Forest Practice Board

WRIA Water Resource Inventory Area

GLOSSARY

This glossary is provided to help new readers differentiate between a number of terms related to types of plans, goals, and spatial scales relevant to recovery planning for salmon and steelhead in the Lake Ozette Basin.

Adaptive management: The process of adjusting management actions and/or directions as new and better information emerges about the ecosystem.

Anadromous fish: Species that are hatched in freshwater, migrate to and mature in salt water, and return to freshwater to spawn.

Baseline monitoring: In the context of recovery planning, baseline monitoring is done before implementation, in order to establish historical and/or current conditions against which progress (or lack of progress) can be measured.

Broad-sense recovery goals: Goals defined in the recovery planning process, generally by local recovery planning groups, that go beyond the requirements for delisting, to address, for example, other legislative mandates or social, economic, and ecological values.

Compliance monitoring: Monitoring to determine whether a specific performance standard, environmental standard, regulation, or law is met.

Delisting criteria: Criteria incorporated into ESA recovery plans that define both biological viability (biological criteria) and alleviation of the causes for decline (threats criteria, based on the five listing factors in ESA section 4[a][1]), and that, when met, would result in a determination that a species is no longer threatened or endangered and can be proposed for removal from the Federal list of threatened and endangered species.

Diversity: All the genetic and phenotypic (life history, behavioral, and morphological) variation within a population. Variations could include anadromy vs. lifelong residence in freshwater, fecundity, run timing, spawn timing, juvenile behavior, age at smolting, age at maturity, egg size, developmental rate, ocean distribution patterns, male and female spawning behavior, physiology, molecular genetic characteristics, etc.

Effectiveness monitoring: Monitoring set up to test cause-and-effect hypotheses about recovery actions: Did the management actions achieve their direct effect or goal? For example, did fencing a riparian area to exclude livestock result in recovery of riparian vegetation?

ESA recovery plan: A plan to recover a species listed as threatened or endangered under the U.S. Endangered Species Act (ESA). The ESA requires that recovery plans, to the extent practicable, incorporate (1) objective, measurable criteria that, when met, would result in a determination that the species is no longer threatened or endangered; (2) site-specific management actions that may be necessary to achieve the plan's goals; and (3) estimates of the time required and costs to implement recovery actions.

Evolutionarily significant unit (ESU): A group of Pacific salmon or steelhead trout that is (1) substantially reproductively isolated from other conspecific units and (2) represents an important component of the evolutionary legacy of the species. All Pacific salmon belong to the family *Salmonidae* and the genus *Oncorhynchus*, while sockeye belong to the species *Oncorhynchus nerka*. Lake Ozette sockeye are an “evolutionarily significant unit” of *O. nerka*.

Factors for decline: Five general categories of causes for decline of a species, listed in the Endangered Species Act section 4(a)(1)(b): (A) the present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; or (E) other natural or manmade factors affecting its continued existence.

Hyporheic zone: Area of saturated sediment and gravel beneath and beside streams and rivers where groundwater and surface water mix.

Implementation monitoring: Monitoring to determine whether an activity was performed and/or completed as planned.

Independent population: Any collection of one or more local breeding units whose population dynamics or extinction risk over a 100-year time period is not substantially altered by exchanges of individuals with other populations.

Indicator: A variable used to forecast the value or change in the value of another variable.

Large woody debris (LWD): A general term for wood naturally occurring or artificially placed in streams, including branches, stumps, logs that meet minimum diameter criteria that vary by biogeographical region, and logjams. Streams with adequate LWD tend to have more pools and greater habitat complexity, and store greater amounts of sediment.

Legacy effects: Impacts from past activities (usually a past land use action) that continue to affect a stream or watershed in the present day.

Limiting factor: Physical, biological, or chemical features (e.g., inadequate spawning habitat, high water temperature, insufficient prey resources) experienced by the fish at the population, intermediate (e.g., stratum or major population grouping), or ESU levels that result in reductions in viable salmonid population (VSP) parameters (abundance, productivity, spatial structure, and diversity). Key limiting factors are those with the greatest impacts on a population’s ability to reach its desired status.

Morphology: The form and structure of an organism, with special emphasis on external features.

Parr: The stage in anadromous salmonid development between absorption of the yolk sac and transformation to smolt before migration seaward.

Phenotype: The external appearance of an organism resulting from the interaction of its genetic makeup and the environment.

Piscivorous: (Adj.) Fish that prey on other fish for food.

Productivity: For Pacific salmon and steelhead, this is a measure of a population's ability to sustain itself or its ability to rebound from low numbers. The terms "population growth rate" and "population productivity" are interchangeable when referring to measures of population production over an entire life cycle. Can be expressed as the number of recruits (adults) per spawner or the number of smolts per spawner.

Recovery domain: An administrative unit for recovery planning defined by NMFS based on ESU boundaries, ecosystem boundaries, and existing local planning processes. Recovery domains may contain one or more listed ESUs.

Recovery goals: Goals incorporated into a recovery plan, which may include recovery, delisting, reclassification, and/or other goals. Broad-sense goals are a subset of recovery goals.

Recovery strategy: According to NMFS Recovery Planning Guidance (July 2006), a recovery strategy is a statement that identifies the assumptions and logic – the rationale – for the species' recovery program. The term is also used as a broad statement of types of actions or objectives that are further broken down into more specific actions or projects.

Redd: A nest constructed by female salmonids in streambed gravels where eggs are deposited and fertilization occurs.

Riparian area: Area with distinctive soils and vegetation between a stream or other body of water and the adjacent upland. It includes wetlands and those portions of floodplains and valley bottoms that support riparian vegetation.

Salmonid: Fish of the family *Salmonidae*, including salmon, trout, chars, grayling, and whitefish. In general usage, the term usually refers to salmon, trout, and chars.

Smolt: A juvenile salmonid in the seaward migration stage, undergoing physiological and behavioral changes to adapt from freshwater to saltwater.

Spatial structure: Geographic distribution of a population or populations in an ESU.

Stakeholders: Agencies, groups, or private citizens with an interest in recovery planning, or who will be affected by recovery planning and actions.

Technical Recovery Team (TRT): Teams convened by NMFS to develop technical products related to recovery planning. TRTs are complemented by planning forums unique to specific states, tribes, or regions, which use TRT and other technical products to identify recovery actions.

Threats: Human activities or natural events (e.g., road building, floodplain development, fish harvest, hatchery influences, volcanoes) that cause or contribute to limiting factors. Threats may exist in the present or be likely to occur in the future.

Viability criteria: Criteria defined by NMFS-appointed Technical Recovery Teams based on the biological parameters of abundance, productivity, spatial structure, and diversity, which describe a viable salmonid population (VSP) (an independent population with a negligible risk of extinction over a 100-year time frame) and which describe a general framework for how many and which populations within an ESU should be at a particular status for the ESU to have an acceptably low risk of extinction. These criteria are used as technical input into the recovery planning process and provide a technical foundation for development of biological delisting criteria.

Viable salmonid population (VSP): an independent population of Pacific salmon or steelhead trout that has a negligible risk of extinction over a 100-year time frame. Viability at the independent population scale is evaluated based on the parameters of abundance, productivity, spatial structure, and diversity.

VSP parameters: Abundance, productivity, spatial structure, and diversity. These describe characteristics of salmonid populations that are useful in evaluating population viability. See NOAA Tech. Memo. NMFS-NWFSC-42, “Viable salmonid populations and the recovery of evolutionarily significant units,” McElhany et al. June 2000.

1 INTRODUCTION

The Endangered Species Act (ESA) of 1973, Section 4(f), requires NOAA's National Marine Fisheries Service (NMFS) to develop recovery plans for species listed under the Act. The primary purpose of recovery plans is to identify actions needed to restore threatened and endangered species to the point that they are again self-sustaining elements of their ecosystems and no longer need the protections of the ESA.

This is a recovery plan for the protection and restoration of Lake Ozette sockeye salmon (*Oncorhynchus nerka*), which spawn in Lake Ozette or its tributaries, on the Olympic Peninsula at the western edge of Washington State (Figure 1.1). In 1999, Lake Ozette sockeye were listed under the ESA as a species threatened with extinction (64 FR 14528, March 25, 1999). The lake, its perimeter shore, and most of the Ozette River, which forms the outlet of the lake to estuary and Pacific Ocean, are included in the 922,000-acre Olympic National Park (ONP).

This plan complements, recognizes, and works within the authorities of the ONP, Clallam County, the Forest Practices Habitat Conservation Plan (FPHCP), the WDNR Habitat Conservation Plan (HCP), and tribal trust and treaty rights, and does not augment or supersede these or other authorities.

This plan is based on an empirical development of hypotheses about what is limiting the survival of Lake Ozette sockeye. These hypotheses are designed to be tested in the course of time, through monitoring the fish, their environment, and the effects of the actions that may be taken to improve the sockeye's environment and survival chances. The process of designing actions based on best available information, then monitoring the results to find out what works best and changing the actions as appropriate, is called adaptive management. This plan is intended as a tool for adaptive management for Lake Ozette sockeye salmon recovery. It can be used by whatever entities and planning groups become involved in voluntary implementation of the plan.

1.1 CONTEXT OF PLAN DEVELOPMENT

While NMFS is the agency responsible for recovery planning for salmon and steelhead under the ESA, the agency believes it is critically important to base ESA recovery plans for salmon on the many state, regional, tribal, local, and private conservation efforts already underway throughout the region. Local support of recovery plans by those whose activities directly affect the listed species, and whose actions will be most affected by recovery actions, is essential. NMFS therefore supports and participates in locally led collaborative efforts to develop recovery plans, involving local communities, state, tribal, and Federal entities, and other stakeholders.

This plan is the product of a collaborative process initiated by NMFS and involving the participation and contributions of a wide group of private entities, citizens, governments, and sovereigns (Tribes) with the potential to contribute to recovery. In 2005, NMFS and the Lake Ozette Steering Committee, which includes diverse stakeholders, the Makah and Quileute tribes, Federal agencies, including Olympic National Park, local citizens, and the State of Washington, began working together to write a draft recovery plan for Lake Ozette sockeye salmon (Appendix A: List of Steering Committee Meeting Participants). The goal was to produce a plan that meets NMFS' ESA requirements for recovery plans as well as the State of Washington's recovery planning needs (http://www.governor.wa.gov/gsro/default/htm).

1.2 PURPOSE OF PLAN

The ESA requires recovery plans to be developed and implemented for species listed as endangered or threatened under the statute. In the context of the ESA, recovery can be defined as the process of restoring listed species and their ecosystems to the point that they no longer need protections under the Act. A recovery plan serves as a road map for species recovery—it lays out where we need to go and how best to get there. Without a plan to organize, coordinate and prioritize the many possible recovery actions on the part of Federal, state, and tribal agencies, local watershed councils and districts, and private citizens, species recovery efforts may be inefficient or even ineffective. Prompt development and implementation of a recovery plan will help target limited resources effectively.

However, recovery plans are guidance documents, not regulatory, and do not obligate anyone except NMFS itself to take any of the actions proposed. The ESA clearly envisions recovery plans as the central organizing tool for guiding each species' recovery process, but it is up to local planning groups and/or jurisdictions to voluntarily implement the actions the plan recommends or proposes.

In many cases, this plan simply acknowledges and recommends coordinating the pre-existing, ongoing recovery efforts and the relevant laws or regulations that are expected to benefit the species and its environment. Accordingly, some of the ongoing actions that are integrated into the plan are required under other, separate resource management regulatory processes, such as implementation of forest practices habitat conservation plans, Clallam County road maintenance, operation of the sockeye hatcheries, and regulation of fisheries that may affect sockeye. In addition, landowners might implement recommended actions on properties for which they are responsible. Similarly, other regulatory authorities might enact regulations based on the recommendations in this plan, such as Clallam County for land use issues, or Washington State Department of Fish and Wildlife/Department of Ecology and the Tribes for harvest issues and water quality standards, as applicable (e.g., the Makah Water Quality Standards for the Ozette Reservation).

This recovery plan is not an end in itself. After it is adopted, further work will be needed on such important questions as who will do what, the specific costs, the funding sources that may be available, the time frame for various actions, and what opportunities will be provided for public and agency input and involvement. Work will start on an implementation plan for Lake Ozette sockeye recovery in 2009, after the plan is adopted.

1.3 ESA REQUIREMENTS

ESA section 4(a)(1) lists potential factors for decline of a species that are to be addressed in recovery plans and re-examined for re-classification or delisting (see Section 3.3.3 Listing Factor [Threats] Criteria):

A. The present or threatened destruction, modification, or curtailment of [the species'] habitat or range
B. Over-utilization for commercial, recreational, scientific or educational purposes
C. Disease or predation
D. The inadequacy of existing regulatory mechanisms
E. Other natural or human-made factors affecting its continued existence

ESA section 4(f)(1)(B) directs that recovery plans, to the extent practicable, incorporate:

1. a description of such site-specific management actions as may be necessary to achieve the plan's goal for the conservation and survival of the species;
2. objective, measurable criteria which, when met, would result in a determination, in accordance with the provisions of this chapter, that the species be removed from the list; and;
3. estimates of the time required and the cost to carry out those measures needed to achieve the plan's goal and to achieve intermediate steps toward that goal.

In addition, it is important for recovery plans to provide the public and decision makers with a clear understanding of the goals and scientifically supported strategies needed to recover a listed species (NMFS Interim Recovery Planning Guidance, July 2006).

Once a species is deemed recovered and therefore removed from a listed status, section 4(g) of the ESA requires the monitoring of the species for a period of no less than 5 years to ensure that it retains its recovered status.

1.4 RECOVERY GOALS

The primary goal of ESA recovery plans is for the species to reach the point that it no longer needs the protection of the Act – i.e. the species can be delisted because it has been recovered. This point should be defined in terms of the best available biological science. Biological recovery for a salmon species means that it is naturally self-sustaining – enough fish spawn in the wild and return year after year so they are likely to persist in the long run, defined as the next 100 years. The species also has to be resilient enough to survive catastrophic changes in the environment, including natural events such as floods, earthquakes, storms, and changes in ocean productivity.

Recovery plans may also contain “broad-sense goals” that go beyond the requirements for delisting to acknowledge social, cultural, or economic values regarding the listed species. Recovery goals and delisting criteria are discussed in greater detail in Chapter 3.

1.5 ORGANIZATION OF RECOVERY PLANNING

The spawning and rearing range of Lake Ozette sockeye salmon lies within the Puget Sound “recovery domain,” one of four recovery domains that NMFS delineated throughout Washington, Oregon, and Idaho to organize recovery planning for the 17 salmon ESUs currently listed in this region (Figure 1.1).

1.5.1 Technical Recovery Teams

For each domain, NMFS appointed an independent technical recovery team (TRT) that has geographic and species expertise for the listed salmon populations within the domain and can provide a solid scientific foundation for recovery plans. The charge of each TRT is to develop recommendations on biological viability criteria for ESUs and populations, to provide scientific support for local and regional recovery planning efforts, and to scientifically evaluate recovery plans. The TRTs include biologists from NMFS, state, tribal, and local agencies, academic institutions, and private consulting groups.

All TRTs use the same biological principles for developing their ESU and population viability criteria, which are described in a NMFS’ technical memorandum, *Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units* (McElhany et al. 2000). Viable salmonid populations (VSP) are defined in terms of four parameters: abundance, productivity or growth rate, diversity, and spatial structure. Each TRT’s recommendations are based on the VSP framework, as well as on considerations regarding data availability, the unique biological characteristics of the ESUs and habitats in the domain, and the members’ collective experience and expertise. NMFS has encouraged the TRTs to develop regionally specific approaches for evaluating viability and identifying factors limiting recovery, but each TRT is working from a common scientific foundation to ensure that the recovery plans are scientifically sound and based on consistent biological principles.

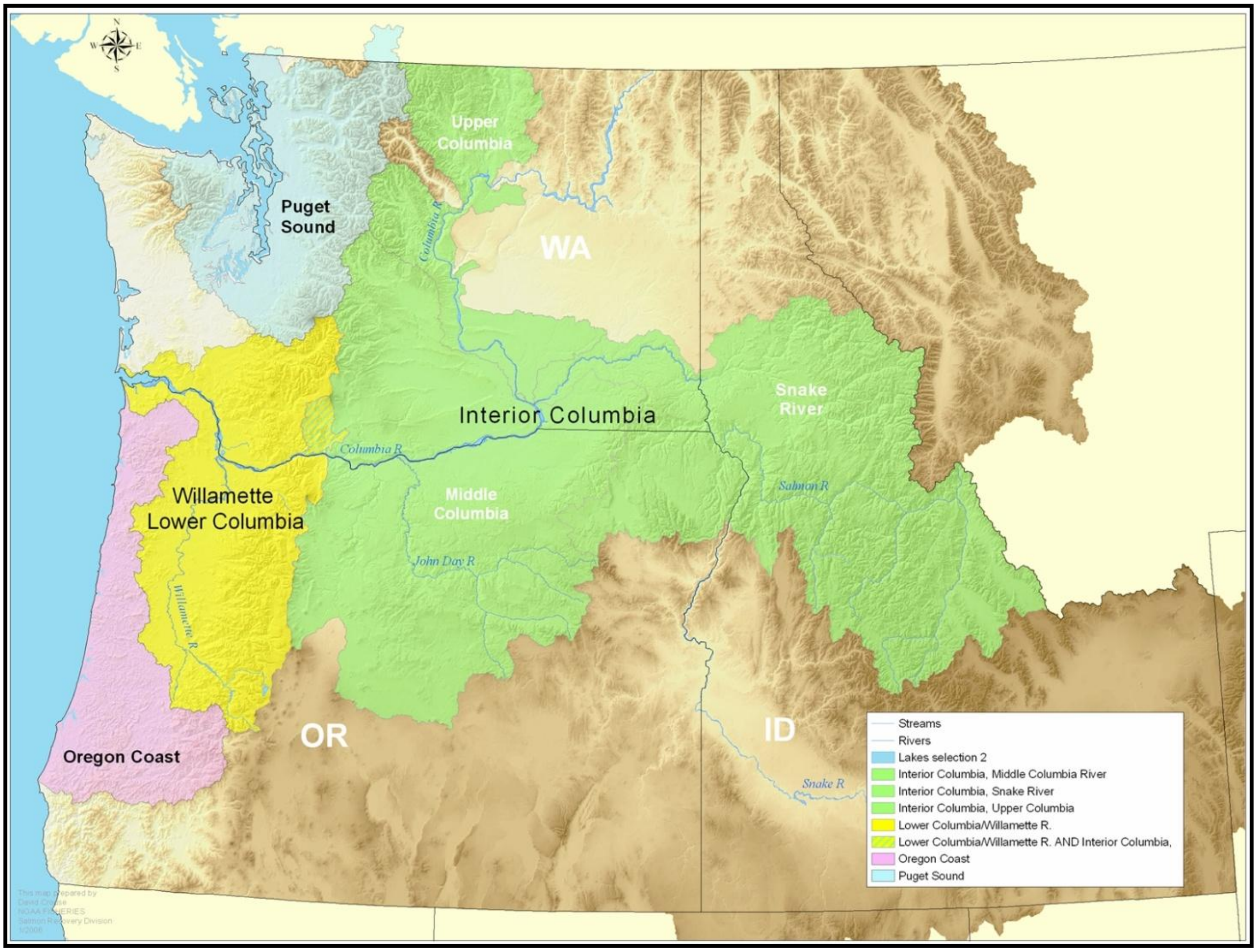

Figure 1.1. NMFS Pacific Northwest Salmon Recovery Domains.

Convened in 2000, the TRT for the Puget Sound domain, which encompasses the listed Lake Ozette sockeye, Hood Canal summer chum, and Puget Sound Chinook salmon ESUs, includes biologists from NMFS and state, tribal, and local resource management entities. A list of members and other information relating to the Puget Sound TRT (PSTRT) is available at http://www.nwfsc.noaa.gov/trt/trt_puget.htm. The PSTRT was tasked with identifying the historical population structure of the Lake Ozette sockeye ESU and recommending viability criteria for the ESU; this work was made available to the Lake Ozette Sockeye Steering Committee in two draft documents (Currens et al. 2006; Rawson et al. 2008).

1.5.2 Lake Ozette Sockeye Steering Committee

In each domain, NMFS has worked with state, tribal, local, and other Federal stakeholders to develop a planning forum appropriate to the domain, building to the extent possible on ongoing, locally led efforts. In this case, the local forum is the Lake Ozette Steering Committee. The role of these planning forums is to use technical products from the TRT and other sources to agree on recommendations to make to NMFS regarding recovery goals; to assess limiting factors; and then to develop locally appropriate and locally supported recovery actions needed to achieve the recovery goals. While these forums also are working from a consistent set of assumptions regarding needed recovery plan elements, the process by which they develop those elements, and the form they take, may differ among domains. For the Lake Ozette sockeye ESU, preliminary limiting factors analyses, watershed assessments, NMFS status reviews, and draft TRT products provided building blocks for the recovery plan.

In order to facilitate communication and coordinate development of a draft recovery plan with diverse interest groups, NMFS worked with an existing, locally based citizen group called the Lake Ozette Steering Committee. The Steering Committee has met periodically since 1981 to discuss natural resource issues related to sockeye salmon. Early participants included the Makah Tribe, ONP, U.S. Fish and Wildlife Service (USFWS), Washington State Department of Fisheries (WDF), University of Washington, and Crown-Zellerbach Corporation. Subsequent meetings resulted in several research projects to gather information on the abundance, distribution, and habitat conditions of the sockeye, but research lagged for lack of funding.

Largely as a result of the 1999 ESA listing, multi-agency efforts to coordinate research and recovery planning resumed, and the Lake Ozette Steering Committee was reorganized and expanded to include NMFS as well as local landowners and other interests. In 1999 and 2000, the Steering Committee formed a hatchery working group to coordinate issues relating to development of a Hatchery and Genetic Management Plan (HGMP)/Joint Resource Management Plan (JRMP) for Lake Ozette sockeye salmon. A habitat working group was also formed to develop a ranked list of potential limiting factors, as well as a ranked list of research and monitoring priorities. Beginning in October 2005, NMFS coordinated monthly Steering Committee meetings in Sekiu and Port Angeles, Washington and expanded meeting participation to ensure input from a wide range of diverse stakeholders.

The Lake Ozette Steering Committee is made up of representatives from the Makah and Quileute Tribes, Olympic National Park, Clallam County, local land owners, Washington Governor’s Salmon Recovery Office, Washington Department of Fish and Wildlife (WDFW), Washington Department of Natural Resources (DNR), NMFS, U.S. Environmental Protection Agency (EPA), North Pacific Coast Lead Entity (NPCLE), North Pacific Coast Lead Entity (NPCLE), private timber companies, and local citizens. Although it is not a formally sanctioned State of Washington recovery board, the Committee’s diverse members have met consistently during plan development. A facilitator was hired by NMFS to manage the Steering Committee meetings and communicate with the Steering Committee between meetings. NMFS sought input and review from Steering Committee members as the recovery plan was developed.

Monthly Steering Committee meetings enabled NMFS and PSTRT members to share draft recovery plan products and seek Steering Committee review and comment as the draft plan was developed. The preliminary draft of the Lake Ozette Sockeye Limiting

Factors Analysis (Haggerty et al. 2007) and NMFS' Status Report for Completing the Sockeye Recovery Plan were posted on the North Olympic Peninsula Lead Entity web page at http://noplegroup.org/NOPLE/pages/watersheds/OzetteLakeWatershedPage.htm.

In addition to monthly Steering Committee meetings, NMFS periodically briefed staff from the following key stakeholder groups during development of the draft recovery plan: Olympic National Park, Clallam County Commissioners and Planning Department, Makah Tribe, Quileute Tribe, Olympic Coast National Marine Sanctuary, Lake Ozette watershed landowners, NOPLE, and NPCLE.

In 2005, a recovery organization for Lake Ozette sockeye had not been established because the Washington Governor's Salmon Recovery Office had not received a request for one by a local salmon recovery lead entity. The newly formed Washington Coast Sustainable Salmon Partnership is now a regional salmon recovery organization that can support recovery planning and implementation in the Washington Coast Region, including Lake Ozette.

1.6 TRIBAL TRUST AND TREATY RESPONSIBILITIES

NMFS has treaty and tribal trust obligations that go beyond the ESA requirements for many listed species. Northwest Indian tribes have legally enforceable treaty rights, including reserve of a share of salmon harvest. The tribes are also co-managers with state and Federal agencies in the conduct of salmon stock assessment activities and in regulating harvest and hatchery actions affecting the salmon resource.

The sockeye salmon population recovery goals included in this plan are accentuated by the need to protect treaty-guaranteed tribal fishing rights. The Treaty of Neah Bay (1855) and the Treaty of Olympia (1856) identify lands ceded to the federal government by the Makah and Quileute Tribes, respectively. The Tribes share a common boundary of their ceded lands, described in both treaties. The treaties reserved to the tribes the right of fishing "at all usual and accustomed grounds and stations." This right was reaffirmed by the Boldt Decision in 1974 (*U.S. v. Washington*, 384 F. Supp. 312, 362).

Under the Federal trust responsibility, Federal agencies, including NMFS, have a legal obligation to support the Tribes in efforts to preserve and rebuild Treaty salmon fisheries in their usual and accustomed fishing areas. The concept of "trust responsibility" is derived from the special relationship between the Federal Government and Indians, first delineated by Supreme Court Chief Justice John Marshall in *Cherokee Nation v. Georgia*, 30 U.S. 1 (5 Pet.) (1831). Later, in *Seminole Nation v. United States*, 316 U.S. 286 (1942), the Court noted that the United States "has charged itself with moral obligations of the highest responsibility and trust" toward Indian Tribes. The scope of the Federal trust relationship is broad and incumbent upon all Federal agencies. The U.S. Government has an obligation to protect tribal land, assets, and resources, as well as a duty to carry out the mandates of Federal law with respect to American Indian and

Alaska Native Tribes. This unique relationship provides the Constitutional basis for legislation, Treaties, and Executive Orders that recognize unique rights or privileges to Native Americans to protect their property and their way of life.

In furtherance of this trust responsibility, and to demonstrate respect for sovereign tribal governments, the principles described above were incorporated into a Secretarial Order dated June 5, 1997, and signed by the Secretaries of Commerce and the Interior. This Order, "American Indian Tribal Rights, Federal-Tribal Trust Responsibilities, and the Endangered Species Act," directs both Departments to carry out their responsibilities under the ESA in a manner that harmonizes the Federal trust responsibility with tribes, tribal sovereignty, and statutory missions of the Departments, so as to avoid or minimize the potential for conflict and confrontation. The Order directed the Departments to work directly with Indian tribes on a government-to-government basis to promote healthy ecosystems, recognized the unique legal status of Indian lands, and affirmed tribal management authorities and Federal consultation responsibilities in carrying out the conservation measures of the ESA.

The NMFS trust responsibility for tribal treaty rights is further articulated in a 1998 letter from Terry Garcia (NOAA) to Ted Strong (CRITFC): "It is our policy that the recovery of salmonid populations must achieve two goals: (1) the recovery and delisting of salmonids listed under the provisions of the ESA; (2) the restoration of salmonid populations, over time, to a level to provide a sustainable harvest sufficient to allow for the meaningful exercise of tribal fishing rights. We see no conflict between the statutory goals of the ESA and the federal trust responsibilities to Indian tribes. Rather, the two federal responsibilities complement one another. Unfortunately, in light of the long-term decline of salmonid populations, we cannot achieve either goal within a short time frame. It is important that we achieve a steady upward trend toward ESA delisting in the near term, while making river and land improvements for the long-term" (NOAA 1998).

Achieving the basic purpose of the ESA (to bring the species to the point that it no longer needs the protection of the Act) may not by itself fully meet these trust responsibilities and treaty obligations, although it will lead to major improvements in the current situation. Ensuring that salmon populations are restored to sufficient abundance, productivity, diversity, and spatial distribution levels that can allow sustainable harvest can be an important element in fulfilling Federal trust and treaty rights responsibilities as well as garnering public support for recovery plans.

It is appropriate for recovery plans to take these considerations into account and plan for a recovery strategy that includes harvest. In some cases, increases in the naturally spawning populations may be sufficient to support harvest. In others, the recovery strategy may include appropriate use of hatcheries to support a portion of the harvest. So long as the overall plan is likely to achieve the recovery of the listed ESU, it will be acceptable as a recovery plan.

As noted in the above statement by NMFS, ESA and tribal trust responsibilities complement one another. Both depend on a steady upward trend toward ESA recovery and delisting in the near term, while making aquatic habitat, harvest, and land management improvements for the long-term. Furthermore, ESA delisting cannot occur until both biological objectives and the listing factors are considered and NMFS determines, based on an evaluation of the listing factors, that the ESU is no longer likely to require the protection of the Act. Therefore, NMFS will make no delisting decision until it is clear that the threats to the ESU have been addressed and that the status and trends of both the fish and their habitats will be healthy and sustainable in the long-term.

1.7 OLYMPIC NATIONAL PARK

Olympic National Park protects 922,651 acres of three distinctly different ecosystems — rugged glacier-capped mountains, more than 70 miles of wild Pacific coast, and old-growth and temperate rain forest. Olympic National Park’s 3,500 miles of rivers and streams give home to 29 species of native freshwater fish, including numerous species of Pacific salmon and steelhead. Five species of fish have special status within Olympic National Park: Lake Ozette sockeye salmon, Puget Sound Chinook salmon, Puget Sound steelhead, Hood Canal summer chum salmon, and the Coastal-Puget Sound population of bull trout that is part of the Olympic Peninsula Management Unit. Areas designated as ESA critical habitat and essential habitat for Pacific salmonids are also within or near the park.

Lake Ozette sockeye salmon are the only ESA-listed species administered by NMFS that have a significant portion of their critical habitat located within or immediately adjacent to a national park. Consequently, any recovery actions implemented need to be consistent not only with the requirements of the Endangered Species Act, but also with the National Park Service (NPS) laws, mandates, and policies, and the enabling legislation of Olympic National Park.

Specific NPS laws and mandates include the 1916 Organic Act that created the National Park Service; the General Authorities Act of 1970; the act of March 27, 1978, relating to the management of the national park system; and the National Parks Omnibus Management Act (1998).

The NPS Organic Act (16 USC § 1) provides the fundamental management direction for all units of the national park system:

> [P]romote and regulate the use of the Federal areas known as national parks, monuments, and reservations…by such means and measures conform to the fundamental purpose of said parks, monuments and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.

The National Park System General Authorities Act (16 USC § 1a-1 et seq.) affirms that while all national park system units remain “distinct in character,” they are “united through their interrelated purposes and resources into one national park system as cumulative expressions of a single national heritage." The act makes it clear that the NPS Organic Act and other protective mandates apply equally to all units of the system. Further, amendments state that NPS management of park units should not "derogat[e]…the purposes and values for which these various areas have been established."

The mission of the National Park Service at Olympic National Park is rooted in and grows from the park's legislated mandate found in the Act of Congress establishing the park on June 29, 1938 (which abolished the Mount Olympus National Monument established on March 3, 1909 and provided authority to proclaim certain enlargements) and in subsequent Congressional legislation.

The act establishing Olympic National Park, approved on June 29, 1938 (H.R. 10024) and the accompanying House Report (Report No. 2247) more specifically defined the purposes of the park, stating:

> The purpose of the proposed national park is to preserve for the benefit, use and enjoyment of the people, the finest sample of primeval forests of Sitka spruce, western hemlock, Douglas fir, and western red cedar in the entire United States; to provide suitable winter range and permanent protection for the herds of native Roosevelt elk and other wildlife indigenous to the area; to conserve and render available to the people, for recreational use, this outstanding mountainous country, containing numerous glaciers and perpetual snow fields, and a portion of the surrounding verdant forests together with a narrow strip along the beautiful Washington coast.

The park boundary within the Ozette watershed was adjusted a number of times: 1) A portion of the Pacific coast area (including the western shore of Lake Ozette) and the Queets corridor were added in 1953 (Truman 1953, Presidential Proclamation); 2) Additions at Lake Ozette, Shi Shi Beach, Port Angeles, Heart O' the Hills Parkway and the Queets were authorized in 1976 (PL 94-578); and 3) All submerged lands and waters of Lake Ozette, Washington, and the Ozette River, Washington were added in 1986 (PL 99-635).

An additional purpose of the park is to preserve for future use and enjoyment the character and values of the Olympic Wilderness. On November 16, 1988, Congress enacted the Washington Park Wilderness Act (P.L. 100-668) which designated 876,669 acres of Olympic National Park as wilderness and 378 acres as potential wilderness. These lands, known as the Olympic Wilderness, are managed in accordance with applicable Federal laws, regulations, policies, and plans including the Wilderness Act of 1964, NPS Wilderness Preservation and Management policies (Director's Order-41, NPS 1999), the Olympic National Park Backcountry Management Plan (amended in 1992), and Olympic National Park's General Management Plan (in preparation).

When the Washington Park Wilderness Act was passed, Congress also recognized a potential conflict between the establishment of wilderness areas and the use of adjacent lands. Specifically, "in response to concerns raised as to the impacts on ecosystems and natural resources within national parks from land use activities outside of the national park boundaries," the Senate Committee on Energy and Natural Resources directed the National Park Service to conduct a study of the watershed of Lake Ozette, "with particular focus on the immediate scenic backdrop of the Lake." The committee further directed that the study should examine and consider the various alternatives to protect this area, including acquisition, land exchanges, or acquisition of interests in the land. Olympic National Park's General Management Plan in part addresses this issue.

Additional Federal legislation that affects the management of national park areas includes the National Environmental Policy Act, the Endangered Species Act, Clean Water and Clean Air Acts, the National Historic Preservation Act, and other legislation and regulations ensuring the protection of resources and visitor use. In addition, *Management Policies 2006,* the basic service-wide policy document of the National Park Service, also affects park management.

Within Olympic National Park, the NPS is responsible for adhering to the above Federal laws, policies, and guidance documents to prevent impairment of park resources and values, to ensure conservation and protection of park resources, to avoid unacceptable impacts, and to allow the appropriate use of the parks. The NPS decision maker, generally either the park superintendent or regional director, is responsible for assuring that all actions that are proposed within the park avoid impairment and unacceptable impacts.

Olympic National Park was established by law with exclusive Federal jurisdiction. In RCW 37.08.210, Washington State ceded jurisdiction in the park to the Federal government, with a few specific exceptions, such as the right to serve warrants within the park for crimes committed outside the park. Exclusive jurisdiction implies that only Federal laws apply on the park's lands, and therefore the park implements specific regulations for the use of lands and resources in the park. These regulations are independent of regulations governing land and resource use on adjacent State jurisdiction lands. Park rangers enforce Federal laws and regulations within the park. The exclusive jurisdiction of Olympic National Park, however, does not affect treaty reserved authorities of the tribes. The Tribes exercise their inherent sovereignty to regulate activities of their members throughout the territories ceded to the United States, as well as in other areas where they have reserved treaty rights to natural resources.

The Federal decision making process is tied to the National Environmental Policy Act of 1969 (NEPA), Council of Environmental Quality and Department of the Interior NEPA regulations, and subsequent NPS policies contained in NPS Director's Order-12. Any action, project, activity, or program that is funded in whole or in part by a Federal agency, is under the direct or indirect jurisdiction of a Federal agency that could affect park resources, or is proposed on park lands requires an analysis under NEPA. When an outside entity proposes an action that would occur in the park or could impact park resources, generally that entity works with the park to complete the environmental analysis.

Prior to any action directed at the recovery of Ozette sockeye within Olympic National Park, an environmental analysis must be completed to: 1) Ensure that recovery actions proposed within the park are consistent with applicable laws and regulations; 2) Ensure that all other recovery actions are consistent with the NPS *Management Policies 2006* and other relevant policy directives and plans (e.g. ONP General Management Plan); 3) Ensure that consultation with area tribes is completed; 4) Ensure public involvement in the decision making process; and, 5) Ensure the appropriate permits are obtained if the proposed actions are approved by the NPS decision maker. This analysis must adhere to NPS guidelines as detailed in NPS Director's Order-12.

2 BACKGROUND AND CURRENT STATUS

This section includes overviews of the Lake Ozette watershed, the biology of sockeye salmon and the Lake Ozette sockeye ESU, as well as summaries of past and current land use in the watershed, current status of the sockeye population, and current hatchery management as it is relevant to sockeye recovery.

2.1 WATERSHED DESCRIPTION

Lake Ozette watershed is located along the northwest tip of the Olympic Peninsula in Washington State (Figure 2.1). Lake Ozette is situated on the coastal plain between the Pacific Ocean and the Olympic Mountains. The terrain of the Ozette watershed is slightly rolling to steep, with a gradual increase in elevation from zero feet at sea level (at the Ozette River mouth), to 34 feet at the lake's outlet, to just under 2,000 feet at the watershed's highest point in the upper Big River watershed. Most of the watershed ranges from 200 to 800 feet elevation. The geology of the Ozette watershed is an interesting mix of flat and gently sloping glacial and glacio-fluvial deposits situated between resistant knobs and small hills composed of Tertiary marine sedimentary rock units (mechanically weak silt- and sand-stones). Some glacial landforms extend for several square miles, while others occupy small valleys. Other portions of the watershed (e.g., upper Big River) are steep and rugged and are underlain by Eocene-age volcanic flows and breccias. The climate of the northwest Olympic Peninsula can be characterized as temperate coastal-marine, with mild winters and cool summers. Annual precipitation at the Quillayute State Airport from 1967 to 2005 averaged 102.6 inches. The bulk of this precipitation fell as rain between October and April.

Lake Ozette is approximately 8 miles (12.9 km) long from north to south and 2 miles (3.2 km) wide. The lake is irregularly shaped and contains several bays (North End, Deer, Umbrella, Swan, Ericson's, Boat, Allen's, and South End bays), distinct points (Deer, Eagle, Shafer's, Rocky, Cemetery, and Birkestol points) and three islands (Garden, Tivoli, and Baby Island). With a surface area of 11.8 mi^2 (30.6 km^2; 7,550 acres; 3,056 ha), Lake Ozette is the third largest natural lake in Washington State. The lake has a drainage basin area of 77 mi^2 (199.4 km^2), an average depth of approximately 130 feet (40 m), and a maximum depth of 320 feet (98 m) (Dlugokenski et al. 1981).

The average water surface elevation of the lake is 34 feet above mean sea level (msl) (10.4 m; National Geodetic Vertical Datum of 1929 [NGVD 1929]). In recent years (1982-2005), extreme low and high water surface elevations of the lake have ranged from 30.8 feet (9.4m) to 41.5 feet (12.6 m) above msl. Shoreline vegetation, substrate, and topography vary widely around the lake, with additional variations according to time of year and lake level.

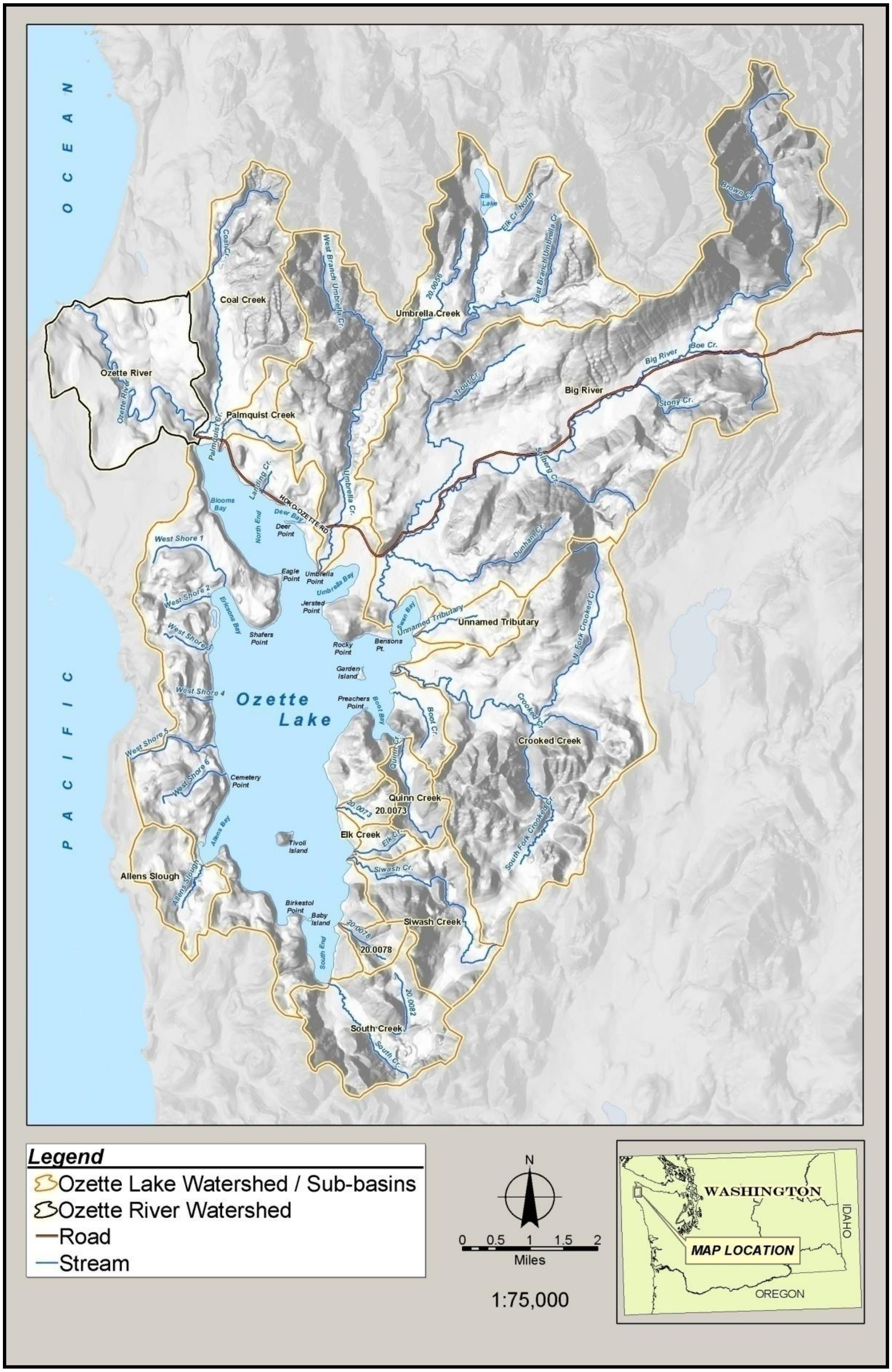

Figure 2.1. Lake Ozette watershed overview map.

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The Ozette River drains the lake from the north end; there are no other outlet streams draining the lake. The river travels approximately 5.3 miles (8.5 km) along a sinuous course to the Pacific Ocean. The total drainage area of the Ozette watershed at the confluence with the Pacific Ocean is 88.4 mi^2 (229 km^2). Coal Creek, which enters just downstream from the lake's outlet, is the largest tributary to the Ozette River. Several significant tributaries drain into Lake Ozette: Big River, Umbrella Creek, Crooked Creek, Siwash Creek, and South Creek (Table 2.1). Several smaller streams also feed the lake: Palmquist, Quinn, and Elk Creeks, as well as several other unnamed streams.

Wind and hydro-geomorphic events (e.g., floods and landslides) are considered the primary natural disturbance agents in coastal temperate rain forests, including the Ozette watershed (Alaback 1996). Strong winter storms are common on the Pacific coast, frequently causing windthrow and toppling shallow-rooted trees (ibid.). In addition, large magnitude (~magnitude 9) great earthquakes have been shown to recur at a 400-600 year frequency along this region of the Pacific Coast (Atwater and Hemphill-Haley 1997).

Table 2.1. Lake Ozette and tributary drainage basin areas.

Watershed/Subbasin	**Watershed/Subbasin Description**	**Basin Area (sq. mi.)**	**Basin Area (sq. km.)**
Big River	Entire Big River Watershed	22.8	59
Crooked Creek	Entire Crooked Creek Watershed	12.2	31.6
Umbrella Creek	Entire Umbrella Creek Watershed	10.6	27.6
South Creek	Entire South Creek Watershed	3.3	8.4
Siwash Creek	Entire Siwash Creek Watershed	2.9	7.4
Palmquist Creek	Entire Palmquist Creek Watershed	1.1	2.8
Lake Ozette Tributary	Unnamed Trib. between Crooked and Dunham Creeks	0.9	2.3
Quinn Creek	Entire Quinn Creek Watershed	0.9	2.3
Lake Ozette Tributary	Unnamed Tributary between Crooked and Quinn	0.7	1.7
Lake Ozette Tributary	Unnamed Tributary between Siwash and South Creeks	0.5	1.2
Unnamed Tributary 20.0073	Entire 20.0073 Watershed	0.4	0.9
Elk Creek	Entire Elk Creek Watershed	0.3	0.8
Lake Ozette Watershed	**Entire Lake Ozette Watershed**	**77**	**199**
Coal Creek	Entire Coal Creek Watershed	4.6	11.8
Ozette River at Pacific Ocean	**Entire Lake Ozette and Ozette River Watershed**	**88.4**	**229**

The Lake Ozette watershed is predominantly forested. Lake Ozette and Elk Lake are the largest unforested areas within the watershed. Other unforested areas also occur where bogs and open-water wetlands naturally exist. The forest contained within the Ozette watershed can be characterized as a coastal temperate rainforest ecosystem. Sitka spruce (*Picea sitchensis*) and western hemlock (*Tsuga heterophylla*), are the dominant conifer species, followed by western red cedar (*Calocedrus decurrens*) pacific silver fir (*Abies amabilis*), Douglas fir (*Psuedotsuga mensiezii*), and western yew (*Taxus brevifolia*). Red alder (*Alnus rubra*) is the most prevalent deciduous tree, and is common along streams and disturbed sites. Vine maple (*Acer circinatum*) and bigleaf maple (*Acer macrophylla*) are also common in riparian areas, wetlands, and meadows. Schoonmaker et al. (1997) define this section of the Pacific coastal temperate rain forest as seasonal temperate rain forest, as compared to warm temperate rainforest to the south and perhumid temperate rain forest and sub-polar temperate rain forest zones to the north. It has been classified as seasonal because less than 10 percent of the total rainfall occurs during summer months.

Understory vegetation in mature temperate rainforests is complex. In the Ozette watershed there are approximately 363 vascular plant species (Buckingham et al. 1995). Fungi and lichen are ubiquitous in areas of primary forest. They compose a significant fraction of the forest biomass and play an important role in nutrient cycling within the forest ecosystem. The lake and watershed contain a diverse assemblage of terrestrial and aquatic mammals, birds, and amphibians.

The Lake Ozette fish community includes a rich array of approximately 26 species of fishes presumed to be present. There are seven “species” of salmonids present in the lake system including: sockeye salmon (*Oncorhynchus nerka*), kokanee salmon (*Oncorhynchus nerka kennerlyi*), coho salmon (*Oncorhynchus kisutch*), chum salmon (*Oncorhynchus keta*), Chinook salmon (*Oncorhynchus tshawytscha*), rainbow/steelhead trout (*Oncorhynchus mykiss*), and cutthroat trout (*Oncorhynchus clarki*). Approximately 18 non-salmonid fish species are also thought or known to be present within the Lake Ozette watershed, including the following: speckled dace (*Rhinichthys osculus*), coastrange sculpin (*Cottus aleuticus*), prickly sculpin (*Cottus asper*), reticulate sculpin (*Cottus perplexus*), riffle sculpin (*Cottus gulosus*), torrent sculpin (*Cottus rhotheus*), brook lamprey (*Lampetra richardsoni*), pacific lamprey (*Lampetra tridentata*), three-spine stickleback (*Gasterosteus aculeatus*), Olympic mudminnow (*Novumbra hubbsi*), peamouth (*Mylocheilus caurinus*), Tui chub (*Gila bicolor*), northern pikeminnow (*Ptychocheilus oregonensis*), redside shiner (*Richardsonius balteatus*), American shad (*Alosa sapidissma*), yellow perch (*Perca flavenscens*), largemouth bass (*Micropterus salmoides*), brown bullhead (*Ictalurus nebulosus*), and yellow bullhead (*Ictalurus natalis*) (MFM 2000; Gustafson 1997; Mongillo and Hallock 1997; Jacobs et al. 1996; MFM unpublished fish captures). Several other species of fish use the estuarine portion of the lower Ozette River and likely include sturgeon (*Acipenser spp.*), marine cottids, marine flatfish, and surf smelt (*Hypomesus pretiosus*).

2.2 SOCKEYE SALMON (General Overview)

Most of the time salmon return to spawn in the streams or lakes where they were born. However, they occasionally “stray” and choose to mate where conditions are right, perhaps in an adjacent stream or lake. The result is that salmon populations that are geographically widespread may have some amount of genetic similarity. They are linked because of straying, and differentiated because of long-term adaptation to different environments.

All Pacific salmon belong to the family *Salmonidae* and the genus *Oncorhynchus*, while sockeye belong to the species *Oncorhynchus nerka*. Lake Ozette sockeye are an "evolutionarily significant unit" (ESU) of *O. nerka*. ESUs are defined on the basis of geographic range as well as genetic, behavioral, and other traits. Other salmonid ESUs are, for example, Puget Sound Chinook salmon, Hood Canal chum salmon, and Upper Columbia steelhead.

Sockeye salmon are the second most abundant of the seven Pacific salmon species (Quinn 2005). They display more life history diversity than all other members of the *Oncorhynchus* genus (Burgner 1991). Sockeye salmon are generally anadromous, but distinct populations of non-anadromous *O. nerka* also exist; these fish are commonly referred to as kokanee (*O. nerka kennerlyi*) or silver trout (Wydoski and Whitney 2003).

The vast majority of sockeye populations spawn in or near lakes. Spawning can take place in lake tributaries, lake outlets, rivers between lakes, and on lake shorelines or beaches where suitable upwelling or intra-gravel flow is present. Spawn timing is often determined by water temperature. In spawning habitats with cooler water temperatures, sockeye typically spawn earlier (August) than in warmer habitats (November) (Burgner 1991). Sockeye fry spawned in lake tributaries typically exhibit a behavior of rapid downstream migration to the nursery lake after emergence, whereas lake/beach spawned sockeye rapidly migrate to open limnetic waters after emergence. Lake-rearing juveniles typically spend 1 to 3 years in their nursery lake before emigrating to the marine environment (Gustafson et al. 1997). Other life history variants include sea-type and river-type sockeye. Sea-type (also referred to as ocean-type) populations typically use large rivers and side channels or spring-fed tributary systems for spawning and emigrate to sea soon after emergence. River-type sockeye rear in rivers for one year before emigrating to sea. Quinn (2005) describes the differences between sea-type and river-type sockeye as a continuum of rearing patterns rather than as two discrete types.

Upon smoltification, sockeye emigrate to the ocean. Peak emigration to the ocean occurs in mid-April to early May in southern sockeye populations (<52ºN latitude) and as late as early July in northern populations (62ºN latitude) (Burgner 1991). Typically, river-type sockeye populations make little use of estuaries during their emigration to the marine environment (Quinn 2005). Estuarine habitats may be more extensively used by sea-type sockeye (Quinn 2005). Upon entering marine waters, sockeye may reside in the nearshore or coastal environment for several months but are typically distributed offshore by fall (Burgner 1991).

In the marine environment, Asiatic sockeye are restricted to the zone north of 42ºN latitude and North American sockeye stocks to the zone north of 46ºN latitude. Within these zones, sockeye salmon have a wide distribution. In North America, their range is south to the Sacramento River (California; historical) and as far north as Kotzebue Sound (Alaska). However, sockeye in commercially important numbers occur only from the Columbia River to the Kuskokwim River in the Bering Sea (Foerster 1968; Burgner 1991; Quinn 2005). The Fraser River and Bristol Bay watersheds are the two dominant sockeye producing systems in North America (Gustafson et al. 1997). Other significant sockeye producing systems include the Chignik, Karluk, Copper, Skeena, Nass, and Somass rivers. Within the Gulf of Alaska, southern North American stocks (B.C/Washington) tend to be farther south than Alaskan stocks (Burgner 1991). In the Western Pacific, sockeye can be found from the Kuril Islands (Japan) to Cape Chaplina (Russia). More than 90 percent of all Asiatic sockeye are produced on the Kamchatka Peninsula, in the Ozernaya and Kamchatka River systems (Burgner 1991; Gustafson et al. 1997).

The extant sockeye populations of Washington State represent the current southern extent of the species range. The NMFS West Coast Sockeye Biological Review Team (BRT) examined genetic, life history, biogeographic, geologic, and environmental information to define salmon ESUs in Washington State. They identified six sockeye salmon ESUs: Okanogan, Wenatchee, Quinault, Ozette, Baker, and Pleasant. The BRT identified Big Bear Creek, a tributary to Lake Sammamish, as a provisional ESU, but uncertainty regarding the historical presence of sockeye salmon in the Lake Washington/Sammamish drainage hindered definitive ESU identification. Sockeye spawn in several small aggregations in Washington rivers in the absence of lake-rearing habitat, but information on these riverine-spawning aggregations was insufficient to determine ESU status. Lake Ozette sockeye are distinguished from other Washington sockeye ESUs based upon unique genetic characteristics, early river entry, the relatively large adult body size, and large average smolt size relative to other coastal Washington sockeye populations (Gustafson et al. 1997).

2.3 LAKE OZETTE SOCKEYE SALMON ESU

Historically, the Ozette watershed had thriving populations of several salmon species, including sockeye salmon. Lake Ozette sockeye were an important contributor to subsistence tribal fisheries, as well as for early settlers in the watershed. Although the Makah Tribe's annual harvest of Lake Ozette sockeye reached an estimated high of more than 17,000 in 1949 (WDF 1955; Figure 2.2), the harvest declined sharply in the 1960s because of declining numbers of fish. The Makah Tribe's commercial sockeye fishery ceased in 1974 and all ceremonial and subsistence fishing ended in 1982, in an effort to protect and increase the abundance of spawning sockeye (Jacobs et al. 1996). Despite the cessation of sockeye harvest, sockeye abundance has not rebounded.

In 1997, the BRT concluded that if conditions observed in the early and mid-1990s continued into the future, Lake Ozette sockeye were likely to become in danger of extinction in the foreseeable future (Gustafson et al. 1997). In 1999, Lake Ozette sockeye salmon were listed as a threatened species under the ESA (64 FR 14528, March 25, 1999). The listing was primarily attributed to concerns over abundance and effects of small population genetic and demographic variability.

The Lake Ozette sockeye salmon ESU is made up of only one population (Currens et al. 2006), which currently contains five distinct spawning aggregations that are also described in this plan as subpopulations. The subpopulations can be grouped according to whether they spawn in tributaries (Umbrella Creek, Big River, and Crooked Creek) or near lake beaches (Olsen's Beach and Allen's Beach). Current and historical known beach spawning sites are depicted in Figure 2.3. Certain limiting factors, habitat conditions, and life histories are common to all the subpopulations, while others vary between subpopulations but can be grouped based on spawning environment (i.e., tributary vs. beach) (Figure 2.4).

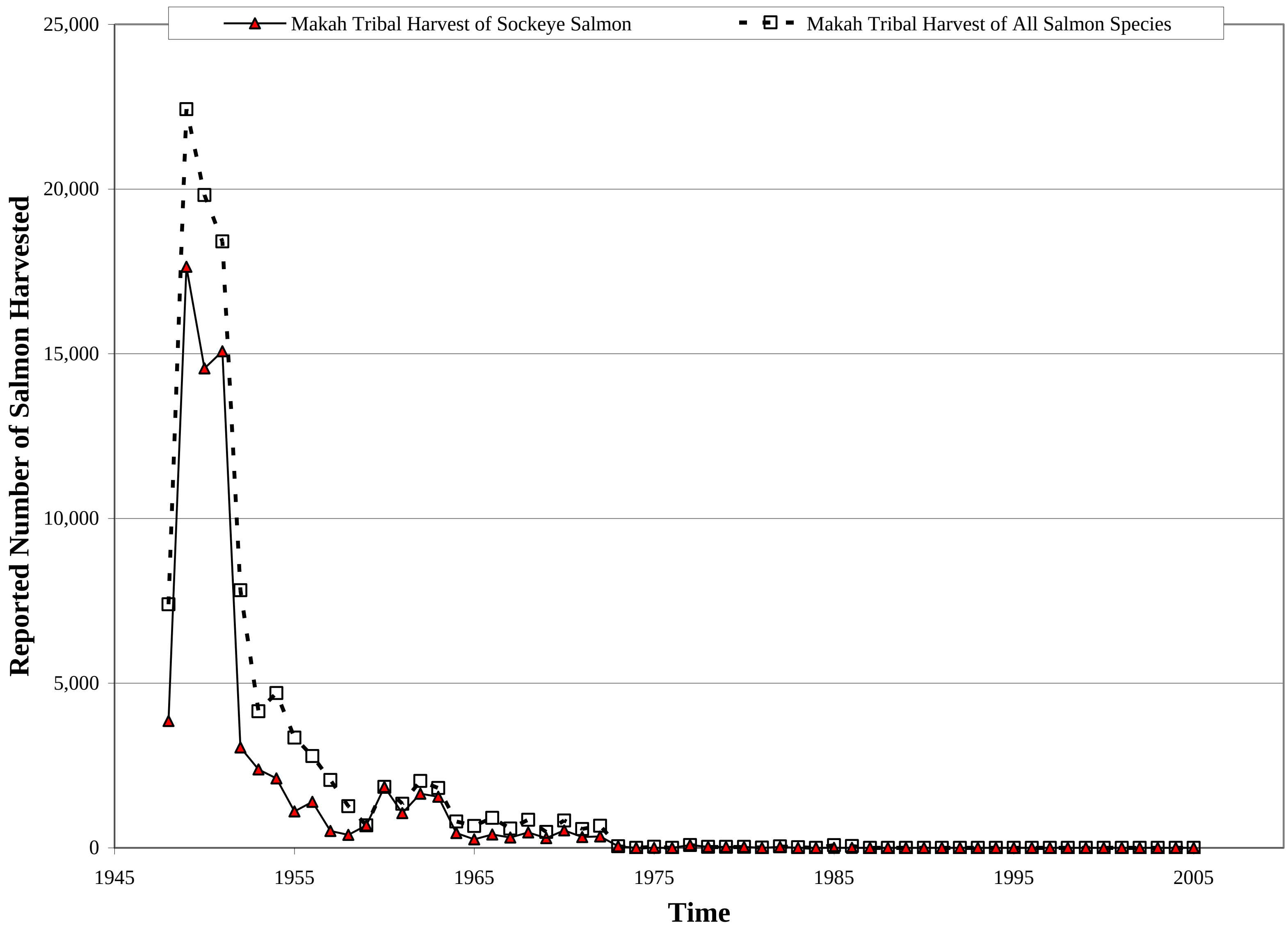

Figure 2.2. Reported Makah Tribal harvest of Lake Ozette sockeye and other Lake Ozette salmon species from 1948 to 2005. Note: No harvest record data exist for the period prior to 1948. (source: WDF 1955; Jacobs et al. 1996; Haggerty et al. 2009)

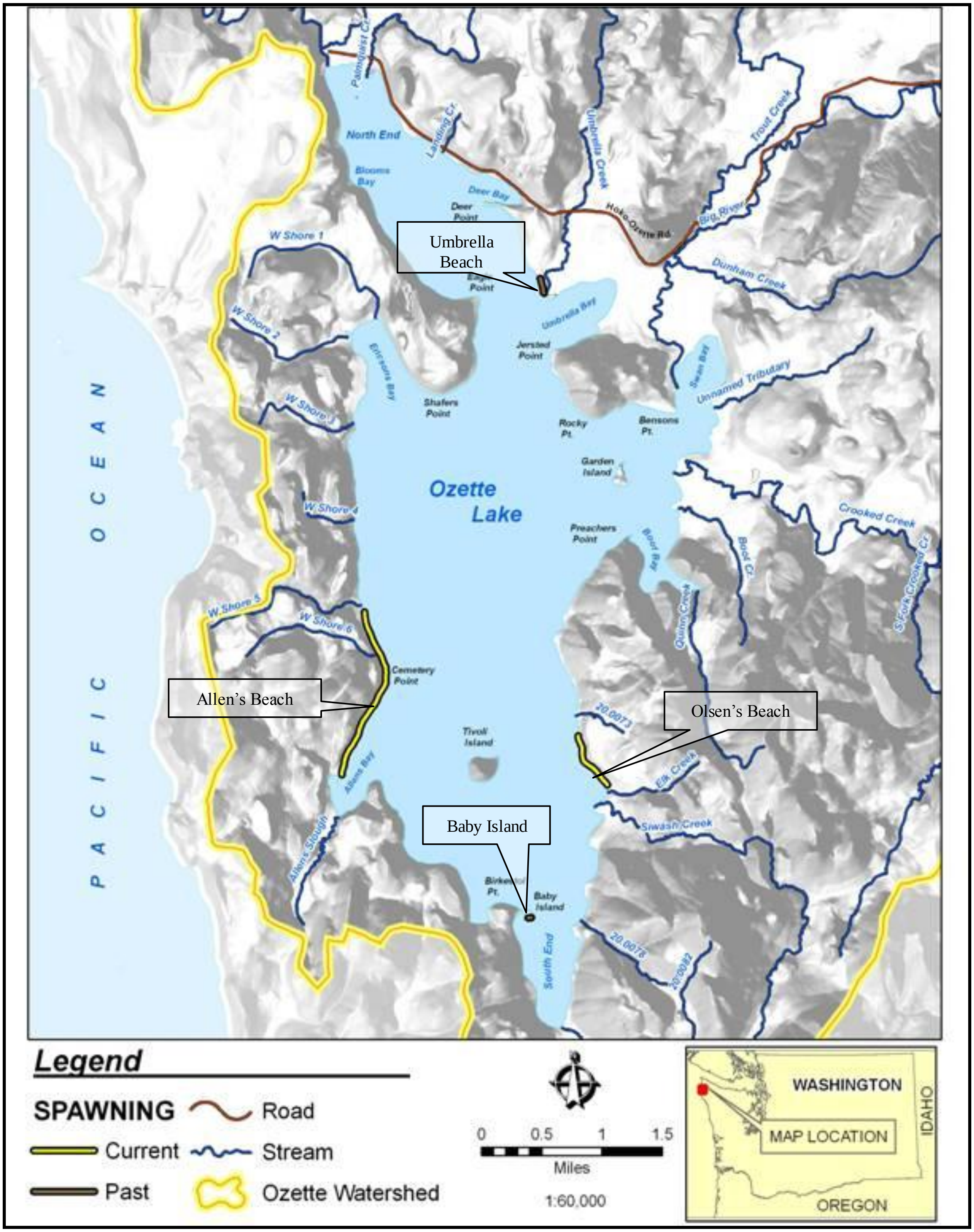

Figure 2.3. Known current and historical Lake Ozette sockeye beach spawning locations (modified from Haggerty et al. 2009).

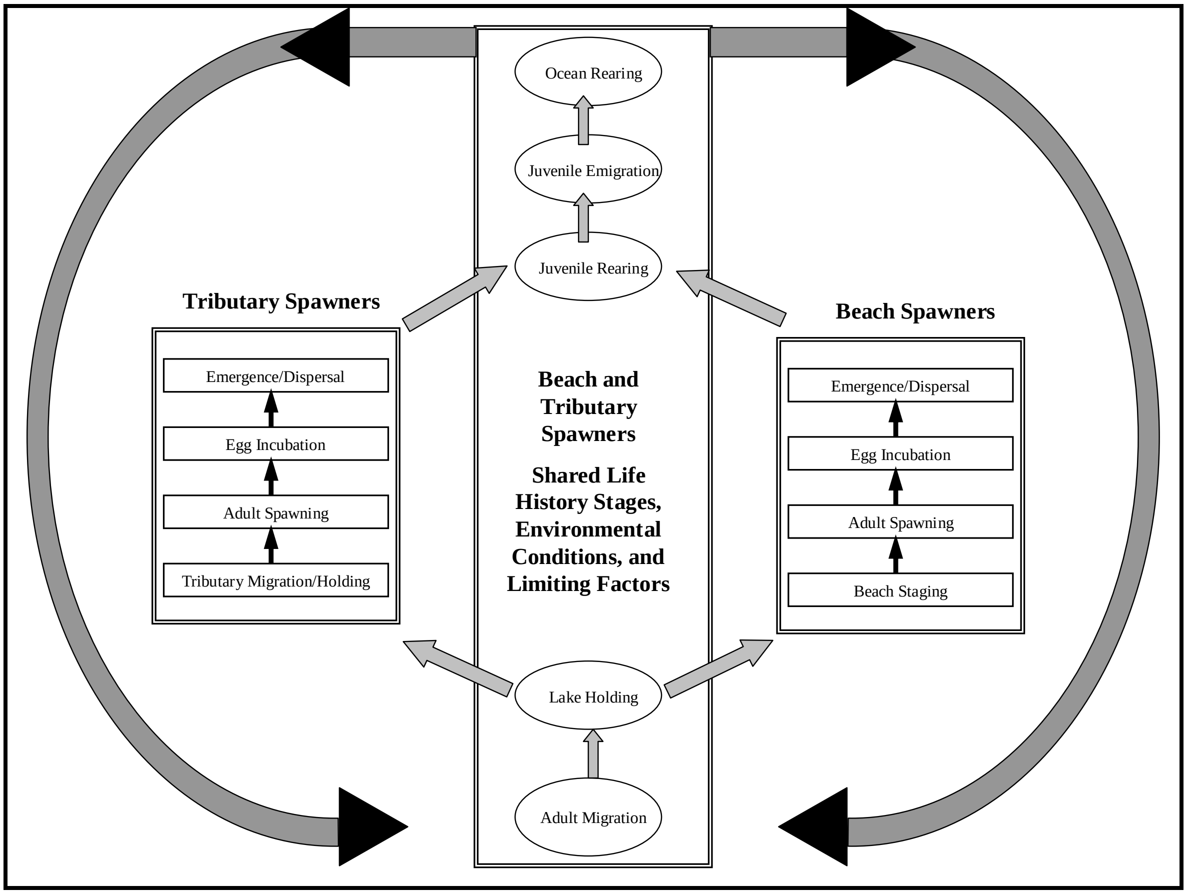

Figure 2.4. Conceptual diagram of Lake Ozette sockeye salmon life histories.

After the ocean rearing/migration phase, sockeye return to Lake Ozette from mid-April to mid-August, primarily as age-4 adults. Beach spawners are almost exclusively age 4 (~99 percent), whereas preliminary otolith age data from tributary spawners indicates that up to 9 percent of these returning adults are ages 3 and 5 (Haggerty et al. 2009). Sockeye hold for an extended period in Lake Ozette (2-10 months). Adult sockeye begin entering the lake in mid-April, and have been observed spawning on spawning beaches through late February. Peak spawning in tributaries takes place in November and December, while some spawning in January has also been observed. Egg incubation occurs from as early as October through as late as May, and fry emergence and dispersal in the lake occurs from February through May. Limited evidence indicates that beach fry move rapidly into offshore rearing areas and that tributary fry migrate to the lake soon after emergence and exclusively at night (Haggerty et al. 2009).

Almost all (~99 percent) juvenile sockeye rear in the lake for one summer and emigrate to sea during their second spring as age-1+ smolts. During the juvenile rearing phase sockeye salmon feed primarily on zooplankton. *Daphnia pulicaria* dominate the diet of juvenile sockeye salmon throughout the year. For detailed information on Lake Ozette sockeye salmon life histories, please refer to the Lake Ozette Sockeye Limiting Factors Analysis (LFA) (Haggerty et al. 2009). Figure 2.5 illustrates the seasonal timing based on a simplified version of the Ozette sockeye life history model. Beach spawning sockeye life histories are presented independently from tributary spawning subpopulations during their spawning, incubation, emergence, and dispersal phases.

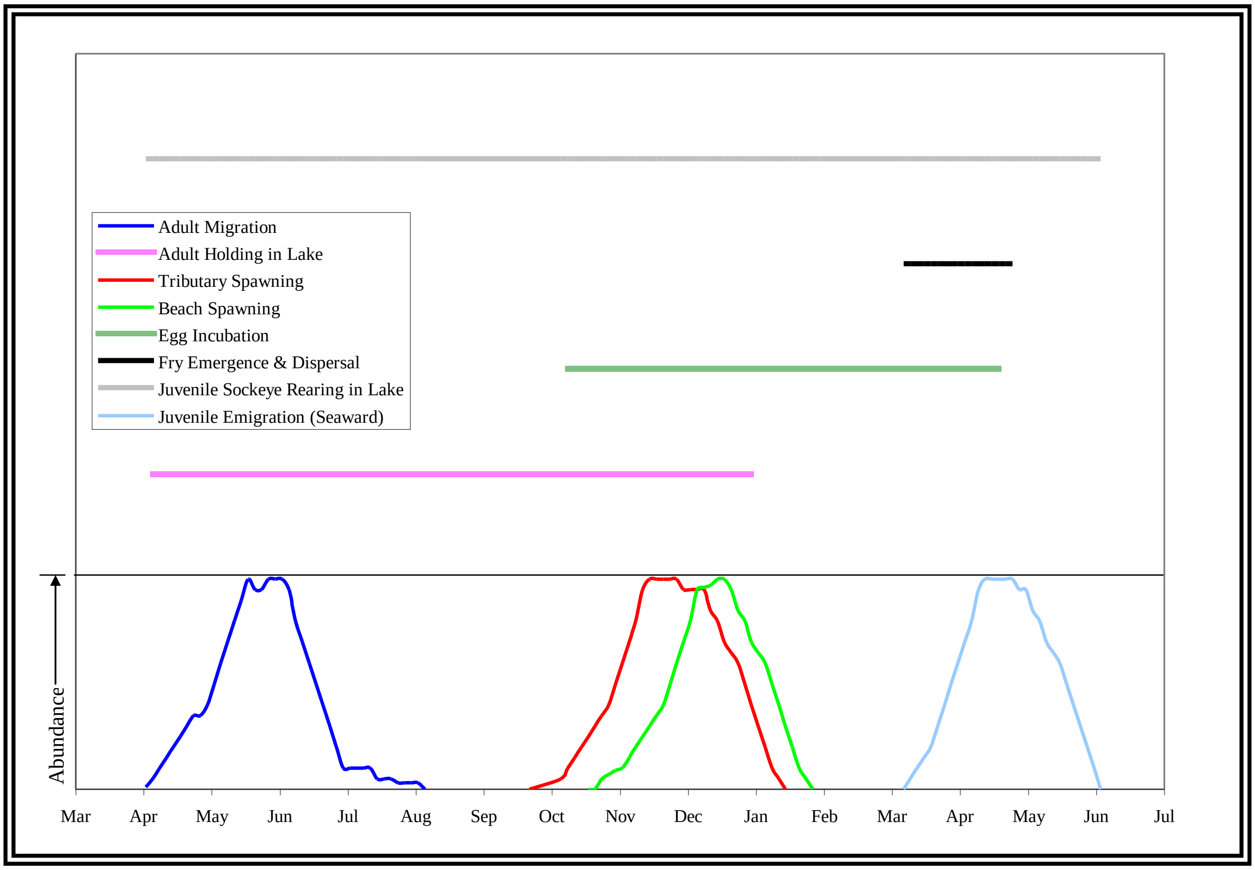

Figure 2.5. Conceptualization of Lake Ozette sockeye life history and timing (modified from Jacobs et al. 1996; note migration, tributary spawning, beach spawning, and smolt emigration are scaled to the estimated relative abundance of animals displaying a life history trait through time, whereas holding, incubation, emergence, and rearing are plotted without a scale of relative abundance.)

2.4 LAKE HYDROLOGY

The hydrology of Lake Ozette has been poorly studied over the contemporary settlement period, but an assortment of lake level, climate, and hydrology data have been collected at various locations in the watershed and coastal region. These data were brought together for the Limiting Factors Analysis (Haggerty et al. 2009) to highlight major physical patterns. A stage gage at the lake outlet has been maintained semi-consistently from 1976 to 2006. Correlated with regional precipitation patterns, Lake Ozette level (which has a range of 12 ft) is typically at its maximum between December and February and its minimum in September (Please see Figure 4.18 in the LFA depicting the relationship of maximum lake stage to winter precipitation). Peak lake stages are highly correlated with total winter rainfall, while minimum lake stages are highly correlated with total summer rainfall and evaporation. During windy periods, lake stage can vary by up to 0.5 feet from north to south because of wind seiche (a long "standing wave" that oscillates from one end of the lake to the other, lasting several hours to days). Lake Ozette stage levels are also considerably influenced both by hydraulic roughness (created, for example, by large woody debris) in the lake outlet, and by the influence of vegetation and land surface disturbance on tributary inflow (Please see Figure 4.14 in the LFA, Lake Ozette water level duration curves).

The hydrology of the Ozette watershed and Lake Ozette is complex and controlled by several variables, which can be affected by natural and human-caused factors. Logjams in the upper one mile of the Ozette River can exert a major hydraulic influence on lake stage. Wood removal beginning with the onset of homesteading (1890s) and continuing until the mid-1980s is thought to have significantly affected lake levels. However, Herrera (2005) was unable to determine the precise amount that low, median, or peak lake levels have declined or changed from pre-settlement conditions. Over the last 30 years, LWD has been very slowly accumulating and recovering from past removal but is still assumed to be only a fraction of its historical abundance. It is also well established that delivery of fine sediment to the lake from tributaries has increased during the last 50 to 100 years (Herrera 2006). Current sediment production rates are estimated to be more than three times greater than pre-disturbance production rates (Herrera 2006).

2.5 SPAWNING HABITAT

Olsen's and Allen's beaches are the only two remaining Lake Ozette beach spawning locations. The number of beach spawning aggregations that have been entirely eliminated remains unknown. Currently used spawning habitat at Olsen's and Allen's beaches, plus the available but currently unused spawning habitat along these two beaches, appears unable to produce more than a fraction of the population that is thought to have once occupied the lake.

Baby Island and Umbrella Beach are of considerable interest because of historical observations of sockeye spawning at these locations (Baby Island in 1994 and Umbrella Beach in 1981), although spawning has not been observed at either place in recent years. Factors that may affect beach and shoreline sediment conditions at both spawning beaches are not well understood, but include alterations of the lake's hydro-period, colonization of native and non-native vegetation, and reduced numbers of sockeye spawning on the beach. In the case of Olsen's Beach, potential additional factors include increased sediment delivery from nearby tributaries and shoreline development.

At mid- to upper elevations of both spawning beaches, sedges, sweet gale, and other vegetation occupy much of the beach area. Meyer and Brenkman (2001) noted that sweet gale, grasses, and sedges were observed at depths of up to 2 meters in December 1994, in the vicinity of where sockeye salmon were spawning. Seeps and springs have been mapped on both Olsen's and Allen's beaches, and appear to be areas where spawning activity is concentrated. To date no comprehensive inventory of seeps and springs has been completed for Lake Ozette.

A preliminary comparison of shoreline vegetation and sediment dynamics based on aerial photography in 1953 and 2003 (Ritchie 2005) found that significant increases in vegetation cover along the Ozette shoreline likely occurred in the last 50 years. Changes were particularly noticeable along the north end of the lake and near the mouth of Umbrella Creek.

It is important to note that current and recent spawning locations, as well as vegetation and substrate conditions along the lake shoreline, may not be representative of past spawning distribution and shoreline conditions. The historical spawning distribution of beach spawning sockeye is not fully understood. Kemmerich (1926) stated that "The shores of the lake afford many ideal spawning beds and over a large area, also numerous small streams of gravel bottom empty into the lake, which are ideal spawning beds." Kemmerich (1939) also recalled that, "We made no special investigations of spawning beds during the years [1923-1926] but merely observed from time to time that most of the spawning seemed to be along the lake shore in suitable places and especially at the mouths of the several creeks." Dlugokenski et al. (1981) observed sockeye spawning to the north of Umbrella Creek during surveys in the late 1970s, but no sockeye have been observed spawning there since, despite exhaustive surveys. The spawning at the mouths of creeks described by Kemmerich (1939) is no longer observed. Meyer and Brenkman (2001) also observed sockeye spawning at Baby Island during the winter of 1994, but no sockeye have been observed spawning there since, also despite exhaustive surveys.

From the above historical observations and known habitat use by sockeye throughout their range, a larger picture of spawning habitat potentially used by sockeye in Ozette can be developed. Beach spawning habitat quality is controlled by substrate size and composition (e.g., gravel with interstitial spaces, low percentage fines), and intergravel circulation from lake current patterns (Blair and Quinn 1991; Hendry et al. 1995; Leonetti 1997) or upwelling hyporheic water and/or groundwater (Blair et al. 1993; Burger et al. 1995; Young 2004). Historically, high quality spawning habitat was likely provided by numerous hydrogeomorphic situations:

1. Spawning on shallow non-vegetated beaches with suitable clean substrate exposed to wind-driven currents and wave action (Leonetti 1997).
2. Spawning at or near upwelling springs or seeps (hyporheic water or groundwater), regardless of water depth, where temperature regimes and intergravel flow are maintained. This reduces mortality during redd dewatering in shallow areas (Burger et al. 1995) or during times of little or no wind-driven current in deeper waters (Leonetti 1997).
3. Spawning at or near tributary inlet (deltas) with suitable substrate (deltaic gravel deposits), good intergravel circulation (upwelling hyporheic water and/or groundwater), and stable hyporheic temperature regimes (e.g., Umbrella Beach: Dlugokenski et al. 1981). Hyporheic water temperature regimes in tributary deltas would likely be slightly warmer and more stable than tributary

temperatures, but cooler than ambient lake temperatures or groundwater (White 1993; Edwards 1998).

4. Spawning in tributaries above deltaic zones.

The degree to which spawning habitat has been reduced has not been quantified for the entire lake shoreline. However, the findings of Herrera (2005, 2006) strongly suggest that mean lake level during the beach sockeye spawning period has been lowered by 1.5 to 3.3 feet from historical levels. Lowered mean lake levels during the spawning and incubation periods directly result in decreased beach spawning area. Herrera (2005, 2006) was unable to fully quantify the percent of habitat lost due to lowered lake levels.

Seasonal lake level changes are known to directly result in sockeye redd dewatering. This occurs when sockeye spawn in November, December, and January at elevations along the beaches that become exposed by lower lake levels before incubation and emergence. Peak spawn-timing, depth of spawning, and lake level at emergence are all important factors that influence the degree to which redd desiccation will occur. Years with early high lake levels (November and December) that coincide with peak spawn timing followed by lower than average late winter and early spring months likely result in more significant redd desiccation events. It is unclear what effect the long-term role of LWD removal or land use effects on hydrology has on timing or rate of seasonal lake level changes.

2.6 OZETTE WATERSHED LAND USE

For thousands of years prior to European settlement, the area around Lake Ozette was occupied by Native Americans. It is known that the prairies west of Lake Ozette were regularly burned by Native Americans to maintain open areas, which attracted and fed game such as deer and elk (Wray 1997); however, there is no evidence to indicate other significant or extensive anthropogenic effects on the Ozette watershed before European settlement. Forest fires were infrequent, and mature spruce and cedar trees achieved ages of 400 years and older. In modern times, anthropogenic effects in the Ozette watershed are primarily caused by timber harvest, road construction and maintenance, residential and agricultural development, tourism development, and stream clearing, including past stream improvement projects and policies implemented by Washington Department of Fisheries, and later, Washington State Department of Natural Resources.

2.6.1 Historical Settlement

The Treaty of Neah Bay (1855) and the Treaty of Olympia (1856) identify lands ceded to the federal government by the Makah and Quileute Tribes, respectively. The Tribes share a common boundary of their ceded lands, described in both treaties. The treaties reserved to the Tribes the right of fishing “at all usual and accustomed grounds and stations.” This right was reaffirmed by the Boldt Decision in 1974 (*U.S. v. Washington*, 384 F. Supp. 312, 362). The main Makah reservation encompasses 27,265 acres, and the Makah reservation of Ozette, located around the site of the historic Ozette Village, consists of 740 acres. The Ozette Village population decreased in 1896, when the Makah moved to Neah Bay so their children could attend school (Wray 1997). The Ozette reservation was transferred in trust to the Makah (Public Law 91-489) and is now part of the Makah Reservation.

Swan (1869), who may have been the first white man to see Lake Ozette, describes journeying to the lake by trail with a group of natives from the Ozette village. Franz Boas, an American anthropologist who visited the area in the early 20th century, estimated the pre-contact Makah population at 4,000. In interviews in 1935 (Swindell 1941), Makah fishermen described fishing in the Ozette River, the lake, and the tributaries, using a variety of methods.

The Ozette area was opened to homesteading from 1890 to 1897. Settlement peaked near the turn of the century and declined after the creation of the Olympic Forest Reserve; however, that designation in the Ozette area was eliminated in 1902, and the land was again opened for homesteading. Early settlement was concentrated along the shoreline of the lake and the gentle bottomlands of lower Big River. Many homesteaders in the second round of homesteading sold their claims to timber companies, and the resulting ownership patterns merged into large timber holdings. In 1953, the area west of the lake was transferred to the National Park Service as a part of Olympic National Park. Lake Ozette and a thin strip along the eastern shoreline were added to the park in 1976 (Meyer and Brenkman 2001). Please see section 1.7 of this plan for a full description of the park boundary within the Ozette watershed.

2.6.2 Modern Land Ownership and Land Use

An analysis by Herrera (Herrera 2006) categorized land ownership in the watershed as of four types: private, National Park Service (NPS), Washington Department of Natural Resources (DNR), and the Makah Tribe. Landownership and landownership types are depicted in Figure 2.6. Private land includes large industrial forest landowners and small forest, residential, and agricultural landowners, and makes up approximately 62 percent of the basin. The NPS manages 25.8 percent of the basin, WDNR manages 8.4 percent, and the Makah Tribe (Ozette Reservation) owns less than 1 percent. Land ownership percentages from Herrera (2006) were adjusted to reflect ownership for the entire basin (including Coal Creek and the Ozette River). Private landowners own an average of 90 percent of the watersheds of the four largest tributaries to Lake Ozette and the Ozette River (Big River, Crooked Creek, Umbrella Creek, and Coal Creek). With the exception of Big River, zoning within these four sub-basins is 99 to 100 percent commercial forest.

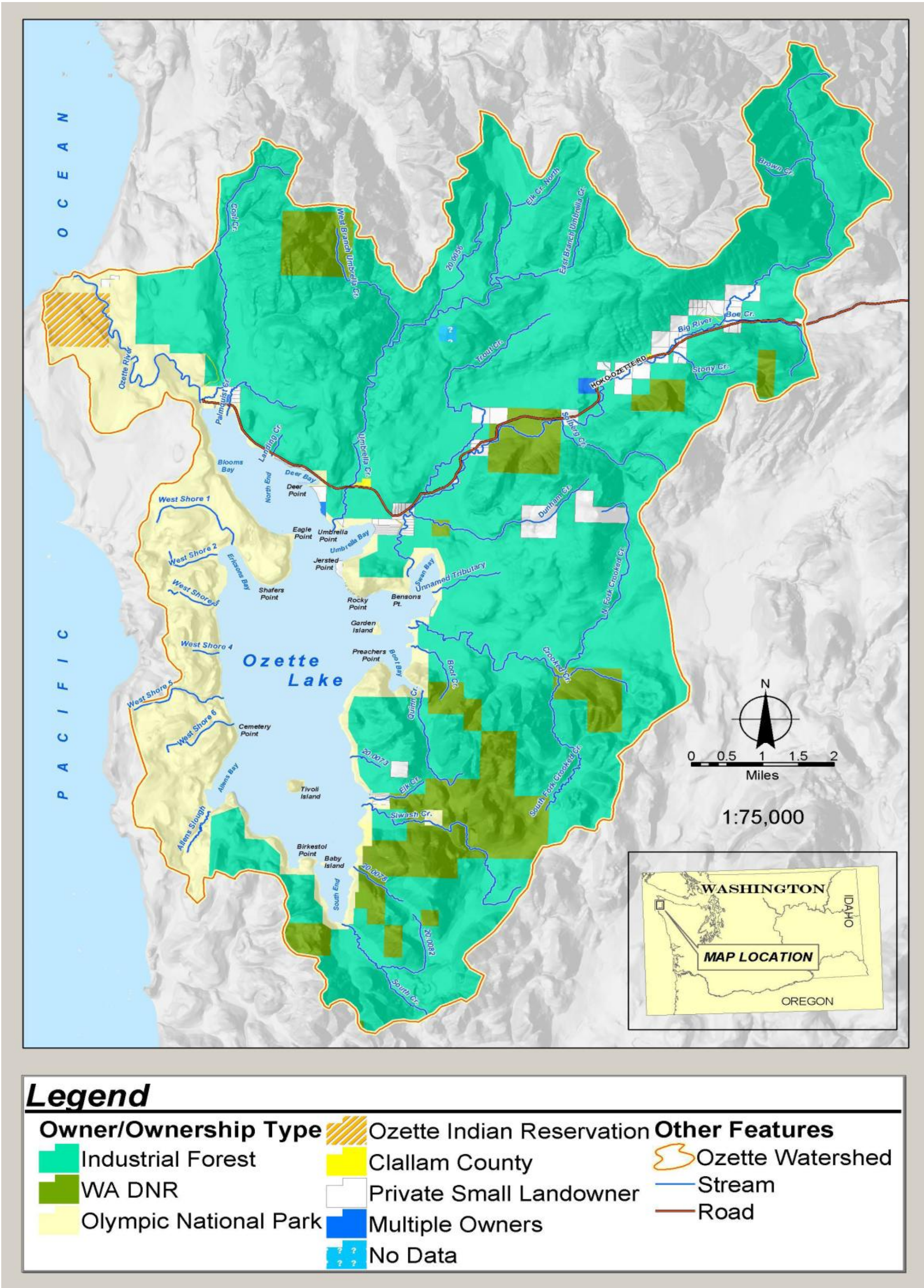

Figure 2.6. Ozette Watershed landownership and landownership type (data source: Clallam County land parcel database). Note: the landparcel data may be subject to inaccurate ownership representations.

2.6.2.1 Olympic National Park

Olympic National Park manages approximately 26 percent of the Lake Ozette watershed, including Lake Ozette and its shoreline, the entire western boundary of the watershed, and much of the land along the Ozette River, except for portions in the Ozette Indian Reservation (Figure 2.6). Olympic National Park facilities at the lake's outlet include a visitor center, ranger station, campground, and parking area. There are currently 15 cabins on lakefront parcels surrounding the lake within Olympic National Park. In addition to the development at the lake outlet, there are two other vehicle access points to the lake at Swan Bay and Rayonier Landing, along the east side of the north end of the lake. Other developed private properties within the boundaries of Olympic National Park are reachable by boat or trail. The Park provides a variety of recreational opportunities, including camping, fishing, backcountry hiking, canoeing, kayaking, and boating.

2.6.2.2 Timber Harvest and Forest Practices

Since commercial timberlands make up 71 percent of the Ozette watershed (81 percent of land area), their management will play a significant role in sockeye salmon conservation and recovery.

2.6.2.2.1 Timber Harvest History

Commercial timber harvest in the Ozette watershed began in the 1930s (Jacobs et al. 1996). By 1964 over 40 percent of the Big River watershed had been clearcut at least once (Figure 2.7). Until the 1970s, there were few regulations governing timber harvest. Streams were used for yarding corridors, riparian trees were removed, and sediment and slash inputs to streams were not regulated. Dlugokenski et al. (1981) noted that during their habitat surveys, trees were felled across Umbrella Creek and yarded through the channel; they also noted one location in the mainstem where heavy equipment had been operating in the channel. The habitat degradation in Lake Ozette tributaries resulting from past commercial forest operations has long been implicated as a major limiting factor affecting salmonid survival (USFWS 1965; Phinney and Bucknell 1975; Bortleson and Dion 1979; Dlugokenski et al. 1981; Blum 1988; WDF et al. 1994; Jacobs et al. 1996; Lestelle 1996; McHenry et al. 1996; MFM 2000; Smith 2000.) Although current regulations and practices have improved, the watersheds still need to heal from legacy effects.

Figure 2.7 depicts the percentage of old growth forest clear-cut through time for the Ozette watershed, as well as the Umbrella Creek, Big River, and Crooked Creek subbasins. An additional analysis was conducted to determine the cumulative percentage of the forested watershed area where second growth forest has been clear-cut. As of 2006, approximately 14.4 percent of the second growth forest within the Ozette watershed had been clear-cut. As of 2006, within the Umbrella Creek, Big River, and Crooked Creek subbasins, approximately 11.8 percent, 18.2 percent, and 11.2 percent of the second growth forests, respectively, had been clear-cut.

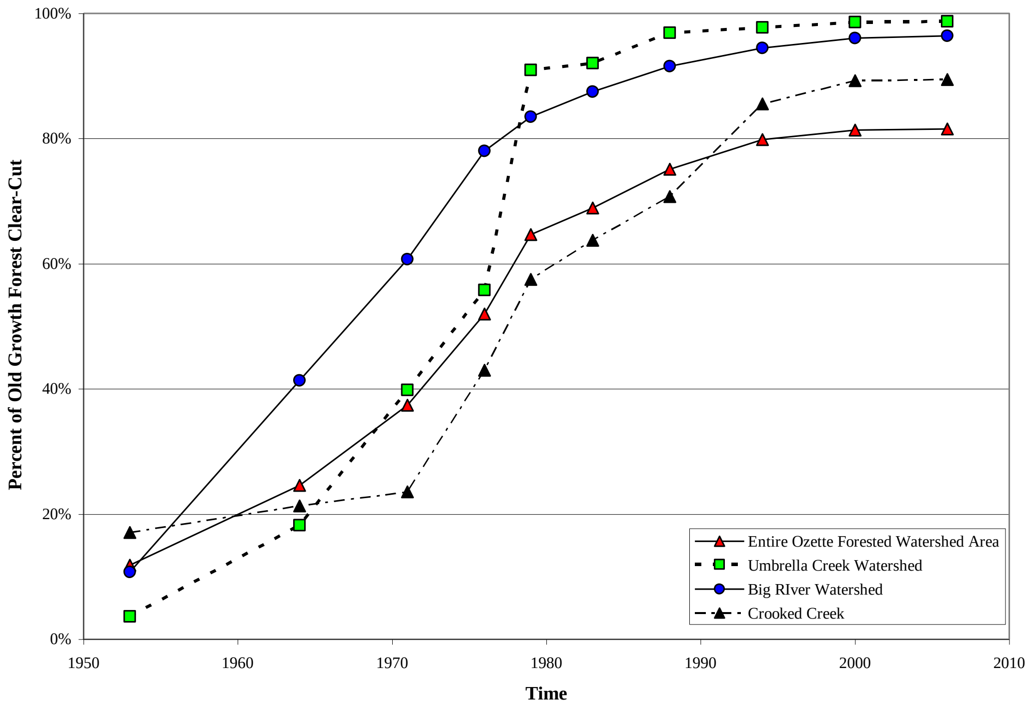

Figure 2.7. Percentage of old growth forest clear-cut through time for the entire forested portion of the Ozette watershed, as well as the Umbrella Creek, Big River, and Crooked Creek subbasins (source: Haggerty et al. 2009).

2.6.2.2.2 Washington State Department of Natural Resources

Statewide, Washington's Department of Natural Resources manages over 5.5 million acres of state-owned lands:

- 3 million acres of the state's trust lands—forests, range, and agricultural lands, and commercial properties—managed to earn revenue to help fund construction of public schools and universities; provide diverse habitat; and provide public recreational opportunities.
- 2.6 million acres of 'aquatic' lands—the marine beds of Puget Sound, Straits of Juan de Fuca and coast, many tidelands and beaches, and navigable lakes and rivers across the state—managed to protect aquatic ecosystems, encourage navigation and commerce, offer public access, and allow sustainable use of renewable resources such as shellfish.
- 31,000 acres in 52 Natural Area Preserves and 92,000 acres in 29 Natural Resources Conservation Areas that protect outstanding examples of ecosystem diversity, often protecting features unique to Washington State.

In the Ozette Basin, which includes state trust lands in the Olympic Experimental State Forest, WDNR manages 8.4 percent of the land base. Stewardship of forested state trust lands in the Experimental Forest is guided by the 1997 multi-species Trust Lands Habitat

Conservation Plan, an agreement with NMFS and USFWS under the ESA. The conservation plan helps WDNR conserve and enhance habitat for Federally listed species such as the northern spotted owl, marbled murrelet, and salmon, as well as other native fish and wildlife. (See next section.)

2.6.2.2.3 Habitat Conservation Plans (HCPs)

Under ESA section 10, states, local governments, and private landowners may apply for an Incidental Take Permit for otherwise lawful activities that may harm species listed as endangered or threatened, or their habitats. To obtain a permit, an applicant must submit a Habitat Conservation Plan (HCP) outlining what he or she will do to minimize or mitigate the impact of the permitted take on the listed species. NMFS and the USFWS usually work together with potential applicants to address all currently listed species, plus fish and wildlife species that may some day require ESA protection. The two services coordinate with applicants to ensure use of the best available science while developing HCPs. Commercial forestry in the Ozette watershed is managed under two HCPs: the Forest Practices HCP, or FPHCP, which applies to private commercial timberlands regulated by State Forest Practice Rules; and the WDNR HCP, which applies to state-owned timber lands managed by the WDNR.

Forest Practices Habitat Conservation Plan

In 1999, the Washington State Legislature passed the Salmon Recovery Funding Act (Engrossed Senate House Bill 5595), which identified forest practices as a critical component for salmon recovery. Through the Act, the Legislature recognized a report known as the Forests and Fish Report (FFR) as being responsive to its policy directive for a collaborative, incentive-based approach to support salmon recovery. The FFR was developed to create forest practices prescriptions that would protect riparian and aquatic habitat for the conservation of listed salmon species and other unlisted fish and stream associated amphibian species. The groups that contributed to the development of the FFR included state agencies (WDNR, Washington Department of Fish and Wildlife [WDFW], Washington Department of Ecology [DOE], and the Governor’s Office), Federal agencies (USFWS, NMFS, EPA), certain Washington Tribes and the Northwest Indian Fisheries Commission, the Washington State Association of Counties, the Washington Forest Protection Association (WFPA), and the Washington Farm Forestry Association (WFFA).

In 1999, the Washington State Legislature also passed the Forest Practices Salmon Recovery Act (Engrossed Senate House Bill 2091), which directed the Washington Forest Practices Board to adopt new forest practices rules, encouraging the Forest Practices Board to follow the recommendations of the FFR. In its rulemaking procedures, the Forest Practices Board conducted an evaluation of the FFR, as well as alternatives to the FFR. This evaluation included an Environmental Impact Statement (EIS) under the Washington State Environmental Policy Act (SEPA). The Final State Environmental Impact Statement, entitled Alternatives for Forest Practices Rules for

Aquatic and Riparian Resources, was published in April 2001. The Forest Practices Board adopted new permanent forest practices rules in 2001 based on the FFR. As directed by the Washington State Legislature, through the Forest Practices Salmon Recovery Act, Governor Gary Locke designated the Commissioner of Public Lands to negotiate on behalf of the State of Washington with the relevant Federal agencies to satisfy Federal requirements under the ESA pursuant to the Revised Code of Washington (RCW), Chapter 77.85.190(3).

Beginning in 2001, the State began working closely with USFWS and NMFS to develop what has become the Forest Practices Habitat Conservation Plan (FPHCP), under section 10(a)(1)(B) of the ESA, based on the forest practices rules adopted in 2001. On February 9, 2005, the State submitted a formal application for Incidental Take Permits (ITPs). In June 2006, NMFS and the USFWS issued ITPs to the State of Washington that incorporated the terms of the FPHCP. In approving the ITP (which also covers Lake Ozette sockeye salmon) NMFS found implementation of the FPHCP "consistent with the long-term survival and recovery of covered species" (NMFS 2006). NMFS' approval of the FPHCP includes an extensive record that describes how implementing the conservation measures in the FPHCP will likely contribute to recovery of watershed processes that support salmon and trout statewide.

The FPHCP covers 16 listed threatened and endangered species under NMFS' jurisdiction, including Lake Ozette sockeye. The administrative framework of the FPHCP allows for the development, implementation, and refinement of the state's Forest Practices program, including creation of new Forest Practices Rules and guidance, administering forest practices permitting, performing compliance monitoring, and taking enforcement action. An additional part of the process was the concept of refining forest practices based on adaptive management. The science-based compliance monitoring and adaptive management programs included in the FPHCP allow evaluations of plan effects and changes to environmental protections to take place over time as more is learned regarding the plan's effectiveness in promoting recovery of ESA listed salmon populations. Details of the FPHCP are summarized at *http://www.nwr.noaa.gov/Salmon-Habitat/Habitat-Conservation-Plans;washington-Forest-Practices/Index.cfm.*

Washington Department of Natural Resources Habitat Conservation Plan

In 1999, NMFS issued the WDNR an Incidental Take Permit under ESA section 10, based on the HCP approved in 1997. The WDNR HCP covers all forested state trust lands in western Washington. The Riparian Forest Restoration Strategy (RFRS), developed with the Services and approved in 2005, defines the management goal for riparian areas as the restoration of high quality habitat to aid in salmon recovery efforts and to contribute to the conservation of other aquatic and riparian dependent species. Riparian management includes various types of thinning and also the natural development of some unmanaged areas to result in restoring structurally complex older riparian forests. Details of the Riparian Forest Recovery Strategy are described in a document available at:

http://www.dnr.wa.gov/ResearchScience/Topics/TrustLandsHCP/Pages/hcp_rfrs_implement.aspx.

2.6.2.3 Private Residential and Agricultural Development

There are currently 15 cabins/homes on lakefront parcels surrounding the lake. The area around the lake outlet was developed into a resort in the 1950s, and was redeveloped into the ONP Ozette visitor center, ranger station, campground, and parking area in the 1980s. Currently, this is the most developed part of the lake shoreline. The developed length of shoreline comprises approximately 1-2 percent of the total shoreline length.

Along Big River, agricultural and residential development has been confined to the lower 10 miles of the river. Most residential development along Big River is near the original wagon trail. Currently, about 245 acres of land (~1.2 percent of the watershed area) are cleared for residential or agricultural use, and there are approximately 62 houses and other buildings within the Big River valley. In agricultural areas, the riparian zone and floodplain of the river were cleared of vegetation and converted to pasture. Currently, approximately 9,900 feet of Big River shoreline are adjacent to developed residential or agricultural land.

2.6.2.4 Makah Tribe Ozette Reservation

The Ozette Reservation encompasses Cape Alava and 1.11 miles of coastal shoreline, and extends eastward, containing nearly 0.7 miles of the Ozette River. The 740-acre reservation is currently managed as a cultural management zone by the Makah Tribe.

2.6.3 Roads

Lake Ozette in 1923 was described by Kemmerich (1926) as being “isolated” by its location “25 miles from Clallam Bay over an almost impassable road.” The first road to Lake Ozette was completed in 1926 (Jacobs et al. 1996) and thereafter road and railroad building kept pace with timber harvest in the watershed. In 1935, approximately 12.8 miles of road or railroad grade are shown on the USGS map. This increased to 25 miles in 1956, and by 1987 the USGS maps show 258.5 miles of road. Road delineation using aerial photos and mapping in GIS resulted in the estimates of road length and road densities for major subbasins depicted in Figure 2.8. In 2006, the total length of roads within the Ozette watershed was 417 miles. This road length results in an overall watershed road density of 5.5 mi/mi^2 (excluding the surface area of the lake). The 2006 orthophoto coverage indicates that road densities on non-Federal land exceed 6 mi/mi^2 within the Ozette watershed.

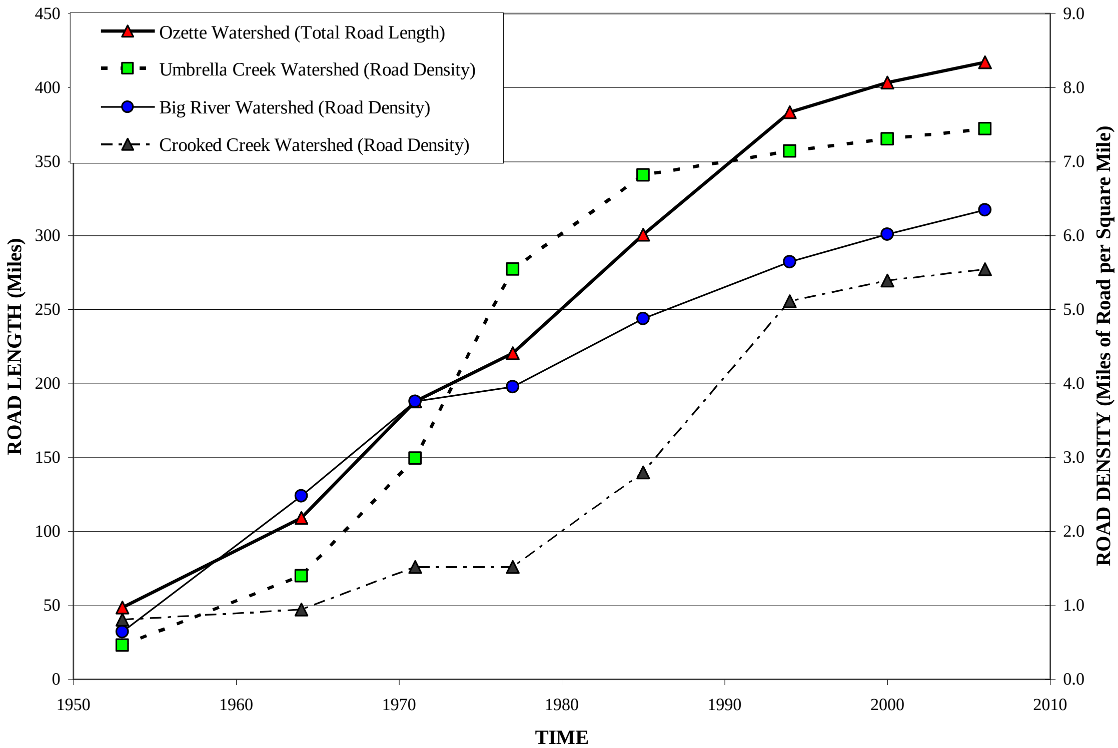

Figure 2.8. Ozette watershed road lengths and road densities for major subbasins through time (road lengths based on aerial photo coverage; basin areas used in road density calculations were generated using a digital elevation model).

The Hoko-Ozette Road is the only significant public road in the area. It follows the original wagon trail to Ozette from Clallam Bay and parallels Big River for approximately 7.8 river miles (Swan Bay Road to Nicolas Road). Within this reach, the road prism is frequently within the floodplain and channel migration zone of Big River. Kramer (1953) reported the road to be "*at times covered with flood waters*" during stream clearing activities in December 1952. Since then, the road has been raised repeatedly, but it still floods periodically. The road functions as a dike or levee during high water in some locations. Approximately 4,100 feet (1,250 meters) of bank hardening occurs along the county road and private property. Approximately 3.06 miles of riparian area are impacted by the road (road length within 200 feet of the bankfull edge of Big River; source: preliminary review of 2003 color aerial photos).

2.7 LAKE OZETTE SOCKEYE ESU CRITICAL HABITAT

The ESA requires the Federal government to designate "critical habitat" for any species it lists under the ESA. The Act defines critical habitat as areas that contain physical or biological features that are essential for the conservation of the species, and that may require special management or protection. Critical habitat designations must be based on the best scientific information available, in an open public process, within specific timeframes. On September 2, 2005, NMFS published a final rule (70 FR 52630) to designate critical habitat for Ozette Lake sockeye and 12 other ESUs/DPSs of salmon and steelhead (Figure 2.9). The final rule took effect on January 2, 2006.

A critical habitat designation does not set up a preserve or refuge, and critical habitat requirements do not apply to citizens engaged in activities on private land that do not involve a Federal agency. The designation applies only when Federal funding, permits, or projects are involved. Under section 7 of the ESA, all Federal agencies must ensure that any actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of a listed species, or destroy or adversely modify its designated critical habitat. Before critical habitat was designated, careful consideration was given to its economic impacts, impacts on national security, and other relevant impacts. The Secretary of Commerce may exclude an area from critical habitat if the benefits of exclusion outweigh the benefits of designation, unless excluding the area will result in the extinction of the species concerned.

For anadromous fish, the essential features of designated critical habitat include substrate, water quality, water quantity, water temperature, food, riparian vegetation, access, water, velocity, space, and safe passage. These features also describe the habitat factors associated with viability for all ESUs/DPSs. The specific habitat requirements for each ESU/DPS differ by life history type and life stage.

NMFS formally designated the following areas within the Ozette Lake watershed as critical habitat that is necessary for the survival and recovery of the Ozette Lake sockeye salmon ESU (70 FR 52630, September 2, 2005): Ozette Lake and the Ozette Lake watershed, including the Ozette River (Lat 48.1818, Long -124.7076) upstream to endpoints in: Big River (48.1844, -124.4987); Coal Creek (48.1631,-124.6612); the East Branch of Umbrella Creek (48.1835, -124.5659); North Fork Crooked Creek (48.1020, -124.5507); Ozette River (48.0370, -124.6218); South Fork Crooked Creek (48.0897, -124.5597); Umbrella Creek (48.2127, -124.5787); and three unnamed Ozette Lake tributaries (48.1771, -124.5967; “Hatchery Creek”- WRIA 20.0056); (48.1740, -124.6005; tributary to Umbrella Creek); and (48.1649, -124.5208; “Stony Creek”). See Figure 2.9 for a detailed map depicting designated critical habitat within the Ozette Lake Sockeye ESU.

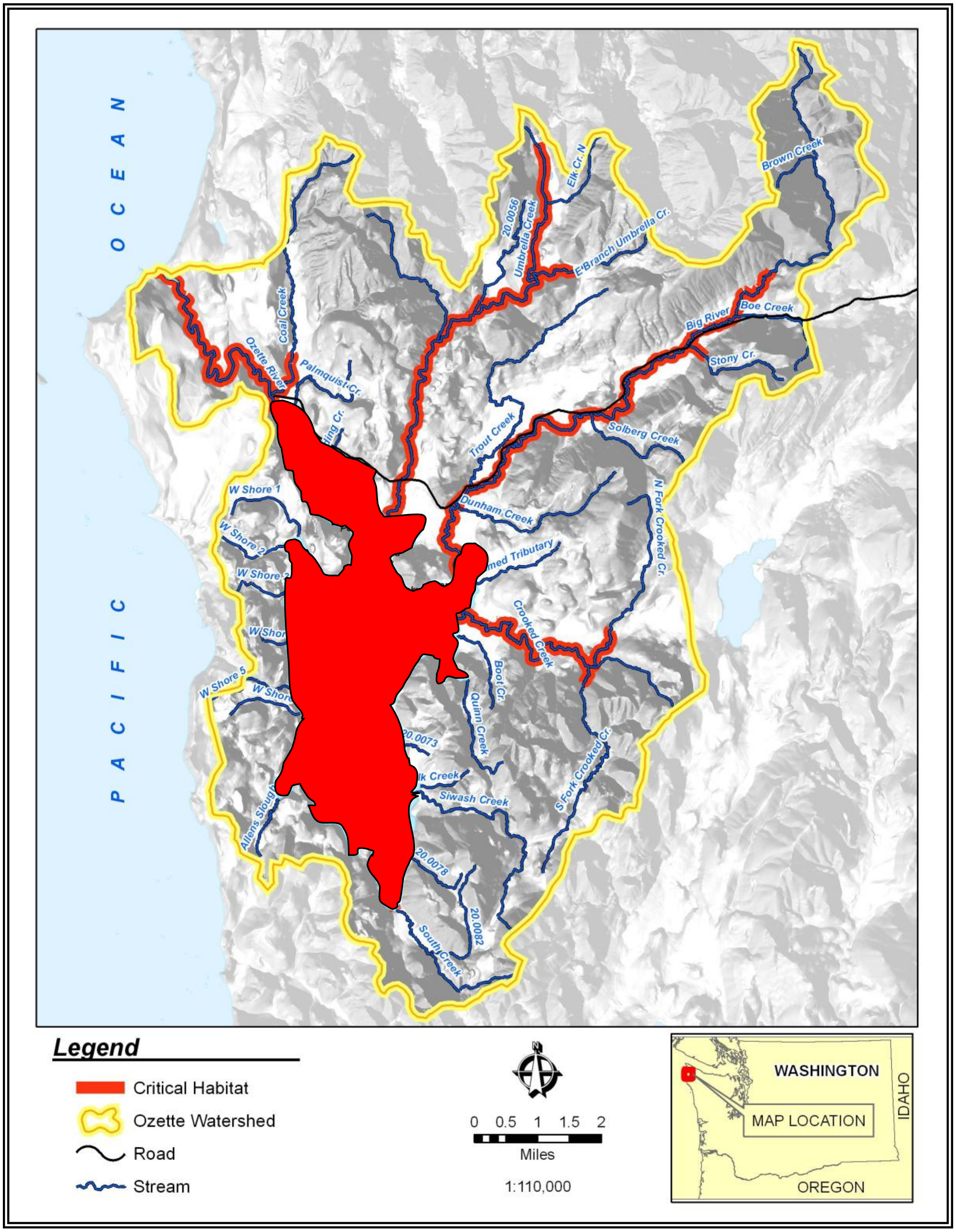

Figure 2.9. Designated critical habitat for Lake Ozette sockeye salmon. Note: the entire lake is designated critical habitat. (Data from: 70 FR 52630, September 2, 2005).

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2.8 LAKE OZETTE SOCKEYE POPULATION STATUS AND ADULT ABUNDANCE TRENDS

The population status and adult abundance trends for Lake Ozette sockeye have been investigated and summarized recently in several reports (Jacobs et al. 1996; Gustafson et al. 1997; NMFS 1998; MFM 2000; Good et al. 2005; Haggerty et al. 2009). Low numbers of adult Lake Ozette sockeye returning to spawn, documented in studies conducted as part of NMFS' ESA status review and listing process (Gustafson et al. 1997; NMFS 1998; and Good et al. 2005), were a primary reason for listing the sockeye as threatened. The steep decline reported in those status reviews is no longer apparent in the abundance data; however, this fact can be attributed largely to the recent increase in the number of tributary-spawning sockeye. The most recent 4-year average abundance estimate was just over 4,600 sockeye (Haggerty et al. 2009 [return years 2000-2003]), still considerably lower than historical numbers. However, the majority of these fish were direct or indirect descendants of the Umbrella Creek hatchery program.

The NMFS status reviews are summarized in Section 2.8.1. More recent, detailed adult sockeye abundance data and adult run-size estimates, spawning aggregation escapements, and recent and long-term trends in both total run sizes and spawning aggregation abundance can be found in the Limiting Factors Analysis (Haggerty et al. 2009). These recent data are summarized in Section 2.8.2.

2.8.1 NMFS Status Reviews

The three most recent status reviews of Lake Ozette sockeye (Gustafson et al. 1997; NMFS 1998; Good et al. 2005) differed only slightly in emphasis; all agreed that overall abundance is low, that degraded habitat conditions represent a limiting factor for this ESU, and that more data are needed. This section briefly summarizes the findings of the three reviews.

2.8.1.1 Biological Review Team 1997 (Gustafson et al. 1997)

In 1997, the West Coast Sockeye Biological Review Team (BRT), made up of scientists from the NMFS Northwest Fisheries Science Center, determined that Lake Ozette sockeye are distinct from other Washington sockeye salmon populations and that they represent a unique evolutionarily significant unit (ESU) (Gustafson et al. 1997). The BRT reported that at the time of the status review, Lake Ozette sockeye escapements averaged less than 1,000 fish per year and had little room for further declines before abundance would be critically low. The BRT found that the 5-year (1992-1996) average abundance was only 700 adult sockeye and that the population was declining at a rate of 10 percent per year. They concluded that if present conditions (those observed in the early and mid-1990s) were to continue, Lake Ozette sockeye were likely to become in danger of extinction in the foreseeable future.

The BRT identified several major concerns that led to their finding of danger of extinction in the foreseeable future:

- Siltation of beach spawning habitat
- Very low adult abundance relative to harvest in the 1950s
- Overall downward trend coupled with large fluctuations in abundance
- Potential genetic effects of ongoing hatchery production and past practices of sockeye salmon being interbred with genetically dissimilar kokanee

2.8.1.2 Biological Review Team 1998 (NMFS 1998)

In late 1998, the BRT met to discuss new information and comments received regarding their earlier determinations concerning the status of the Lake Ozette and Baker Lake sockeye salmon ESUs. The BRT received adult migrant abundance data for return years 1997 and 1998 from the Makah Tribe. These data were then pooled with data used in the 1997 status review. The five-year geometric mean estimated abundance for the period 1994-1998 was 580, slightly below the average of 700 reported by Gustafson et al. (1997). The BRT concluded that this decrease was largely due to the fact that the earlier average included two dominant brood-cycle years, while the recent average included only one. The BRT found that the return year 1998 minimum count of 984 was substantially above the count of 498 that was observed 4 years (one generation) earlier, and that this was likely the result of a change in counting methods (time lapse video) and expanded operation of a weir in the Ozette River near the lake outlet (resulting in a more complete count of the sockeye salmon run).

During the updated population trend analysis, the BRT found that the short-term (10-year) trend had improved from a "precipitous" decline of 10 percent per year (Gustafson et al. 1997) to a relatively low 2 percent annual increase. The BRT could not determine how much of the "improvement" or change was due to the influence of enhanced enumeration methods. The BRT also found that the long-term trend remained slightly downward at minus 2 percent per year. The BRT concluded that the Lake Ozette sockeye salmon ESU was not in danger of extinction. However, the BRT further stated that, "*…if present conditions continue into the future, it [*the Lake Ozette sockeye ESU*] is likely to become endangered in the foreseeable future*." There was a moderate level of uncertainty around the BRT's conclusions because of uncertainties regarding the reliability of adult sockeye abundance estimates and the historical presence of river-spawning sockeye salmon.

The BRT concluded, "Current escapements averaging below 1,000 adults per year imply a moderate degree of risk from small population genetic and demographic variability, with little room for further declines before abundances reach critically low levels." Additional perceived risks to the ESU included the following:

- Low current adult abundance
- Trends and variability in adult abundance

- Overall downward trend coupled with large fluctuations in abundance
- Siltation of beach spawning habitat
- Very low adult abundance relative to harvest in the 1950s
- Potential genetic effects of past interbreeding with genetically dissimilar kokanee

2.8.1.3 Biological Review Team 2005 (Good et al. 2005)

In June 2005, the BRT completed an updated status review of 28 West Coast salmon and steelhead ESUs (Good et al. 2005). The review for Lake Ozette sockeye included the following biological categories: population structure, population status data (e.g., adult abundance, run timing, spawning distribution and disposition), threats to viable salmonid population (VSP) parameters, and previous BRT conclusions.

The BRT concluded that the Lake Ozette sockeye salmon ESU is composed of one historical population, with substantial substructuring of individuals into multiple spawning aggregations. The BRT determined that the existing spawning aggregations spawn in two beach locations (Allen’s Beach and Olsen’s Beach) and in two tributaries (Umbrella Creek and Big River). (Note: The BRT did not include Crooked Creek as a discrete spawning aggregation.) The BRT postulated that there were probably more beach spawning aggregations historically, but it is not possible to determine how many subpopulations existed previously.

Adult sockeye run-size estimates were revised upwards after the 1997 status review because of methodological changes in sockeye enumeration and run size estimation. The most significant change was the use of 24-hour per day monitoring of the weir in the Ozette River near the lake outlet, using underwater time-lapse video instead of 6- to 8-hour per day human observers. Run sizes used in the 2005 updated status review were provisional, adjusted based on assessments of human error and inter-annual run timing. The new estimates are included in Section 2.8.2.2. The improved enumeration and estimation methods still include a significant level of uncertainty, which suggests that methods used before 1998 are likely even more unreliable. The current trends in abundance are unknown for the beach spawning aggregations. The BRT concluded that the overall abundance had declined from historical levels; whether this decline resulted in fewer spawning aggregations, lower abundances at each aggregation, or both, is not known.

The BRT included an updated threats review based upon work conducted by Makah Fisheries Management (MFM) and the Lake Ozette Sockeye Steering Committee, with primary sources of threats to VSP parameters listed as follows:

- Loss of adequate quality and quantity of spawning and rearing habitat
- Predation and disruption of natural predator-prey relationships
- Introduction of nonnative fish and plant species
- Past overexploitation
- Poor ocean conditions

- Interactions among those factors

The majority of BRT members (70 percent) categorized the Lake Ozette sockeye salmon ESU as "likely to become endangered." The remainder were split equally between the categories of "in danger of extinction" or "not likely to become endangered." The BRT noted that a risk assessment for this ESU continues to be hampered by incomplete data. Recent evaluations have cast even more doubt on the usefulness of population data prior to 1997. However, the BRT concluded, "It appears that overall abundance is low for this population, which represents an entire ESU, and may be substantially below historical levels." The BRT also voiced concerns about habitat degradation in the lake resulting in the loss of numerous sites suitable for beach spawning.

2.8.2 Recent Data on Adult Sockeye Population Size and Trends

Detailed adult sockeye abundance data, adult run-size estimates, spawning aggregation escapement estimates, and estimated recent and long-term trends in both total run sizes and spawning aggregation abundance can be found in the Lake Ozette Sockeye LFA (Haggerty et al. 2009). The following is a summary of data and estimates that will serve as the baseline for the analysis of limiting factors and consideration of recovery actions in this recovery plan.

2.8.2.1 Historical (Pre-1977) Adult Sockeye Run Sizes

Very few data are available for estimating historical escapement levels for Lake Ozette sockeye salmon. A weir was used to enumerate sockeye salmon entering Lake Ozette in 1924, 1925, and 1926, but no harvest data for interceptory fisheries are available for those years (see Figure 2.10). In addition, these are only partial counts that do not incorporate the entire run-time window for Lake Ozette sockeye.

Between 1948 and 1976, harvest data are available but no escapement data were collected, creating substantial uncertainty regarding run sizes during this period (see Figure 2.10). Makah Fisheries Management (2000) questioned the accuracy and reliability of the reported harvest numbers, since they came from verbal reports of fish bought by local fish buyers. However, Washington Department of Fisheries (1955) cites the source of the catch data along with the numbers of nets used in the Ozette River fishery. It can still be argued that in some years the harvest may have been significantly less, and in other years more, considering that much of the harvest may not have been sold and consequently not reported. Blum (1988) speculated that the Lake Ozette sockeye run exceeded 50,000 fish prior to the 1940s. In any case, over a 20-year period, Lake Ozette sockeye harvests went from several thousand per year to zero because of decreasing sockeye abundance.

For the last 20-plus years (1982-present) no harvest of Lake Ozette sockeye salmon has taken place in tribal fisheries. From 1973 to 1977, tribal regulations strictly limited harvest of sockeye salmon. Reported catch during this 5-year period was 133 fish. From

1978 through 1982, tribal regulations limited the harvest to 30 fish per year for ceremonial purposes.

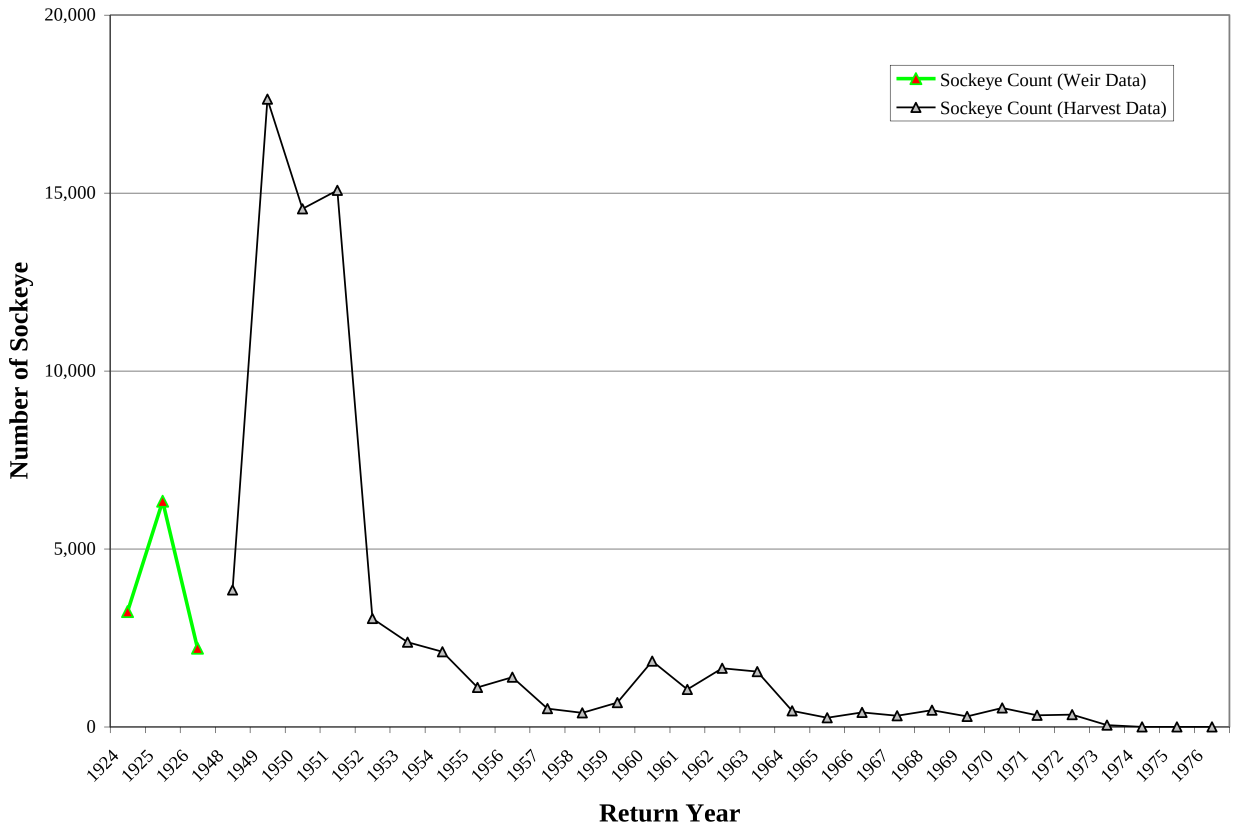

Figure 2.10. Historical abundance of Lake Ozette sockeye (RY1924-1926 and RY1948-1976) based on Kemmerich (1945) and Jacobs et al. (1996).

2.8.2.2 Recent (1977-2003) Adult Sockeye Run Sizes

The first contemporary attempt to quantify the Lake Ozette sockeye adult run size occurred between 1977 and 1980, when a joint study between the U.S. Fish and Wildlife Service (USFWS), U.S. Geological Survey (USGS), and the Makah Tribe operated a counting weir in the Ozette River, near the lake's outlet. Lake Ozette sockeye run sizes from 1977 to present are considered "recent" estimates within the context of this discussion. The methods used to enumerate and estimate Lake Ozette sockeye run sizes have changed significantly between 1977 and the present. Incorrectly applied critical assumptions that were part of the older methods limited the quality of data collected and likely underestimated run sizes (see MFM 2000; Haggerty et al. 2009). A thorough review of adult sockeye enumeration methods used in recent years (1977-2003) is included in the Lake Ozette Sockeye LFA (Haggerty et al. 2009). Estimated adult Lake Ozette sockeye salmon run sizes presented in Jacobs et al. (1996) and MFM (2000) for the period 1977 to 1999 are depicted in Table 2.2. MFM (2000) used information and data collected in 1998 and 1999 to adjust run-size estimates between 1988 and 1997.

Haggerty et al. (2009) reexamined pre-1998 datasets and run-size estimates in order to compare the most recent run-size estimates with those made in the past (e.g., Jacobs et al. 1996; MFM 2000). Common factors such as run timing and visual sockeye detection rates were used to adjust previous run-size estimates. This was done so that all run-size estimates were based upon the same basic assumptions (day and night transit, run timing, observer error). Two critical variables (run timing and observer error) had to be estimated for pre-1998 datasets. A three-step range was used for each ***unknown*** variable, resulting in nine run-size estimates for each return year (for a complete description of details see Haggerty et al. 2009; Haggerty 2004, 2005a, 2005b, 2005c, and 2005d). The median value of the nine run-size estimates was then defined as the run-size estimate for a given year. Figure 2.11 depicts the newly constructed run-size estimates for return years 1977 through 2003, grouped by brood year. These newly constructed run-size estimates illustrate the high uncertainty for each of the pre-1996 run-size estimates; no discernible trend is present.

Table 2.2. Estimated Lake Ozette sockeye run sizes, monitoring periods, and methods used. For details on methods used see Lake Ozette Sockeye LFA (source: Haggerty et al. 2009).

YEAR	Weir Operations Start	Weir Operations End	No. Adults Observed	Estimated Run Size (Jacobs et al. 1996)	Estimated Run Size (MFM 2000)	Method of Estimate	Citations
1977	~5/14/1977	~8/10/1977	920 + 84 harvested	1,004	1,004	N = n + Harvest	Dlugokenski *et al.* (1981)
1978	~5/24/1978	~8/8/1978	890 + 30 harvested	920	920	N = n + Harvest	Dlugokenski *et al.* (1981)
1979	~5/20/1979	~8/8/1979	510 + 30 harvested	540	540	N = n + Harvest	Dlugokenski *et al.* (1981)
1980	?	?	255 + 30 harvested	432	432	N = n/p + Harvest	Dlugokenski *et al.* (1981)
1981	6/8/1981	7/8/1981	239		350	N = n/p	MFM 1981a
1982	6/9/1982	8/17/1982	2,061 + 29 harvested	2,147	2,152	N = n + Harvest	Blum 1988
1983	NA	NA	NA	350	NA	NA	No Data Collected
1984	6/19/1984	8/7/1984	804	2,170	2,170	N = n/p	Blum 1988
1985	NA	NA	NA	NA	NA	NA	NA
1986	?	?	NA	691	691	N = n/p	LaRiviere 1991;
1987	NA	NA	NA	NA	NA	NA	NA
1988	6/27/1988	6/29/1988	218	2,191	3,599	N = n/p	LaRiviere 1991
1989	6/19/1989	6/30/1989	143	588	603	N = n/p	LaRiviere 1991
1990	6/7/1990	8/11/1990	175	263	385	N = n/p	LaRiviere 1991
1991	5/23/1991	7/12/1991	NA	684	684	N = n/p	Drange and LaRiviere 1991
1992	5/29/1992	7/9/1992	1,175	2,166	2,548	N = n/p	MFM 2000
1993	?	?	69	≤267	NA	N = n/p	MFM 2000
1994	6/6/1994	7/15/1994	NA	498	585	N = n/p	MFM 2000
1995	?	?	NA	314	314	N = n/p	MFM 2000
1996	6/18/1996	6/29/1996	NA	NA	1,778	N = n/p	MFM 2000
1997	6/9/1997	7/1/1997	280	NA	1,133	N = n/p	MFM 2000
1998	5/7/1998	7/2/1998	980	NA	1,406	MFM 2000	MFM 2000
1999	5/1/1999	9/30/1999	1,945	NA	2,076	MFM 2000	MFM 2000

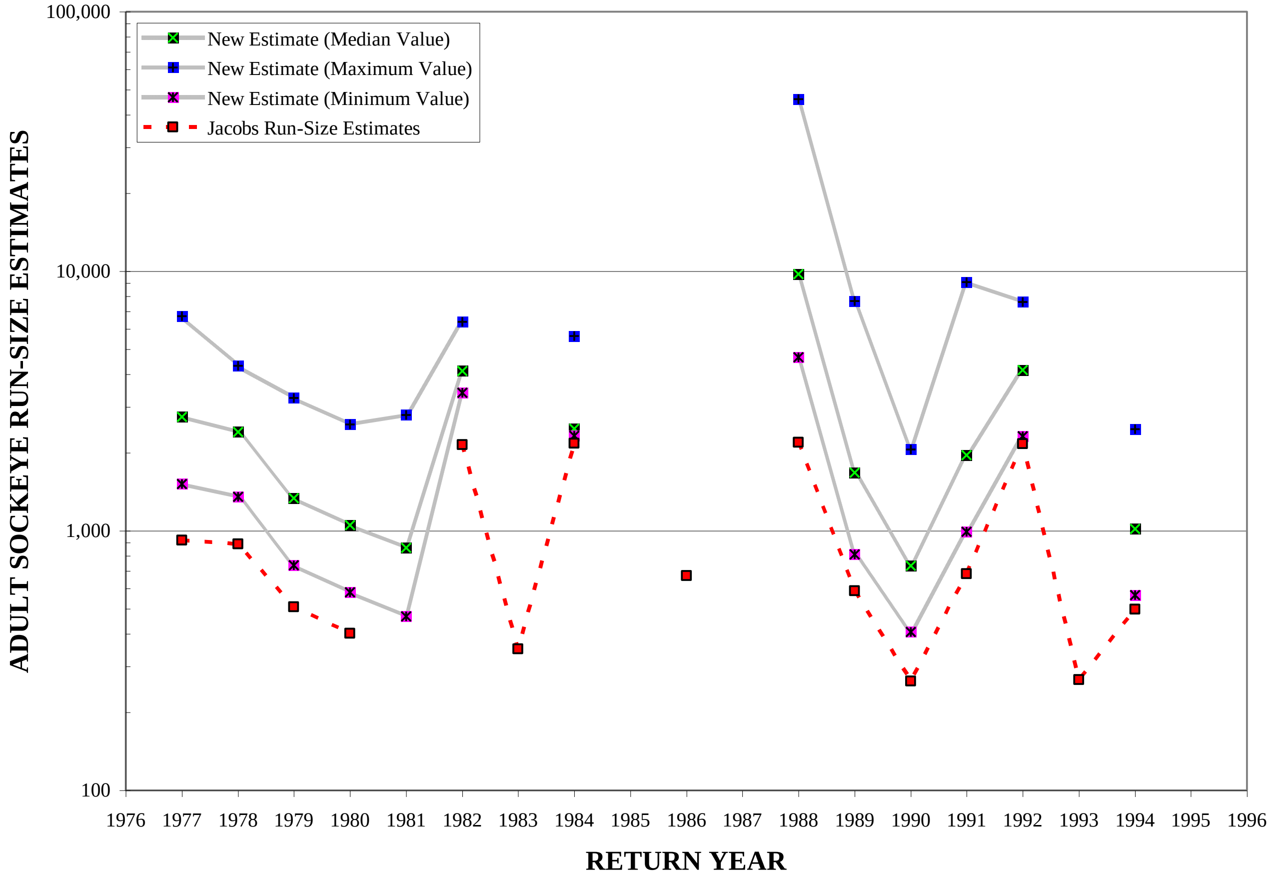

Figure 2.11. Lake Ozette Sockeye run-size estimates for return years 1977-1995, adjusted based on sockeye detection rates and new run-timing curves (from RY 1998-2003) contrasted with estimates reported in Jacobs et al. 1996 (Modified from Haggerty et al. 2009).

The methods used to derive the most recent (1996-2003) run-size estimates are described in detail in Haggerty et al. (2009) and Haggerty (2004, 2005a, 2005b, 2005c, and 2005d). Sockeye run-size estimates from 1996 to 2003 ranged from a low of 1,609 (1997) to a high of 5,075 (2003), averaging approximately 3,600 sockeye per year. The quality of annual run-size estimates varies depending on the methods used to collect data, data quality, and days of data collection. In some years, such as 1996, very few data were collected and their quality was somewhat questionable. The range of reasonable run-size estimates for 1996 is broad (1,924 to 18,117). Consistent run-size estimate methodology was applied to datasets from 1996 through 2003. For example, the run size in each year is calculated based upon a return window starting April 15 and ending August 15. Where small data gaps were present within a given dataset, a two-sided, hourly time step, 7-day moving average method (see Haggerty 2004) was used to expand for missing time periods. Where bigger blocks of missing data were present (such as in 1996 and 1997) sockeye counts were adjusted based upon the mean proportion of sockeye detected by visual observers from the 1998 and 1999 weir datasets (two years when full counts were made by visual observers). Upon adjusting the visual observer counts, the run-size estimate was then expanded based upon the average proportion of sockeye transiting the weir during RY 1998-2003 for the days where visual observer data were collected. Run-size estimates for return years 1996 through 2003 are provided in Table 2.3.

Table 2.3. Estimated adult sockeye run sizes entering Lake Ozette for return years 1996 through 2003 (source: Haggerty et al. 2009)

Year	Estimated Run size	Confidence in Estimate	Low End Estimate	High End Estimate	Days of Weir Operation	Number of Sockeye Counted	No. of Sockeye Counted to Derive Run-Size Estimate
1996	4,131	Low	1,924	18,117	12	429	429
1997	1,609	Mod-Low	na	na	21	258	236
1998	1,970	Moderate	na	na	91	980	965
1999	2,649	Mod-High	na	na	106	2,282	2,282
2000	5,064	Mod-High	na	na	116	4,423	4,423
2001	4,315	Mod-Low	3,768	na	98	2,288	2,288
2002	3,990	High	na	na	125	3,223	3,223
2003	5,075	Moderate	na	na	83	2,342	2,342
Mean	**3,600**	**Moderate**	**na**	**na**	**82**	**2,028**	**2,024**

Lake Ozette sockeye exhibit a four-year brood cycle, and for this reason trends were evaluated in four brood-year groups (brood years [BY] A, B, C, and D). The mean run size over the last four years can be compared to the preceding four years. Between 1996 and 1999 the run size averaged 2,590 sockeye, while from 2000 to 2003 the run size averaged just over 4,600 sockeye. Within these two four-year cycles, the average return increased by approximately 78 percent between the first and second period. Much of the increased production is likely a result of increased adult returns from Umbrella Creek Hatchery releases, and increased natural production in Umbrella Creek. Nearly 210,000 BY 1996 fed fry and fingerlings were released into Umbrella Creek in 1997 and these releases composed a large portion of the BY 2000 run. Figure 2.12 depicts the estimated run sizes for 1996 through 2003 and compares the proportion of the run-size estimates that are based upon expansion, as well as the percentage (in days) of the run in which the weir was deployed.

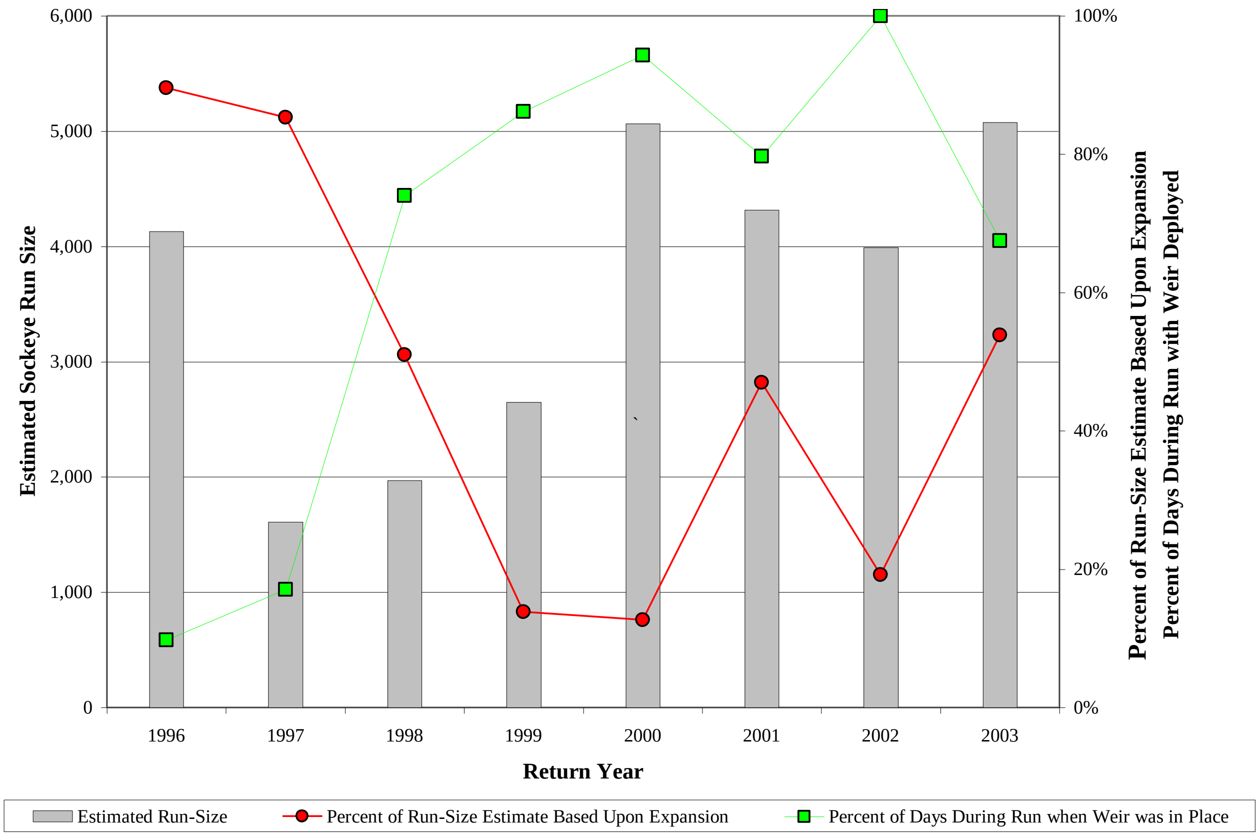

Figure 2.12. Estimated Lake Ozette sockeye run sizes for return years 1996 to 2003 contrasted with the proportion of the run-size estimates that were based upon expansion and the percentage of run-days in which the weir was deployed (source: Haggerty et al. 2009).

2.9 LAKE OZETTE SOCKEYE HATCHERY PRACTICES

In its 1996 status review, the BRT estimated that approximately 24 percent of the sockeye fry entering the lake rearing environment between 1988 and 1995 were of hatchery origin (Gustafson et al. 1997). The team expressed concern about the potential genetic effects of hatchery practices at that time, which included purposeful interbreeding of sockeye with genetically dissimilar kokanee salmon. These concerns were addressed in detail during the development of the Lake Ozette Sockeye Hatchery and Genetic Management Plan (HGMP) (MFM 2000). The HGMP is available at: http://www.nwr.noaa.gov/Salmon-Harvest-Hatcheries/State-Tribal-Management/Ozette-Sockeye-RMP.cfm.

The first sockeye releases into Lake Ozette were from out-of-basin broodstock sources. The last out-of-basin sockeye stocking in Lake Ozette occurred in 1983 (BY 1982 releases). All subsequent hatchery stocking efforts in the watershed relied only on sockeye salmon returning to the spawning grounds within the Lake Ozette watershed as the broodstock source. Adult returns resulting from past out-of-basin hatchery plants had the potential to interbreed with the native Lake Ozette sockeye, although the extent of non-native sockeye stocking was relatively low and its success was unknown. The first documented releases of non-native juvenile sockeye into Lake Ozette occurred with a brood year 1936 plant of approximately 450,000 sockeye fingerlings from the U.S. Bureau of Fisheries Birdsview Station at Baker Lake (Kemmerich 1945). Kemmerich (1945) states that additional transfers of sockeye juveniles from Quilcene and Quinault stations occurred after 1937, but the numbers and dates of those releases were not available. The only other documented out-of-basin sockeye releases were in 1983, when 120,000 (BY 1982) Lake Quinault sockeye fingerlings were released into Lake Ozette (MFM, unpublished hatchery out-planting records). In addition to non-native sockeye, releases of non-native kokanee into Lake Ozette have also been documented. In 1940, over 108,000 kokanee fry from the Lake Crescent Trout Hatchery were released into Lake Ozette (Kloempken 1996 *in* Gustafson et al. 1997). Dlugokenski et al. (1981) also reports a kokanee release of unknown quantity and origin into Lake Ozette in 1958.

2.9.1 Recent Sockeye Salmon Artificial Propagation Efforts (1984-1999)

Initially, hatchery operations and planning attempted to follow the recommendations set forth in Dlugokenski et al. (1981). Dlugokenski et al. developed three management alternatives for rebuilding Lake Ozette sockeye abundance: 1) no action; 2) rehabilitation of existing beach-spawning population and habitat; and 3) importation of an out-of-basin sockeye stock. They recommended management alternative 3 and suggested that 3-5 million sockeye eggs per year should be imported, hatched, and reared in Umbrella Creek over an 8-year period. They believed that use of tributaries for spawning would be required to increase the number of sockeye in Lake Ozette, and that the remaining beach-spawning sockeye aggregation could not adapt to the tributary spawning environment.

It was determined that a local stock with tributary spawners was needed. During the fall of 1982, the Lake Ozette Steering Committee met and decided that their efforts should focus on obtaining broodstock from Lake Quinault (MFM 1983b). The steering committee, WDFW, USFWS, and ONP all wrote letters of support declaring their preference for the Lake Quinault broodstock, in an attempt to secure eggs for hatching and rearing during the spring of 1983 (MFM 1983b). The low run size in 1983 prevented the Tribe from obtaining eggs from Lake Quinault. With a recently constructed incubation facility and no sockeye eggs, the effort to procure broodstock to supply eggs shifted to the Lake Ozette spawning beaches during the fall of 1983. Broodstock were collected from Olsen's Beach and eggs fertilized from spawners were then incubated at the Umbrella Creek facility. Resultant fry were released into Umbrella Creek at the Hoko-Ozette Road Bridge. In the end, eggs from Lake Quinault were obtained for only one year (BY 1982) and in numbers well below the recommendations set forth by Dlugokenski et al. (1981). Efforts to obtain eggs from Lake Quinault slowly waned and attention focused on collecting native beach spawning sockeye from Lake Ozette as the primary broodstock source.

Broodstock were collected from Olsen's Beach every year between 1983 and 1999, except for 1984 and 1989. Additional broodstock were collected from Allen's Beach in 1987, 1988, 1991, 1992, 1994, 1995, and 1996, and from Umbrella Creek in 1997. It is not possible to quantify the number of broodstock collected from the two beach spawning aggregations for all years collections were made, but the vast majority of broodstock were collected from Olsen's Beach during this period. The number of fish collected and the resulting releases varied significantly between years. From 1986 to 1999, a total of 1,415 sockeye salmon were collected from the spawning beaches and used as broodstock. Table 2.4 illustrates the total number of fingerlings or fry and eggs produced from broodstock collected at Lake Ozette sockeye spawning beaches and released at various locations in the watershed from 1984 through 2000. Figure 2.13 depicts the number of fish or eggs released for each year during this period, for each release site.

Table 2.4. Total number of fingerlings or fry and eggs produced from broodstock collected at Lake Ozette sockeye spawning beaches, released at various locations in the watershed from 1984 through 2000 (modified from MFM 2000).

Release Site	Number of Years	Total Number of Fry or Fingerlings Released	Total Number of Eggs Planted	Total Number of Released Fry and Eggs
Umbrella Creek	8	691,748	0	691,748
Lake Ozette	8	242,599	16,628	259,227
Big River	1	0	14,299	14,299
Crooked Creek Mainstem	1	0	34,530	34,530
N.F. Crooked Creek	3	34,500	67,589	102,089
TOTAL		**968,847**	**133,046**	**1,101,893**

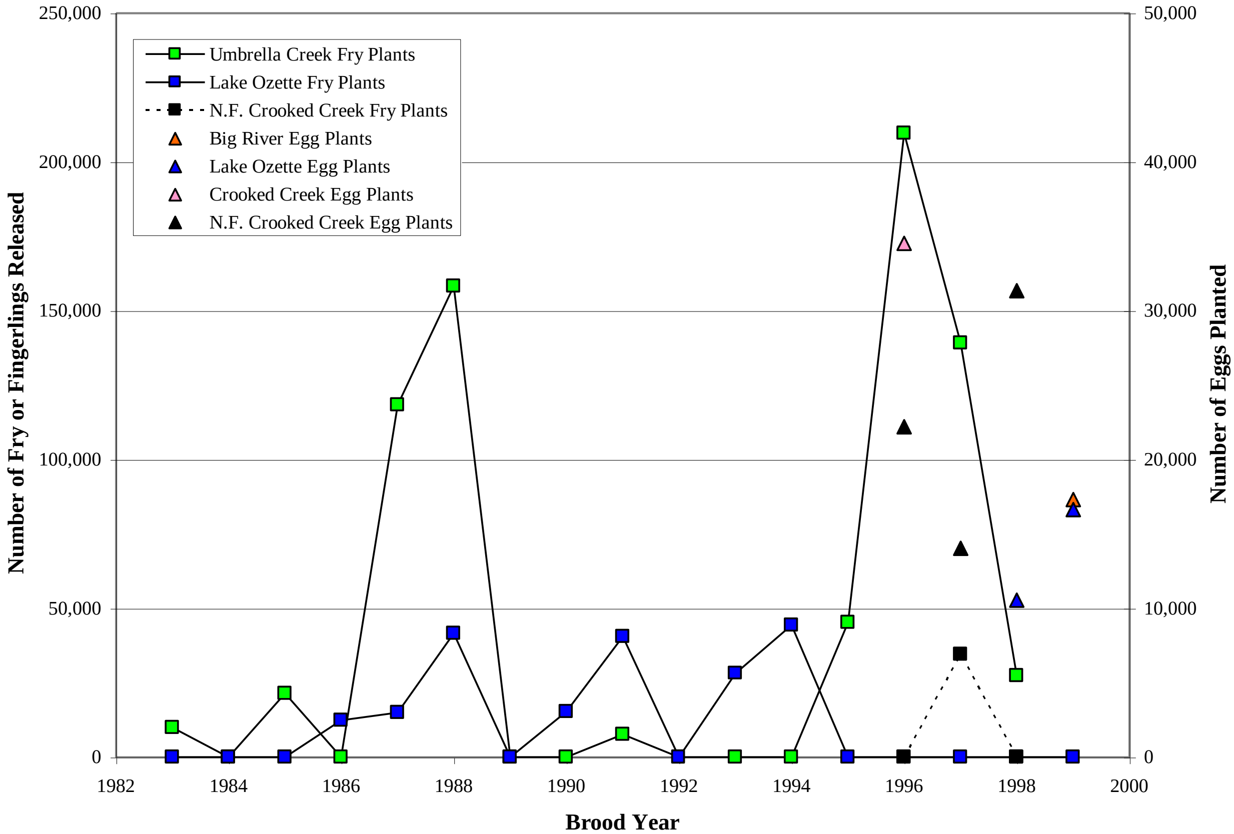

Figure 2.13. Total number of sockeye fry or fingerlings and eggs produced from broodstock collected at Lake Ozette beach spawning grounds released into various areas of the Lake Ozette watershed from 1984 through 2000 (BY 1983 to BY 1999; source: MFM, unpublished hatchery release data).

2.9.2 Hatchery and Genetic Management Plan

The ESA listing of Lake Ozette sockeye in 1999 necessitated the development of a Hatchery and Genetic Management Plan (HGMP) (MFM 2000) for the Makah Tribe's hatchery program to receive Federal authorization under the ESA. Actions that may affect listed species can be reviewed by NMFS through ESA section 7, section 10, or the 4(d) rule, and "take" prohibitions under section 9 of the ESA can be limited for actions considered sufficiently conservative (NMFS 2003). NMFS, with agreement from the Makah Tribe, evaluated the HGMP for effects on Lake Ozette sockeye under Limit 6 of the ESA 4(d) Rule for the listed ESU (65 FR 42422). The HGMP was evaluated under Limit 6 of the Rule because of its standing as a joint tribal/state resource management plan (RMP), reflecting the co-management status of the Makah Tribe and WDFW in managing the salmon resource. NMFS issued a final determination for the HGMP in July 2003, finding that the plan adequately addressed criteria under Limit 6 of the 4(d) rule, exempting the plan from the ESA section 9 take prohibitions (69 FR 18874). The joint

RMP evaluated by NMFS is the HGMP and will be referred to in this document as the HGMP.

The HGMP is part of the overall recovery planning process for Lake Ozette sockeye. It contains a complex set of goals and a well-defined strategy for assisting recovery and preserving the genetic diversity of Lake Ozette sockeye. The HGMP contains measures and actions exclusively needed to maintain the operation of the hatchery component of Lake Ozette sockeye recovery, as well as population and habitat monitoring components not normally associated with hatchery activities. The HGMP clearly states that the HGMP alone will not result in recovery of Lake Ozette sockeye, and that a comprehensive approach to habitat protection, habitat assessment, and habitat protection and restoration is needed so that hatchery and habitat components can work in concert with one another to promote species recovery.

The HGMP includes an extensive monitoring plan that allows for many of the program performance indicators to be monitored and evaluated annually. Much of the new population status, life history, ecological interaction, and habitat limiting factors data presented in this recovery plan and the LFA were collected as part of the HGMP monitoring effort. Monitoring and annual program evaluation also make it possible to adjust hatchery and research actions consistent with the adaptive management approach specified in the HGMP.

The HGMP lists these goals:

1. Prevent further decline of the ESU population.
2. Increase abundance of naturally spawning Lake Ozette sockeye salmon to self-sustaining levels that meet future estimated escapement goals and enable sustainable tribal and non-tribal commercial, ceremonial and subsistence (C&S), and sport fisheries.
3. Conserve the genetic and ecological characteristics of Lake Ozette sockeye salmon.
4. Increase distribution and diversity of Lake Ozette sockeye salmon in their present and historical localities along the lakeshore of Lake Ozette and its tributaries using supplementation, reintroduction, and natural colonization.
5. Rebuild naturally spawning aggregations of sockeye in the Ozette watershed sufficiently to restore their role in ecological processes, including nutrient recycling and serving as prey for other species of fish and wildlife, and sufficiently to restore traditional native uses (MFM 2000).

The HGMP incorporates an innovative approach to adaptive management, treating restoration activities as experiments that will produce knowledge needed to refine future actions, including those necessary to help meet recovery goals included in this plan. It contains four steps:

1. Identify recovery strategies that test hypotheses about the limiting factors or causes for decline of the population.

2. Design recovery activities as experiments to collect information from which decision-makers can learn.
3. Analyze the responses to recovery activities.
4. Implement changes based on synthesis of information and adaptive management.

The initial strategy of the HGMP included two main components:

1. Reintroduction and supplementation efforts were directed to Big River and Umbrella Creek, using tributary returns for broodstock, with intensive monitoring of the experimental introductions to clearly understand their outcome. The intent is that reintroduction into these tributaries will increase viability (abundance, productivity, spatial structure, and diversity) of Lake Ozette sockeye, which should be of long-term benefit to the recovery of the population.
2. Artificial production activities for beach spawning fish were limited to studies of limiting factors, genetic composition, and life history, using methods described in the HGMP. Determinations of whether and how to supplement or reintroduce lake aggregations will be made pending results of the research.

Implementation of the HGMP started with BY 2000 returns to the lake. Since then, no broodstock have been collected from the beaches and no planting in the Crooked Creek watershed has occurred. Hatchery efforts have focused on refining broodstock capture, incubation, and release methods within Umbrella Creek; refining incubation and release strategies within Big River; and conducting small-scale limiting factor studies at the spawning beaches.

Since the implementation of the HGMP began in BY 2000, a total of 746 sockeye (379 females and 367 males) have been collected for broodstock from Umbrella Creek (less than 10 percent of the total adult return to Umbrella Creek between 2000 and 2003; MFM unpublished broodstock collection data). A total of 783,617 fry and fingerlings have been released into the Umbrella Creek (36 percent of the total) and Big River (64 percent) watersheds (MFM unpublished sockeye release data). A simplified summary of juvenile sockeye hatchery releases in the Lake Ozette watershed is presented in Table 2.5.

Table 2.5. Summary of HGMP sockeye fry and fingerling releases in the Ozette watershed for brood years 2000 through 2003 (source: MFM, unpublished hatchery release data).

Brood Year	Release Date	Size (Grams)	Number of Fry or Fingerlings Released	Release Site	Broodstock Source
2000	April/May 2001	0.13	63,201	Big River (Stony Creek)	Umbrella Creek
2000	7/29/2001	1.01	50,168	Big River (Stony Creek)	Umbrella Creek
2000	7/27/2001	1.17	48,379	Umbrella Creek	Umbrella Creek
2000	7/27/2001	0.8	32,328	Umbrella Creek	Umbrella Creek
2001	April/May 2002	0.13	75,900	Big River (Stony Creek)	Umbrella Creek
2001	6/28/2002	0.86	75,352	Big River (Stony Creek)	Umbrella Creek
2001	July 2002	1.0-1.57	94,958	Umbrella Creek	Umbrella Creek
2002	6/5/2003	0.32	74,377	Big River (Stony Creek)	Umbrella Creek
2002	6/5/2003	0.91	47,990	Big River (Stony Creek)	Umbrella Creek
2002	6/26/2003	0.74	79,325	Umbrella Creek	Umbrella Creek
2002	June 2003	0.4	24,568	Umbrella Creek	Umbrella Creek
2003	May 2004	0.16	102,779	Big River (Stony Creek)	Umbrella Creek
2003	7/2/2004	0.6	12,792	Big River (Stony Creek)	Umbrella Creek
2003	5/25/2004	0.57	1,500	Umbrella Creek	Umbrella Creek

The HGMP limits the tributary reintroduction program to 12 years, or three sockeye salmon generations, per release site. After 12 years (in 2012), the program will be evaluated. If it has been successful in establishing self-sustaining sockeye runs that meet escapement goals, it will be terminated. In its final determination on the HGMP, NMFS further stated that "If, after 12 years, the program is meeting performance standards and is expected to achieve, but has not yet fully accomplished, program goals, continuation of specific components of the program will be proposed and evaluated" (NMFS 2003).

NMFS conducted an assessment of the Makah Lake Ozette hatchery program's relative contribution to the conservation of the listed species (NMFS 2004). This assessment included a detailed evaluation of the hatchery program's effects on ESU viability, including the parameters of abundance, productivity, spatial structure, and diversity. NMFS concluded that the hatchery program is increasing the abundance of naturally spawning sockeye in the ESU; however, tributary spawners from the program are isolated (by design) from the beach spawning aggregations, and are therefore unlikely to benefit either the abundance or the productivity of the natural-origin beach-spawners.

Similarly, NMFS concluded that the hatchery program is likely to increase the spatial structure of the ESU as a whole, although it is not likely to increase the spatial structure of the beach-spawning aggregations. The program is expected to affect the ESU's diversity by extending the range of spatial distribution, which may, in turn, contribute to life history diversity and increase the resiliency of the population (NMFS 2004).

3 RECOVERY GOALS, OBJECTIVES, AND CRITERIA

In general, the goal of ESA recovery planning is to restore the listed species to the point that it is again a self-sustaining element of its ecosystem and it no longer needs the protection of the Act – and it can be delisted. Recovery plans may also contain "broad-sense goals" that may go beyond the requirements for delisting to acknowledge social, cultural, or economic values regarding the listed species.

As indicated in Sections 1.1 and 1.5.2, NMFS has collaborated with the locally based Lake Ozette Steering Committee to develop this recovery plan. NMFS will continue to support local recovery planning in the Lake Ozette watershed. The recovery goal for Lake Ozette sockeye salmon (*Oncorhynchus nerka*) is founded on a belief that citizens and the treaty tribes in the region value the substantial ecological, cultural, social, and economic benefits that are derived from having healthy, diverse populations of sockeye salmon.

The following sections describe ESA requirements, broad-sense goals, and the more specific goals, biological criteria, and threats-based criteria NMFS will use to remove the species from the Federal list of endangered and threatened species.

3.1 ESA REQUIREMENTS

For NMFS to formally approve an ESA recovery plan, it must meet certain statutory requirements specified in ESA sections 4(a)(1) and 4(f)(1)(B):

- ESA section 4(a)(1) lists factors to be considered for listing, re-classification, or delisting of a species. These factors are to be addressed in recovery plans:

  A. The present or threatened destruction, modification, or curtailment of [the species'] habitat or range
  B. Over-utilization for commercial, recreational, scientific, or educational purposes
  C. Disease or predation
  D. The inadequacy of existing regulatory mechanisms
  E. Other natural or manmade factors affecting [the species'] continued existence

- Further, ESA section 4(f)(1)(B) directs that "Each plan must include, to the maximum extent practicable,

  > "(i) a description of such site-specific management actions as may be necessary to achieve the plan's goals for the conservation and survival of the species;

> (ii) objective, measurable criteria which, when met, would result in a determination, in accordance with the provisions of this section, that the species be removed from the list; and,
>
> (iii) estimates of the time required and cost to carry out those measures needed to achieve the plan's goal and to achieve intermediate steps toward that goal."

In addition, it is important for the plans to provide the public and decision-makers with a clear understanding of the goals and scientifically supported strategies needed to recover a listed species (NMFS 2006a).

3.2 RECOVERY GOALS

Recovery of the Lake Ozette sockeye ESU will require actions that conserve, preserve, restore, and enhance ecosystem processes and dynamics in the watershed and adjacent nearshore environment. Actions addressing instream and in-lake processes and conditions, riparian habitat diversity and complexity, and upland watershed health need to be applied in concert with complementary management of harvest and hatcheries. Recovery is a process that leads to a naturally self-sustaining sockeye population that not only exhibits the characteristics of viability, but also provides a harvestable surplus for tribal and recreational fisheries. As described in Section 1.5.2, the cooperation and coordination of all parties (landowners, Tribes, County, co-managers, local citizens, state and Federal agencies) will be important for the successful implementation of this recovery plan.

Olympic National Park manages Lake Ozette, its lakeshore, and portions of the Ozette River watershed under the guiding principles of the Park Services' Organic Act of 1916. This Act requires the Park administration to conserve the Park's scenery, natural resources, and wildlife for the enjoyment of current and future generations. These far-reaching goals are implemented through the Park's General Management Plan, which is another important tool to help achieve the recovery goals for Lake Ozette sockeye salmon (see Section 7.2.1.5). The Park also has an important role to coordinate its actions with other landowners, Tribes, WDFW, and local citizens to recover Lake Ozette sockeye salmon.

3.2.1 Broad-Sense Recovery Goals

The following is a vision statement crafted by NMFS and the Lake Ozette Steering Committee for future conditions for the Lake Ozette sockeye ESU and its human and biological setting: *The naturally spawning Lake Ozette sockeye population is sufficiently abundant, productive, and diverse (in terms of life histories and geographic distribution) to provide significant ecological, cultural, social, and economic benefits. Protection and restoration of ecosystems have sustained processes necessary to maintain sockeye as well* *as other salmon, steelhead, cutthroat trout, and other native fish and wildlife species. Community livability, economic well-being, and treaty-reserved fishing rights have benefited by balancing salmon recovery with management of local forest and fishery economies.*

After the proposed plan has gone through a public comment period and NMFS has approved a final plan, the groups involved in voluntarily implementing the plan's recommendations may consider this vision statement and accept, reject or modify it as they wish.

3.2.2 Objectives

The Lake Ozette Sockeye Recovery Plan sets the following broad objectives to be reached by the year 2050:

1. The Lake Ozette sockeye population is viable;[1]

2. Lake Ozette sockeye use habitats throughout their historical range;

3. The extant population of Lake Ozette sockeye is capable of contributing ecological, social, cultural, and economic benefits on a regular and sustainable basis;

4. Landowners and resource managers have the tools for appropriate land and water resource management to alleviate liability for actions that might otherwise invoke penalties under the ESA;

5. Out-of-basin limiting factors (e.g. ocean harvest) have been addressed equitably and in concert with in-basin limiting factors; and

6. Landowners, land managers and agencies are provided with guidance and implementation resources on the protection and management of habitats to promote and maintain the recovery of Lake Ozette sockeye salmon.

3.2.3 Processes Needed to Accomplish Goals and Objectives

1. Collaborative management processes and approaches, including both volunteer and incentive-based programs, encourage protection and restoration of habitat.

[1] A **viable** salmonid population is defined as an independent, naturally self-sustaining population that has less than a five percent risk of extinction due to threats from demographic variation, local environmental variation, and genetic diversity changes over a 100-year period. A population that depends upon naturally spawning hatchery fish for its survival is not viable (McElhany et al. 2000).

2. Management actions are based on a strategic priority framework, linked, in turn, to an adaptive management program that recognizes the importance of protection, enhancement, and restoration throughout the life cycle of the species.

3. Agencies and residents employ a diversity of management approaches across the ESU that meet both social and biological objectives.

4. Landowners and resource managers are provided with information and assistance on how to accomplish recovery goals and objectives.

5. An integrated adaptive management program is in place that includes research, monitoring, and evaluation to facilitate periodic assessments of implementation effectiveness, population status, and habitat status, and to advise the need, if any, to modify future recovery management actions.

3.3 CRITERIA

Evaluating a species for potential delisting requires an explicit analysis of population or demographic parameters (the biological criteria) and also of threats under the five ESA listing factors in ESA section 4(a)(1) (listing factor [threats] criteria). Together these make up the "objective, measurable criteria" required under section 4(f)(1)(B). This section summarizes the biological criteria and threats criteria for the Lake Ozette sockeye.

The TRTs appointed by NMFS define criteria to assess biological viability for each listed species. NMFS develops criteria to assess progress toward alleviating the relevant threats. NMFS Northwest Region may adopt or modify the TRT's viability criteria as the biological criteria for a recovery plan, based on best available scientific information and other considerations as appropriate. For the Lake Ozette Sockeye Recovery Plan, NMFS will use the biological criteria identified by the PSTRT (Currens et al. 2006; Rawson et al. 2008).

As the recovery plan is implemented, additional information will become available along with new scientific analyses that can increase certainty about whether the threats have been abated, whether improvements in population status have occurred for sockeye salmon, and whether linkages between threats and changes in salmon status are understood. NMFS will assess these recovery criteria and the factors for delisting through the adaptive management program for the plan, and NMFS will thoroughly review the criteria at the 5- and 10-year status review of the ESU.

3.3.1 Biological Viability Criteria

All the TRTs use the same biological principles for developing their ESU and population viability criteria. These principles are described below and in more depth in the NMFS technical memorandum, *Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units* (McElhany et al. 2000). Viable salmonid populations (VSP) are described in terms of four parameters: abundance, productivity or growth rate, spatial structure, and diversity. While the ESU is the listed entity under the ESA, the ESU-level viability criteria are based on the collective viability of the individual populations that make up the ESU—their characteristics and their distribution throughout the ESU's geographic range. The population viability criteria are expressed in terms of risk of extinction over a 100-year time frame.

Table 3.1. Summary of proposed Lake Ozette sockeye viability criteria for naturally self-sustaining adults (source: Rawson et al. 2008)

VSP Parameter	Proposed Criteria
Abundance Planning Range	31,250 – 121,000 spawners, over a number of years
Productivity	Population growth rate stable or increasing
Spatial Structure	Multiple spatially distinct and persistent spawning aggregations across the historical range of the population
Diversity	One or more persistent spawning aggregations from each major genetic and life history group historically present within the population

The first task for the TRTs is to identify the populations that make up an ESU. The PSTRT concluded that the Lake Ozette sockeye salmon ESU was historically made up of only one independent population, as it is today (Currens et al. 2006). The extant spawning aggregations located on two beaches in Lake Ozette and in two tributaries to Lake Ozette are considered subpopulations (Currens et al. 2006).

The second task is to consider the available data and construct criteria to describe both the current status of the population and the characteristics it would need to have to be considered "healthy," viable, or recovered. The PSTRT defined population viability criteria for the Lake Ozette sockeye salmon ESU as follows (Rawson et al. 2008).

Abundance: A population will have a low risk of extinction if it has sufficient abundance from naturally produced spawners to survive environmental variation observed in the past and expected in the future, to be resilient to environmental and anthropogenic disturbances, to maintain genetic diversity, and to support or provide ecosystem functions. To define abundance criteria for the Lake Ozette sockeye population, the PSTRT combined two methods of analysis: (1) population viability analysis (PVA), which combines population census data with simple models of population dynamics to estimate extinction probabilities for the population; and (2) estimates of habitat capacity – food resources and necessary environmental characteristics for all relevant life stages. For the PVA, they used estimates of the number of adult sockeye entering Lake Ozette based on census data for the years 1977-2003, compiled by Haggerty et al. (2009), and additional data for 2004-2006 provided by the Makah Tribe. Because of the relative scarcity of historical data for Lake Ozette sockeye, the PSTRT also used data from Lake Quinault sockeye salmon to make the analysis more robust.

For the estimates of habitat capacity, they drew on multiple studies, including habitat inventories, summarized in Haggerty et al. 2009 and Appendix B of this plan. By all accounts, Lake Ozette is a rich environment for both juvenile and adult salmon, and sockeye are not limited by food availability or competition. Spawner capacity for known beach spawning locations and potential tributary spawning areas was estimated based on habitat surveys.

Because of the uncertainties in the available data, the PSTRT provided a "planning range" for abundance, with upper and lower bounds, rather than a point estimate. This planning range is based on the assumption of at least 1:1 spawner/adult replacement and the assumption that the population maintains and recovers adequate historical spatial structure and diversity, i.e., that spawning takes place throughout the spawning range of the population (which is also the ESU).

Based on currently available information, a viable sockeye population in Lake Ozette will range in abundance between 31,250 and 121,000 adult spawners over a number of years (Rawson et al. 2008).

The minimum abundance number in this range is derived through the PSTRT's PVA analysis for a 5 percent risk of extinction using a 30-year dataset of Lake Ozette sockeye estimated abundance. The upper end of the viability planning range is determined by the minimum of the upper range of three habitat capacity estimates. In accordance with PSTRT decision rules, the upper end of the range is the spawner capacity estimate of 121,000 spawners. The PSTRT cautions that the spawning capacity of 121,000 is likely an underestimate if all potential beach and tributary sites were taken into consideration, not just the ones currently being used.

The PSTRT's planning range is associated with a productivity of 1:1 recruits:spawner. A viable combination of abundance and productivity can be described along a curve. As population productivity increases, the necessary abundance for a viable state will be lower. NMFS has asked the PSTRT to further calculate a more specific abundance and productivity target within the planning range, which, over a specified number of years, would represent a level upon which to base the delisting decision. The PSTRT has agreed to perform additional technical analyses, given policy guidance as to the level of certainty desired for the delisting determination. A more specific target will be added to the recovery plan when it becomes available.

Productivity: The productivity (growth rate) of a population is a measure of its ability to sustain itself or its ability to rebound from low numbers. Productivity can be measured as naturally produced spawner-to-spawner ratios (returns per spawner, or recruits per spawner), annual population growth rate, or trends in abundance of naturally produced fish. The PSTRT's population viability analysis model assumes that the population growth rate is stable or increasing, and that the population will sustain itself (i.e., not be declining) at the viability abundance level. The PSTRT recommends that the growth rate for Lake Ozette sockeye, once viability is achieved, should average 1. Until the ESU achieves viability, the growth rate must be greater than 1 (Rawson et al. 2008). In order to evaluate progress in meeting the overall viability goals, it is important to develop an interim ten-year sockeye salmon population goal which will inform NMFS, co-managers, and the public of the improvement achieved to date.

Spatial structure: Spatial structure concerns the geographic distribution of a population in habitats it uses throughout its life cycle, and the processes that affect the distribution. Populations with restricted distributions and few spawning areas are at a higher risk of extinction as a result of catastrophic environmental events (e.g., a single landslide) than populations with more widespread and complex spatial structures. A population with complex spatial structure will include multiple spawning areas and will allow the expression of natural patterns of gene flow.

Because of the contrasting benefits of groups of individuals being close enough together for re-colonization to occur and yet spread out enough so that all groups do not fall victim to the same catastrophe, spatial structure for a viable population should include multiple clusters of groups that are closely aggregated, with the clusters themselves being spread out throughout the geographic area occupied by the population (Rawson et al. 2008).

The PSTRT noted that the current, limited distribution of Lake Ozette sockeye spawners puts the ESU at high risk, and recommends that a viable sockeye population in Lake Ozette should include multiple, spatially distinct and persistent spawning aggregations throughout the historical range of the population. A viable population will therefore contain multiple spawning aggregations along the lake beaches, which are the known historical spawning areas. The certainty that the population achieves a viable condition would be further increased if self-sustaining spawning aggregations in one or more tributaries to the lake were also established.

Diversity: Salmon exhibit considerable diversity within and among populations in their life history, morphological, physiological, and genetic traits. Because environments continually change as a result of natural processes (e.g., fires, floods, drought, and landslides) as well as from anthropogenic influences, populations exhibiting greater diversity are more resilient to both short- and long-term changes. Since salmon regularly face variability in the environments they inhabit, the contributions of diversity to population persistence are critical to consider.

This plan uses the PSTRT's diversity criterion that a viable Ozette sockeye population includes one or more persistent spawning aggregations from each major genetic and life history group historically present within that population (Rawson et al. 2008). The PSTRT notes, however, that there is little information regarding historical diversity for the anadromous Ozette sockeye ESU, and that research is needed on current diversity types, as is a retrospective analysis of the likely historical diversity range. It is known that nearly all of the Lake Ozette beach spawning sockeye return to the lake at age 4 (Haggerty et al. 2009); while there are genetic differences between age cohorts, the age cohorts do not mix (i.e. do not spawn with each other). As a consequence, the population could be more vulnerable to catastrophic events or unfavorable conditions affecting an entire year class. Expanding the distribution of sockeye into different habitats (e.g. historical beach spawning areas and/or tributary spawning) may lead to increasing life history diversity, including changes in age composition, morphology, and behavior.

One form of diversity within the *O. nerka* species in Lake Ozette is the genetic difference between the anadromous sockeye salmon population, which is listed under the ESA, and the resident kokanee salmon, which is not. The genetic differences are large enough that these two groups are different ESUs. The PSTRT indicates that a viable population of sockeye in Lake Ozette would maintain the historical genetic diversity and distinctness between anadromous sockeye salmon and kokanee salmon (Rawson et al. 2008).

3.3.2 Adaptive Management

Adaptive management in salmon recovery planning is a method of decision making in the face of uncertainty. A plan for monitoring, evaluation, and feedback is incorporated into an overall implementation plan so that the results of actions can become feedback on design and implementation of future actions. The PSTRT found that the lack of good historical data (e.g., spawner abundances, distribution over lake beaches and between lake and tributary spawning areas, and life history diversity) was a source of uncertainty in the analysis of viability and risk of extinction for Lake Ozette sockeye. The team strongly recommended improved data monitoring and research as part of implementing the recovery plan. Then the viability criteria can be reevaluated and, if necessary, revised, as part of adaptive management.

As recovery plans for the Puget Sound recovery domain were completed and the PSTRT products finalized, NMFS restructured the PSTRT into the Recovery Implementation Technical Team (RITT). The focus of the newly formed RITT is to provide technical guidance, analysis and products related to implementation of recovery plans in the Puget Sound recovery domain.

Chapter 8 of this plan provides more information on adaptive management and specific needs for monitoring, research, and evaluation for Lake Ozette sockeye recovery. After the recovery plan is adopted, a detailed implementation plan including a monitoring program and provision for adaptive management will be developed in coordination with the RITT, Lake Ozette Steering Committee, and the co-managers.

3.3.3 Listing Factor (Threats) Criteria

Evaluating a species for potential reclassification or delisting requires an explicit analysis of the five ESA listing factors (also called "threats") in addition to evaluation of population or demographic parameters. Listing factors are those features that were evaluated under section 4(a)(1) when the initial determination was made to list the species for ESA protection. Threats are defined as the specific human activities or processes that cause the physical conditions that limit a species' ability to survive. Legal challenges to recovery plans have affirmed the need to frame recovery criteria in terms of threats as assessed under the five listing factors, which are listed in Sections 1.3 and 3.1 above.

At the time of a delisting decision, NMFS will examine whether the section 4(a)(1) listing factors have been addressed, such that delisting is not likely to result in re-emergence of the threats. It is possible that current perceived threats will become insignificant in the future as a result of changes in the natural environment or changes in the way threats affect the entire life cycle of salmon and steelhead. Consequently, NMFS expects that the ranking of threats may change over time and that new threats may be identified. Establishing criteria for each of the relevant listing/delisting factors helps to ensure that underlying causes of decline have been addressed and mitigated prior to considering a species for delisting. During its periodic status reviews, NMFS will evaluate and review the listing factor criteria under conditions at the time to determine how actions implemented to improve upon listing factors have affected VSP characteristics for the naturally produced components of the Lake Ozette sockeye salmon population.

NMFS expects that if the Lake Ozette Sockeye Recovery Plan's actions to address the threats and limiting factors are implemented, they will have a high likelihood of meeting the listing factor (threats) criteria specified in this section.

Each of the threats criteria described below is related to one or more of the major factors limiting recovery described in the plan and listed in NMFS' 2006 Report to Congress on the Pacific Coastal Salmon Recovery Fund (PCSRF) for Lake Ozette sockeye salmon, i.e., (1) riparian area degradation and loss of in-river large woody debris; (2) degraded tributaries/river/lake habitat conditions; (3) excessive sediment in spawning gravels; and (4) predation on adults by otters and seals (MFM 2000; NMFS 2003; NMFS 2006b–http://www.nwr.noaa.gov/Salmon-Recovery-Planning/PCSRF/upload/PCSRF-Rpt-2006.pdf).

Factor A: The present or threatened destruction, modification, or curtailment of a species' habitat or range.

To determine that the Lake Ozette sockeye ESU is recovered, threats to habitat should be addressed as outlined below:

1. Forest management practices continue to be implemented under the Washington Department of Natural Resources Habitat Conservation Plan for state forest lands, and under Washington State Forest Practices Rules consistent with the Forest Practices Habitat Conservation Plan on private lands. Forestry management actions are effectively monitored for consistency with HCP regulations, and rules included in the forestry plans are enforced.

2. Agricultural practices are implemented adequately throughout the watershed to protect riparian areas, floodplains, and stream channels, and to protect water quality from sediment, pesticide, herbicide, and fertilizer runoff.

3. Rural development, including land use conversion from agriculture and forest land to rural development areas, does not reduce water quality or impair natural stream conditions.

4. Channel function, including vegetated riparian areas, canopy cover, stream-bank stability, off-channel and side-channel habitats, natural substrate and sediment processes, natural hydraulic and hydrologic processes, water quality, and channel complexity is restored to provide adequate migration, rearing and spawning habitat.

5. Limnetic processes are protected and restored so that ecological inputs (of sediment, instream and groundwater flows, insects, leaves and wood) and ecological habitat processes support properly functioning lake and shoreline habitat conditions, which in turn support adequate adult migration, rearing, and spawning habitat for Lake Ozette sockeye salmon and the species they prey upon.

6. Nearshore processes are protected and restored so that ecological inputs (of sediment, instream and groundwater flows, insects, leaves and wood) and ecological habitat processes support properly functioning estuary and nearshore habitat conditions that in turn support Lake Ozette sockeye salmon and the species they prey upon.

7. Technical tools accurately assess the impacts of habitat management actions.

8. Deleterious effects of stormwater runoff are eliminated or controlled so as not to impair water quality and quantity in salmonid streams, the lake, or the riparian habitats supporting them.

9. Sufficient instream flow and lake level conditions are achieved to support salmon spawning, rearing, and migration needs and to meet the Lake Ozette sockeye population viability targets.

10. High temperatures no longer pose a threat of lethal or sub-lethal effects, such as decreased embryo viability, impaired life cycle performance of offspring, and

decreases in survival and productivity of adult migrants exposed to high temperatures in Lake Ozette and the Ozette River.

For additional information on threats related to habitat degradation and loss, see Chapter 4 of the plan and the 2006 PCSRF Report to Congress (NMFS 2006b).

Factor B: Overutilization for commercial, recreational, or educational purposes.

To determine that Lake Ozette sockeye salmon are recovered, any utilization for commercial, recreational, scientific, or educational purposes should be addressed as outlined below:

1. Fishery management plans for Lake Ozette sockeye are in place that (a) accurately account for total fishery mortality (i.e., both landed catch and non-landed mortalities) and constrain mortality rates to levels that are consistent with achieving ESU viability (i.e., provide for adequate spawning escapement given intrinsic productivity for both beach and tributary spawning sockeye); and (b) are implemented so that any effects on the abundance, productivity, diversity, and spatial structure of the population are consistent with the recovery of the ESU.

2. Compliance with fishery management rules and regulations is effectively monitored and enforced.

3. Technical tools accurately assess the potential impacts of fishery management actions.

For additional information on threats related to harvest actions, see Chapter 4 of this plan.

Factor C: Disease or predation.

To determine that the ESU is recovered, any disease or predation that threatens its continued existence should be addressed as outlined below:

1. Hatchery operations apply measures that reduce the risk that natural Lake Ozette sockeye salmon are adversely affected by fish diseases and parasites.

2. Suitable methods and levels of marine mammal and river otter control are identified and implemented to mitigate negative interactions with sockeye where predation poses significant risks to recovery. Measures taken must be consistent with NPS, Marine Mammal Protection Act, and National Marine Sanctuary laws policies, or regulations, where applicable.

3. Populations of introduced and native predator species (e.g., cutthroat trout, sculpin, northern pikeminnow, and largemouth bass) are managed such that competition or predation with Lake Ozette sockeye salmon does not impede recovery.

For additional information on current threats resulting from disease or predation, see Chapter 4 of the plan.

Factor D: The inadequacy of existing regulatory mechanisms.

To determine that Lake Ozette sockeye salmon are recovered, any inadequacy of existing regulatory mechanisms that threatens its continued existence should be addressed as outlined below:

1. Local, state, and federal regulatory mechanisms are in place to ensure that any effects on the abundance, productivity, diversity, and spatial structure of the sockeye population are consistent with the recovery of the ESU.

2. Technical tools accurately assess the potential impacts of regulatory actions.

3. Rules and regulations for habitat management, protection, and restoration (e.g., the FPHCP) are effectively enforced.

4. Habitat conditions, watershed functions, riparian corridors, and nearshore processes are conserved and protected through land-use planning that guides population growth and rural development.

5. Habitat conditions and watershed function are protected and restored through regulations that govern resource extraction such as timber harvest.

6. Adequate resources, priorities, regulatory frameworks, and coordination mechanisms are established and/or maintained for the effective management of fisheries and for effective enforcement of land and water use regulations that protect and restore habitats and marine and freshwater bodies.

7. Habitat conditions and watershed functions are protected through land acquisition or easements from willing landowners as appropriate where existing policy or regulation does not provide adequate protection.

8. Adequate Washington Department of Ecology regulatory mechanisms protect water quality and restrict stormwater runoff.

For additional information on existing regulatory mechanisms, see Section 7.2.1 of the plan.

Factor E: Other natural or man-made factors affecting the species' continued existence. To determine that Lake Ozette sockeye salmon are recovered, other natural and man-made threats to its continued existence should be addressed as outlined below:

1. Federal, state, and tribal hatchery management plans are in place to ensure that any effects on the abundance, productivity, diversity, and spatial structure of the population are consistent with the recovery of the ESU.

2. Integrated adaptive management that includes monitoring, evaluation, and research programs is implemented to assess the potential impacts of hatchery, habitat, and harvest management actions.

3. Hatcheries operate using appropriate ecological, genetic, and demographic risk containment measures for (1) hatchery-origin adults returning to natural spawning areas, (2) release of hatchery juveniles, (3) handling of natural-origin adults at hatchery facilities, (4) withdrawal of water for hatchery use, (5) discharge of hatchery effluent, and (5) maintenance of fish health during sockeye salmon propagation in the hatchery.

4. Rules and regulations for hatchery fish management and protection are effectively enforced.

5. Ecological functions of salmon, including their benefits in cycling ocean-derived nutrients into freshwater lake, estuarine, and nearshore areas are considered in developing and implementing fishery, hatchery, and habitat management actions.

6. All hatchery-origin juvenile Lake Ozette sockeye salmon are marked to differentiate them from natural-origin Lake Ozette sockeye, enabling assessments of hatchery and wild sockeye production levels through sampling of fisheries, migratory areas, and adult returns to hatcheries and natural spawning areas.

7. Mechanisms are in place to reduce the incidence of, and impacts from, introduced, invasive, or exotic species.

3.4 DELISTING DECISIONS

NMFS concludes that the biological (Section 3.3.1) and listing factor (threats) criteria (Section 3.3.3), when taken together, describe conditions, commitments, and administrative measures that, when met, would result in a determination that the species is not likely to become endangered within the foreseeable future throughout all or a significant portion of its range. The criteria should exceed the minimum necessary to delist the ESU. In accordance with its responsibilities under section 4(c)(2) of the Act, NMFS will conduct status reviews of Lake Ozette sockeye salmon at least once every five years to evaluate the status of the ESU and determine whether it should be removed from the list or changed in status. Such evaluations will take into account the following:

- The biological criteria (Rawson et al. 2008 and Currens et al. 2006) and listing factor (threats) criteria described above and as amended through the research, monitoring, evaluation, and adaptive management processes included in this plan.

The TRT has provided biological viability criteria that include a planning range for abundance. NMFS has asked the PSTRT to further calculate a more specific abundance and productivity target within this range, which, over a specified number of years, would represent a level upon which to base the delisting decision. A more specific target will be added to the recovery plan when it becomes available.

- The management programs in place to address the threats.
- Principles presented in the Viable Salmonid Populations paper (McElhany et al. 2000).
- Best available information on ESU status and new advances in risk evaluation methodologies.
- Other considerations, including: the distribution of spawning aggregations; the diversity of life history and phenotypes expressed; the function and ecological diversity of occupiable habitat types relative to those available to the historical population; and considerations regarding catastrophic risk.

3.5 MODIFYING OR UPDATING THE RECOVERY PLAN

The ESA requires a review of all listed species at least once every five years. Guidance for these reviews developed jointly by NMFS and the U.S. Fish and Wildlife Service is on the NMFS website: http://www.nmfs.noaa.gov/pr/pdfs/laws/guidance_5_year_review.pdf. According to NMFS Interim Endangered and Threatened Species Recovery Planning Guidance (NMFS Recovery Guidance) (NMFS 2006a), immediately following the five-year species review, an approved recovery plan should be reviewed in conjunction with implementation monitoring, to determine whether or not the plan needs to be brought up to date.

NMFS Recovery Guidance provides three types of plan modifications: 1) an update; 2) a revision; or 3) an addendum. An update involves relatively minor changes. An update may identify specific actions that have been initiated since the plan was completed, as well as changes in species status or background information that do not alter the overall direction of the recovery effort. An update does not suffice if substantive changes are being made in the recovery criteria or if any changes in the recovery strategy, criteria, or actions indicate a shift in the overall direction of recovery; in this case, a revision would be required. Updates can be made by the Salmon Recovery Division, which will seek input from the local stakeholder group prior to making any update. An update would not require a public review and comment period.

NMFS expects that updates will result from implementation of the adaptive management program for this plan. Adaptive management depends on the flow of information from field staff to recovery managers and planners; hence it requires frequent updates from monitoring and research on the effectiveness of recovery actions and the status and trends of the listed species. It may be most efficient to keep the recovery plan current by updating it frequently enough to forego the need for major revisions.

A revision is a substantial rewrite and is usually required if major changes are required in the recovery strategy, objectives, criteria, or actions. A revision may also be required if new threats to the species are identified, when research identifies new life history traits or threats that have significant recovery ramifications, or when the current plan is not achieving its objectives. Revisions represent a major change to the recovery plan and must include a public review and comment period.

An addendum can be added to a recovery plan after the plan has been approved and can accommodate minor information updates or relatively simple additions such as implementation strategies or participation plans, by approval of the field office or Regional Administrator. More significant addenda—adding a species to a recovery plan, for example—should undergo public review and comment before being attached to a plan. Addenda are approved on a case by case basis because of the wide range of significance of different types of addenda. NMFS will seek input from stakeholders on minor addenda to the Lake Ozette Sockeye Salmon Recovery Plan.

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4 LIMITING FACTORS

The causes for decline of Lake Ozette sockeye are numerous and not entirely understood, although several hypotheses were proposed prior to the initiation of the current recovery planning effort (e.g., Jacobs et al. 1996, Gustafson et al. 1997, and MFM 2000). Makah Fisheries Management (2000) summarized the commonly presented factors for decline as follows: (1) loss of adequate quality and quantity of beach spawning habitat; (2) loss of tributary spawning sockeye populations; (3) past over-exploitation; (4) predation and disruption of natural predator-prey relationships; (5) introduction of non-native fish and plant species; (6) temporarily poor ocean conditions; and (7) interactions of these factors. The collective effects of these factors may have further influenced spawning habitat quality by reducing the population size to a threshold where lower densities of spawning fish could not adequately maintain clean, vegetation-free spawning gravels. The introduction of non-native plant and fish species may currently affect the population's ability to recover, but there is currently little evidence to implicate non-native species as an important factor responsible for the decline of Lake Ozette sockeye.

It is important to distinguish between factors responsible for the decline of the population (factors for decline), and factors that currently limit sockeye abundance and productivity (limiting factors), as they are not necessarily one and the same. Certain activities that may have contributed to the decline of Ozette sockeye may no longer operate to limit abundance or productivity (e.g., commercial sockeye harvest).

A more thorough identification of limiting factors hypothesized as currently affecting Lake Ozette sockeye was completed recently and is described in detail in the Lake Ozette Sockeye Limiting Factors Analysis (LFA) (Haggerty et al. 2009). Based on the best available information and analysis, the Lake Ozette Steering Committee's Technical Workgroup evaluated and rated each of the limiting factors hypotheses for its contribution to sockeye population or subpopulation mortality by life stage. The degree of impact of each limiting factor hypothesis was categorized as one of the following: unknown, negligible, low, moderate, or high. Sections 4.1 through 4.4 present a summary of the findings from the Lake Ozette Sockeye LFA (for detailed explanations and evidence for each limiting factor and life stage, please refer to the LFA). Figure 4.1 and Figure 4.2 are simplified depictions of these limiting factor ratings. The figures illustrate the estimated relative mortality thought to be associated with each hypothesized limiting factor for sockeye salmon by subpopulation and life stage.

Limiting factors affecting Lake Ozette sockeye are presented in this plan as a series of hypotheses that can be tested. The adaptive management program will include monitoring and evaluation designed to yield information confirming or disconfirming these hypotheses; this information, in turn, will become feedback to management on the effectiveness of recovery strategies and actions.

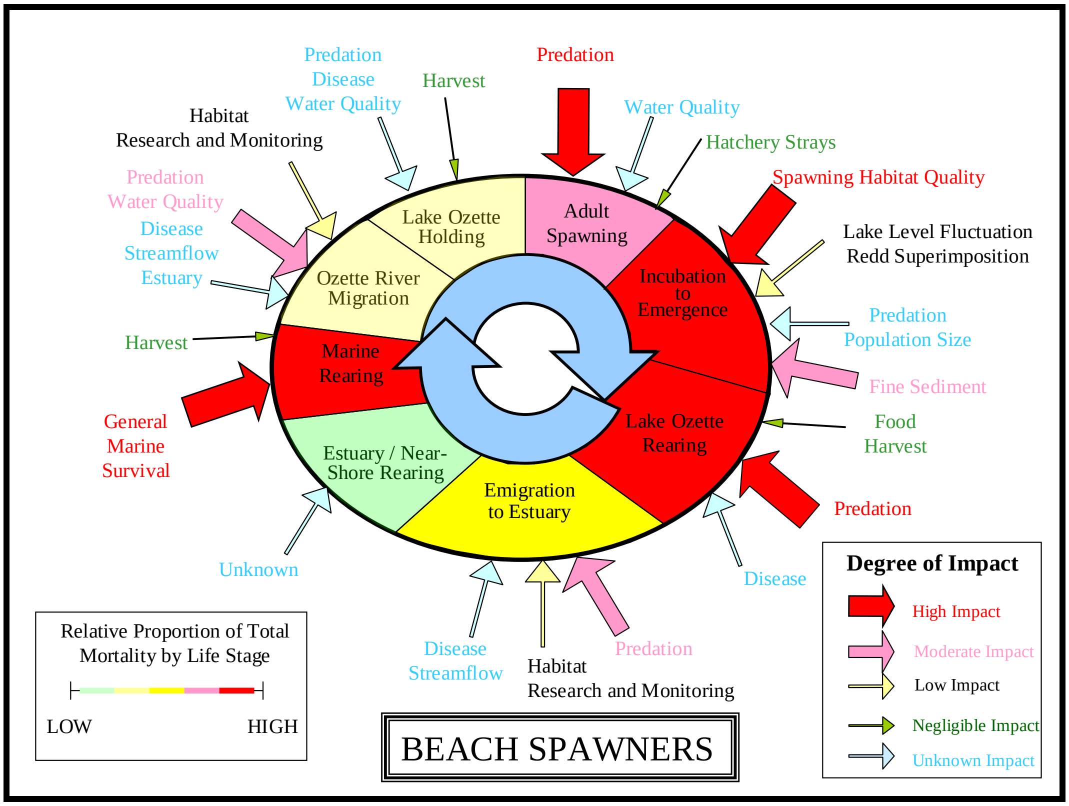

Figure 4.1. Beach spawning sockeye life history stages and hypothesized limiting factors.

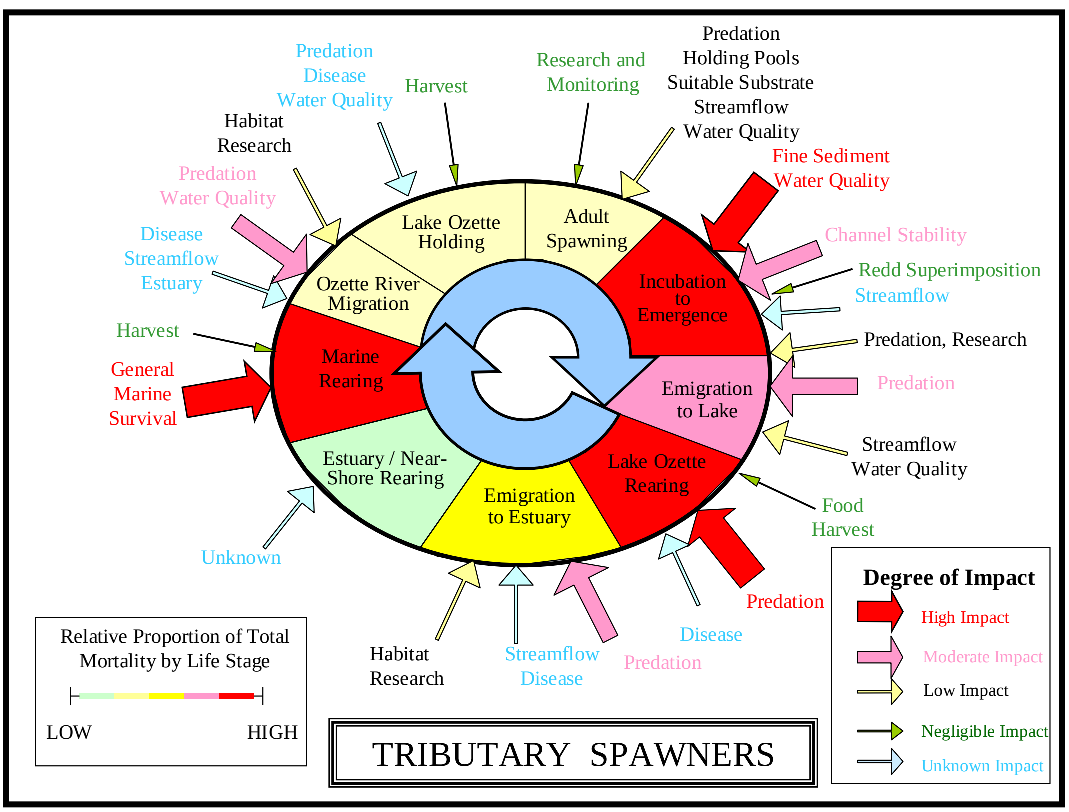

Figure 4.2. Tributary spawning sockeye life history stages and hypothesized limiting factors.

4.1 LIMITING FACTORS APPROACH

Identifying, rating, and describing the factors that limit the productivity and abundance of the species in question enables recovery planners to identify actions, management scenarios, and activities that, in turn, may reduce the limiting factors and help to rebuild the population(s). The Limiting Factors Analysis (Haggerty et al. 2009) identified and rated limiting factors based upon the degree of impact and relative mortality by life stage that directly results from a given phenomenon. The LFA method of identifying limiting factors differed significantly from methods used in other limiting factors analyses conducted within the Puget Sound recovery domain. In these other limiting factors analyses, biologists and planners identified factors that had been altered through various human management practices (e.g., land use, fisheries, hatcheries) and typically did not include intrinsic factors (e.g., marine survival and/or predation) that limit the productivity and abundance of salmonids. In contrast, the approach used in the Lake Ozette Sockeye LFA included both intrinsic limiting factors and anthropogenically influenced limiting factors.

Within the LFA and this recovery plan we assume that the historical (pre-European development) intrinsic factors that "naturally" limited sockeye abundance, productivity, spatial structure, and diversity resulted in a viable sockeye salmon population. Furthermore we assume that in historical times, since Euro-American homesteading began in the watershed, human activities have changed the watershed and ecosystem in which sockeye salmon were once viable by altering the physical features and biological processes that create sockeye salmon habitat at the population and subpopulation scale. These physical and biological alterations have resulted in decreased sockeye viability by reducing the abundance, productivity, spatial structure, and diversity of Ozette sockeye. Past, present, and future actions that affect the physical and biological state of the watershed have the potential to further decrease the viability of Lake Ozette sockeye. In order to develop critical insight into how to improve the physical and biological conditions affecting the viability of Ozette sockeye, the LFA and this recovery plan identify the limiting factors currently affecting sockeye, the processes and inputs that create the limiting factors, and the activities (past and present) that alter inputs and processes.

The Lake Ozette sockeye salmon ESU is composed of one population (PSTRT 2006) and contains five known spawning aggregations. Each spawning aggregation represents an individual subpopulation. Some limiting factors, habitat conditions, and life histories are shared among all subpopulations, while others vary among them. In the LFA, the subpopulations were grouped based on spawning environment, i.e. tributary vs. beach, and limiting factors were described in three categories: those affecting the entire population; those specific to beach spawners; and those specific to tributary spawners. This approach is also used in the recovery plan. Limiting factors identified for each of these three categories are assigned into one of three further categories, reflecting their relative standing as ***Key*** limiting factors, ***Contributing*** limiting factors, or factors ***Not Likely*** limiting.

- ***Key*** limiting factors are those with the greatest impact on the population's ability to reach the status desired for it. Key limiting factors directly result in decreased sockeye salmon viability, because of the degree of impact, frequency and persistence of impact, and/or scale of population affected. A key limiting factor required high ratings in both the degree of impact on sockeye and the relative mortality during at least one life history stage. In addition, conditions influencing the factor must have a significant linkage to anthropogenically influenced processes and inputs.
- ***Contributing*** limiting factors also influence survival and/or directly result in the mortality of sockeye salmon. Contributing limiting factors are likely to cumulatively or individually result in decreased sockeye salmon viability, because of the degree of impact, frequency and persistence of impact, and/or scale of population affected, but the degree of impact is rated low, moderate, or unknown.
- ***Factors not likely limiting*** can influence the survival or directly result in the mortality of individual sockeye salmon, but because of the scale of influence, either by degree of impact or scale of population affected, they are not likely to cumulatively or individually result in decreased sockeye salmon viability. The degree of impact is rated low, negligible, or unknown.

Several parameters regulating and/or affecting each key and contributing limiting factor are described and evaluated in subsections 4.2 through 4.4. Each limiting factor is presented in a structured system that includes five parts: life history stages affected, limiting factor hypothesis, limiting factor rationale, description of processes and inputs regulating limiting factor, and activities and/or conditions affecting processes and inputs.

The limiting factor hypotheses were simplified to make the recovery plan more accessible to a wider audience.[2] Details are available in the Limiting Factors Analysis (Haggerty et al. 2009). Whereas the hypotheses in the Limiting Factors Analysis were logically split up into the smallest possible units of verifiable assertions, for the recovery plan they were combined (lumped) into new single hypotheses that would cover either an entire population segment or the entire sockeye population.

For example, Hypothesis 1 in the recovery plan states that predation on sockeye salmon in recent times is higher than it used to be, probably because of changes in relative numbers of sockeye and predators. In the Limiting Factors Analysis, this general statement relating to all life stages of sockeye and all subpopulations is broken down into life history stages and locations: adult sockeye in the Ozette River heading for the lake; adult sockeye holding in the lake before spawning; juvenile sockeye rearing in the lake; juvenile sockeye in the Ozette River heading for the ocean. Each of these categories in turn may have several "sub-hypotheses" about specific causes for higher predation in specific situations.

[2] The numbers corresponding to the hypotheses in the Recovery Plan and those identified in the Limiting Factors Analysis do not necessarily correspond. However, the principles of those hypotheses brought forward from the LFA to the Recovery Plan are accurately reflected in the Plan.

Recovery plan hypotheses are numbered 1 through 16 according to the order in which they are presented. ***Numbering does not indicate importance, priority, or rank.*** Table 4.1 includes a summary of each limiting factor hypothesis presented in Sections 4.2 to 4.4 of the recovery plan and a link to the related hypotheses in Haggerty et al. (2009). Habitat-forming processes and inputs that may regulate limiting factors within the watershed are also identified in Sections 4.2 to 4.4. Examples of habitat-forming processes and inputs include but are not limited to the following: riparian community succession and organic inputs, sediment delivery and bedload storage and transport, precipitation runoff patterns, channel migration, predator-prey food-web interactions, and thermal and chemical inputs. Habitat-forming processes and inputs affecting limiting factor hypotheses were identified based on best available information for the Lake Ozette watershed. Finally, land use and other activities that affect natural habitat-forming processes and inputs are also identified within Chapter 4. For each limiting factor hypothesis presented, the linkage between habitat-forming processes and inputs is presented, as well as the known anthropogenic activities that affect the natural rate, quantity, or pathway of habitat-forming processes and inputs. Understanding the linkage between limiting factors, processes and inputs, and activities that alter natural habitat-forming processes and inputs is critical in the development of strategies aimed at recovering the conditions that limit VSP parameters. A monitoring and evaluation plan structured as part of an adaptive management program makes it possible to adjust the course of recovery actions as our understanding increases.

Table 4.1. Summary of limiting factors hypotheses presented in this plan and links to limiting factors hypotheses presented in the LFA (Haggerty et al. 2009).

Limiting Factor Hypothesis # Used in Plan	Limiting Factor Hypothesis # in LFA	Limiting Factor Hypothesis Category	Population Segment(s) Affected	Limiting Factor	NARRATIVE
Hypothesis 1 (Predation)	1, 7, 41, 45	Key	ALL	Predation	Changes in relative predator-prey abundances in the Ozette River and Lake Ozette have increased the proportion of juvenile and adult sockeye consumed by predators and resulted in decreased freshwater survival, as well as an overall decrease in the number of sockeye returning to spawn.
Hypothesis 2 (Water Quality)	3, 7, 47	Contributing	ALL	Water Quality	High stream temperatures and low frequency, high intensity turbidity events reduce the fitness of sockeye salmon entering or exiting Lake Ozette and result in decreased survival and productivity.
Hyporthesis 3 (Water Quantity)	4, 48	Contributing	ALL	Streamflow	Reduced streamflows in the Ozette River affect water quality and predation rates and efficiency and reduce the fitness of migrating and emigrating sockeye.

Limiting Factor Hypothesis # Used in Plan	Limiting Factor Hypothesis # in LFA	Limiting Factor Hypothesis Category	Population Segment(s) Affected	Limiting Factor	NARRATIVE
Hypothesis 4 (Habitat)	2, 46	Contributing	ALL	Habitat	Reduced pool depth, volume, and cover have decreased predator avoidance capabilities and refuge areas for sockeye, increasing predator efficiency and reducing refuge habitat.
Hypothesis 5 (Marine Survival)	53	Contributing	ALL	Marine Survival	Survival in the marine environment is driven by large-scale climatic processes, which are not controllable. Variability in marine survival rates for sockeye salmon is significant, but not likely a key limiting factor at present. Large-scale changes in marine conditions should be monitored and may be significant in the future.
Hypothesis (Estuary)	NA	Unknown	ALL	Estuary	Because little is known about the Ozette River estuary, there is no current hypothesis concerning estuarine conditions as a limiting factor for sockeye. This is an important data gap.
Hyporthsis 6 (Beach Spawning Habitat)	13, 17	Key	Beach Spawners	Beach Spawning Habitat	Reduced quality and quantity of beach spawning habitat in Lake Ozette has decreased egg to emergence survival, resulting in reduced fry production from the beach spawning aggregations.

Limiting Factor Hypothesis # Used in Plan	Limiting Factor Hypothesis # in LFA	Limiting Factor Hypothesis Category	Population Segment(s) Affected	Limiting Factor	NARRATIVE
Hypothesis 7 (Predation)	11, 18	Key	Beach Spawners	Predation	Changes in relative predator-prey abundances on Ozette spawning beaches have increased the proportion of adult sockeye, eggs, and newly emerged fry consumed by predators, resulting in decreased freshwater survival.
Hpothesis 8 (Water Quality)	NA	Contributing	Beach Spawners	Water Quality	Turbidity and suspended sediment concentration (SSC) at Olsen's and Allen's Beaches have a limited effect on sockeye salmon because of the distance of spawning habitat from major sediment sources. However, at historical spawning sites near major tributary outfalls, such as Umbrella Beach, the effects of turbidity and SSC would be expected to be similar to those described in Hypothesis 13.
Hypothesis 9 (Lake Level)	14	Contributing	Beach Spawners	Lake Level	Seasonal lake level changes result in redd dewatering, decreasing egg-to-fry survival rates.
Hypotheis 10 (Competition)	15	Contributing	Beach Spawners	Competition	Reduced spawning habitat quality and quantity have increased the competition for suitable habitat at low to moderate spawning escapement levels, resulting in increased redd superimposition and decreased egg-to-fry survival.

Limiting Factor Hypothesis # Used in Plan	Limiting Factor Hypothesis # in LFA	Limiting Factor Hypothesis Category	Population Segment(s) Affected	Limiting Factor	NARRATIVE
Hypothesis 11 (Tributary Spawning Habitat)	26, 31	Key	Tributary Spawners	Tributary Spawning Habitat	Channel simplification and increased sediment production and delivery to streams have decreased the quantity of suitable spawning habitat (i.e., gravel) available to tributary spawning sockeye. Increased levels of fine sediment (<0.85mm) in spawning gravels reduces intra-gravel flow and oxygenation of redds, resulting in decreased egg-to-fry survival.
Hypothesis 12 (Stability)	32	Contributing	Tributary Spawners	Channel Stability	Decreased channel stability and floodplain alterations have reduced egg-to-fry emergence survival in sockeye tributaries.
Hypothesis 13 (Water Quality)	22, 29, 34, 40	Contributing	Tributary Spawners	Water Quality	Elevated turbidity and SSC levels increase stress and reduce sockeye fitness, resulting in increased egg retention rates and pre-spawning mortalities. High levels of turbidity and SSC result in fine sediment deposition in sockeye redds, decreasing egg survival. High levels of turbidity and SSC during the sockeye fry emigration period result in reduced sockeye fry survival, fitness, increased gill abrasion, and altered oxygen uptake.

Limiting Factor Hypothesis # Used in Plan	Limiting Factor Hypothesis # in LFA	Limiting Factor Hypothesis Category	Population Segment(s) Affected	Limiting Factor	NARRATIVE
Hypothesis 14 (Predation)	19, 24, 36, 38	Contributing	Tributary Spawners	Predation	Predation of sockeye fry during emergence, emigration, and dispersal significantly reduces the number of fry rearing in the pelagic zone of the lake. Predation on adult sockeye and eggs in tributaries occurs at low levels and is not likely a significant limiting factor.
Hypothesis 15 (Water Quantity)	21, 27, 33, 39	Contributing	Tributary Spawners	Streamflow	Natural and anthropogenically influenced streamflow variability (magnitude, frequency, and timing of low and high flows) affects sockeye mortality by: 1) delaying adult migration into tributaries (resulting in more predation, egg retention), 2) limiting where adults spawn in a cross-section (e.g., sequestering spawners in areas where egg scour or desiccation is likely), and/or 3) increasing emigrating fry exposure times in tributaries (resulting in predation, water quality issues).

Limiting Factor Hypothesis # Used in Plan	Limiting Factor Hypothesis # in LFA	Limiting Factor Hypothesis Category	Population Segment(s) Affected	Limiting Factor	NARRATIVE
Hypothesis 16 (Holding Pools)	20, 25	Not Currently Limiting	Tributary Spawners	Holding Pools	Current holding pool frequency and volume, reduced from historical conditions, appear to be adequate in relation to the current numbers of adult sockeye salmon. However, as the tributary population continues to expand, this factor may begin to exert an influence.

4.2 LIMITING FACTORS AFFECTING ALL POPULATION SEGMENTS

All Lake Ozette sockeye aggregations experience the same habitat conditions and limiting factors during five life history stages: adult migration (Ozette River), adult holding (Lake Ozette), juvenile rearing (Lake Ozette), smolt emigration to the ocean (Ozette River), and marine rearing. The LFA identified and characterized limiting factors by life stage and degree of impact of each limiting factor within each life stage. The results of the LFA for limiting factors affecting all population segments are shown in Figure 4.3. Each limiting factor was assessed based upon the sockeye life stage affected, the process or input influencing the limiting factor, and activities that affect each process and input. A summary of this assessment is included in Figure 4.4. A detailed narrative of key and contributing limiting factors is included in Sections 4.2.1 and 4.2.2.

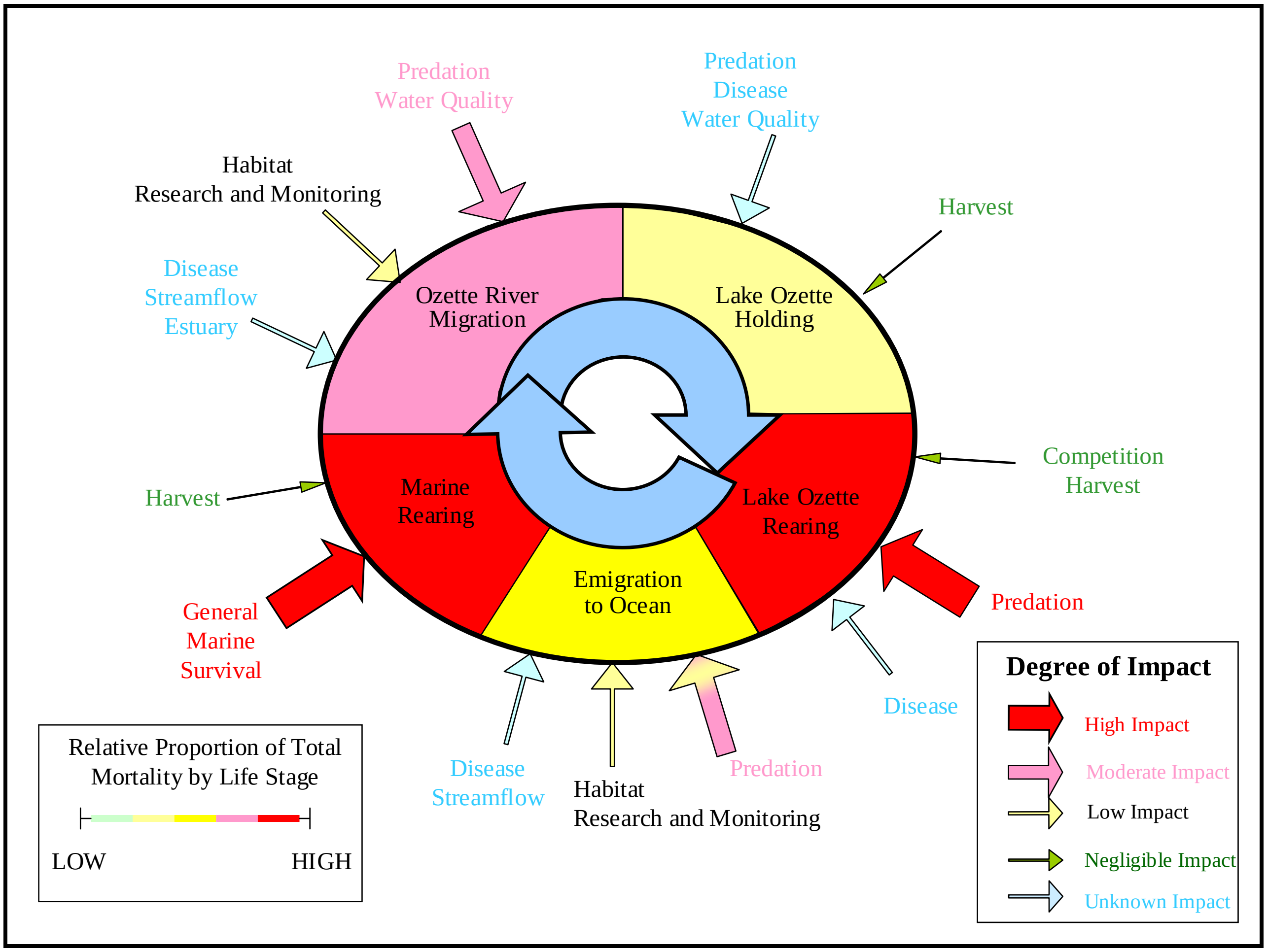

Figure 4.3. Conceptualization of hypothesized limiting factors affecting all Lake Ozette sockeye population segments. Arrows depict the degree of impact for each limiting factor and colored polygons depict the relative proportion of total mortality by life stage.

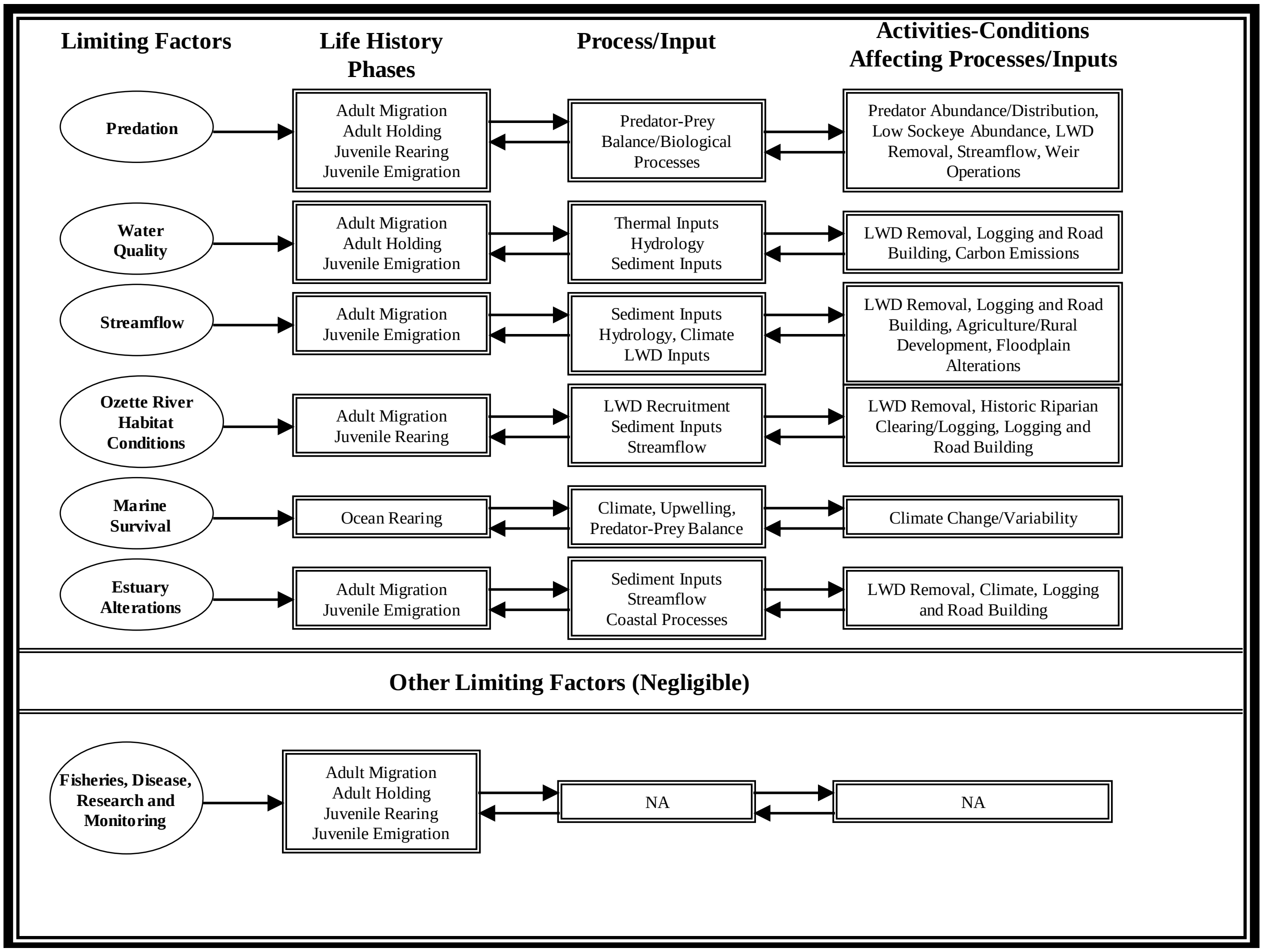

Figure 4.4. Hypothesized limiting factors affecting all population segments, life history phases affected, processes and inputs regulating limiting factors, and activities/conditions affecting processes and inputs.

4.2.1 Key Limiting Factors

Predation is the only key limiting factor identified that affects all population segments.

4.2.1.1 Predation (H#1-Pred)

Hypothesis 1: Changes in relative predator-prey abundances in the Ozette River and Lake Ozette have increased the proportion of juvenile and adult sockeye consumed by predators such as cutthroat trout, northern pikeminnow, largemouth bass, river otters, and harbor seals, and resulted in decreased freshwater survival, as well as an overall decrease in the number of sockeye adults returning to spawn.

Life stages affected: Adult migration, adult holding, juvenile rearing, and juvenile emigration.

Rationale: Sockeye entering Lake Ozette have a high incidence of predator-induced scarring and open wounds (~30-50 percent). A mark and recapture study conducted in

2000 (Gearin et al. 2002) indicates that 10 percent of the sockeye recaptured entering the lake were wounded by seals and otters in the Ozette River, while up to an additional 50 percent of the fish marked downstream were not successfully recaptured entering the lake, suggesting that a significant but unquantified level of aquatic mammal predation occurs in the river, estuary, and nearshore environment. The level of impact on the population is thought to increase as the run size decreases. Natural and hatchery-origin sockeye produced in Lake Ozette tributaries can buffer the effects of predation on the beach spawning population by increasing the number of adult fish entering fresh water and potentially "swamping" predators.

The disposition of adult sockeye entering the lake and holding for several months prior to spawning is not fully understood. Assessing adult sockeye mortality rates during the holding period is complicated by the relatively large size of the lake, the small size of the population, sockeye holding behavior, and limnological conditions that limit direct observations of sockeye mortalities and the number of sockeye surviving to spawn in the lake. Limiting factors affecting sockeye holding in Lake Ozette include predation by aquatic mammals. The degree to which predation on holding adult sockeye limits sockeye survival is unknown and remains a data gap.

Beauchamp et al. (1995) suggested that cutthroat trout within Lake Ozette were consuming most of the fry produced within the watershed. Other factors, such as harvest and habitat degradation, may have reduced the sockeye population to levels such that predators could consume the majority of juveniles produced. It is possible, however, that increased sockeye fry recruitment to the lake from tributary production has decreased the rate of predation since Beauchamp's studies. Age-0 *O. nerka* population dynamics have likely changed dramatically since the early 1990s, commensurate with the advent of substantial fry production by the tributary hatchery program. Future studies should specifically monitor piscivorous fish predation of juvenile sockeye in the lake. Quinn (2005) found that average survival from fry-to-smolt for sockeye in other lake systems averages roughly 25 percent, and that predation is presumably responsible for most of the mortality in the sockeye lakes studied.

Smolt trapping and adult sockeye weir enumeration data indicate that large numbers of predators congregate in the Ozette River during the smolt emigration period. Stomach content analyses of northern pikeminnow collected in the Ozette River smolt trap indicates that they actively feed on sockeye and coho smolts. The impact from predation on the emigrating sockeye smolt population was rated as moderate at low smolt abundance and low at moderate and high smolt abundances.

Processes and inputs: Processes and inputs affecting predator-prey balance and predation efficiency have been altered from pre-European contact conditions. Processes and inputs affecting predator efficiency include LWD recruitment and removal, which resulted in reduced habitat complexity.

Activities affecting inputs/processes: Activities affecting, or that have affected, the predator-prey balance in the Ozette watershed include: introduction of non-native fish species; historical (1948-1977) directed fisheries that resulted in decreased sockeye abundance; selective habitat alterations that negatively affected sockeye habitat (resulting in reduced sockeye abundance) but had a negligible effect (or positive effect) on predators' key habitat; increases in local pinniped populations caused by a combination of disruption and alteration in the marine ecosystem resulting in the reduction in the number of apex predators (e.g., orcas) that feed on pinnipeds; abandonment of the Ozette Village and resulting loss of local pinniped hunting; and implementation of the Marine Mammal Protection Act.

4.2.2 Contributing Limiting Factors

Contributing limiting factors affecting all Lake Ozette sockeye population segments include water quality, Ozette River streamflow, Ozette River habitat conditions, marine survival, and estuary alterations.

4.2.2.1 Water Quality (H#2-WQ)

Hypothesis 2: High stream temperatures and low frequency, high intensity turbidity events reduce the fitness of sockeye salmon entering or exiting Lake Ozette and result in decreased survival and productivity.

Life stages affected: Adult migration, adult holding, and juvenile emigration.

Rationale: High stream temperatures and low frequency, high intensity turbidity events occur during the adult sockeye migration period. The physiological optimum temperature for sockeye salmon is in the range of 12-15ºC (Brett 1971). Temperatures approaching 24°C have been recorded in the Ozette River during the period when adult fish are leaving the ocean and transiting the river to Lake Ozette (Haggerty et al. 2009). During the 2004 adult migration, it was estimated that ~56 percent of adult sockeye entered the Ozette River when daily stream temperatures were >18°C and more than 16 percent entered when daily average stream temperature exceeded 21°C.

Gearin et al. (2002) reported that the mean transit time for adult sockeye from the estuary to lake entry in RY 2000 was 65.2 hours (range=17-154hrs). Sockeye may encounter excessive temperatures (>20ºC) in the Ozette River, but their exposure time appears to be short. The effects of 2- to 4-day exposure to temperatures between 18-24 °C is not well documented in the scientific literature. However, it is important to note that some individuals linger in the river longer; approximately 8 percent of sockeye reported by Gearin et al. (2002) spent 6 to 7 days between the estuary and the lake. High water temperatures in the Ozette River during adult migration are not known to result in significant direct en-route mortality. High temperatures likely make sockeye more susceptible to disease and infection. Elevated temperatures can promote fungal and bacterial infections, as well as secondary wound infection, making sockeye more susceptible to pre-spawning mortality.

During the past 90 years, air temperatures during the adult sockeye migration period are estimated to have increased by 1-2ºC, based on climate data from a nearby monitoring station. Air temperature is arguably the most important meteorological variable affecting lake surface temperature, as it is causally involved in all heat exchange processes except the absorption of solar radiation and the emission of long-wave radiation from the lake surface (Kettle et al. 2004). Thus, the increase in average air temperature suggests an increase in average lake temperature since the early 1900s.

Collectively, poor water quality conditions, especially during the later part of the run, are cause for concern. Adult sockeye covered in silt and bleeding from the gills have been observed in the Ozette River following high turbidity and SSC events. The size and angularity of suspended sediment particles in lower Coal Creek samples may explain field observations of sockeye impacts caused by SSC. The disposition of adult sockeye exposed to such conditions and then entering the lake and holding for several months prior to spawning is unknown; assessment of population status and mortality rates during the holding period is complicated by the relatively large size of the lake, the small size of the population, sockeye holding behavior, and limnological conditions that limit direct observations. However, delayed pre-spawning mortality related to decreased fitness from elevated water temperatures and high SSC events in the Ozette River is likely to reduce the number of sockeye that survive to spawn.

High stream temperatures occur in the Ozette River during the sockeye smolt emigration period, but the majority of the smolts emigrate before stream temperatures reach >16°C. Based on average emigration timing, only a small fraction of sockeye smolts are likely to encounter temperatures exceeding 18°C. Low frequency, high intensity turbidity events resulting in moderate physiological stress are of greater concern. In April, when average Ozette River streamflow is still ~400 cfs, SS inputs from Coal Creek would normally be diluted by flow contributions from the Ozette River; however, even 50 percent dilution of the SSC would have a negligible effect on the predicted impacts on sockeye salmon at the concentration levels estimated to occur following a 2-inch precipitation event (see LFA).

From May to August when the lake level is typically low, no or very limited dilution from the Ozette River would be expected, because high intensity rainfall events usually reverse the flow of the Ozette River (during low lake level periods) and Ozette River flow is made up almost entirely of Coal Creek discharge. Severity indices estimated from data tables in Newcombe and Jensen (1996) indicate that for moderately common storm events in Coal Creek (10 percent to 3 percent probability of occurrence on any given day from May-August), moderate behavioral and physiological stress could occur for juvenile sockeye. Effects could include moderate physiological stress; moderate habitat degradation and impaired homing; and major indications of physiological stress and poor condition. During the month of May, no more than 7.5 percent of the average annual emigrating smolt population is expected to encounter suspended sediment at concentrations predicted to result in moderate physiological stress.

Processes and inputs: Processes and inputs affecting water quality in the Ozette River include: thermal inputs, hydrology, and sediment inputs.

Activities affecting inputs/processes: The following activities affect water quality conditions in the Ozette River:

- Large woody debris (LWD) removal or losses in LWD volume has caused channel destabilization, which, in turn, can result in higher turbidity and suspended sediment concentrations.
- Logging and road building have increased sediment inputs, reduced sediment storage, and resulted in more frequent high suspended sediment concentration events in the Ozette River.
- Channel alterations and sediment mobilizing events have increased coarse sediment deposition at the confluence of Coal Creek and the Ozette River. Increased sediment deposition has resulted in an increase in the lake's outlet control elevation, thereby altering the river's streamflow (see Hypothesis 3), which may result in reduced water quality.
- Increased carbon dioxide and other greenhouse gas emissions have altered and are altering greenhouse gas concentrations in the atmosphere. Increased greenhouse gases in the atmosphere have been linked to global climate change. Global climate change is likely resulting in warmer lake and river temperatures.

4.2.2.2 Ozette River Streamflow (H#3-Q)

Hypothesis 3: Reduced streamflows in the Ozette River affect water quality and predation rates and efficiency and reduce the fitness of migrating and emigrating sockeye.

Life stages affected: Adult migration and juvenile emigration.

Rationale: Available discharge data for the Ozette River at the lake outlet indicate a clear trend of decreasing baseflow (summer discharge) over time from the 1970s to 2000s (Haggerty et al. 2009). The decrease is likely caused by multiple factors acting cumulatively over time.

Available data do not indicate that precipitation or lake level have changed dramatically over time to influence Ozette River discharge. Rather, internal mechanisms are at play. A significant change in the lake stage-streamflow relationship occurred in the Ozette River between 1979 and 2002, indicating that streamflow in the Ozette River is lower for a given lake stage in 2002 than it was in 1979. The percentage of hyporheic (underground) flow to total flow may have changed because of sedimentation near the confluence of the Ozette River and Coal Creek. Increasing shoreline vegetation has increased evapotranspiration, potentially influencing lake levels and thus river discharge. Summer base flows into Lake Ozette may have declined as a result of the effects of land use on fog drip, summer transpiration efficiency of dominant vegetation, soil water retention, and floodplain water storage. These hypothesized reductions in summer water inputs to Lake Ozette could translate to reduced Ozette River streamflow.
Reduced streamflow has the potential to affect water quality, predation rates and efficiency, and migration, reducing the fitness of migrating adult sockeye. For example, in return year (RY) 2003, just under 38 percent of the sockeye entered when streamflow

was less than 100 cfs. Approximately 10 percent of the RY 2003 sockeye entered the lake when flows were less than 35 cfs. The lowest flow in which sockeye were observed migrating was 11 cfs. The overall decrease in baseflow (summer discharge) during the sockeye migration period remains unknown, and the relative contribution of the aforementioned factors is poorly understood, as are the biological effects.

Processes and inputs: Processes and inputs affecting streamflow in the Ozette River include: climate; lake and tributary hydrology; sediment input, routing, and storage in the lake's outlet and the upper half-mile of the Ozette River; and LWD recruitment and storage (in logjams) in the upper one mile of the Ozette River.

Activities affecting inputs/processes: Activities affecting Ozette River streamflow hydrology include:

- Historical LWD removal in the Ozette River
- ONP facilities operation and maintenance in Ozette River riparian zone
- Logging and road building throughout the watershed and specifically in Coal Creek
- Agriculture and rural development in the Big River valley
- Other floodplain alterations in major tributaries to the lake

4.2.2.3 Ozette River Habitat Conditions (H#4-Hab)

Hypothesis 4: Reduced pool depth, volume, and cover have decreased sockeye refuge areas and their ability to avoid predators, thus increasing predator efficiency.

Life stages affected: Adult migration and juvenile emigration.

Rationale: The loss of large (>50 cm diameter) woody debris (LWD) in the Ozette River through past removal operations has undoubtedly reduced habitat complexity throughout much, if not all, of the Ozette River. Past riparian forest removal adjacent to the upper 0.4 miles of the Ozette River has reduced LWD inputs, delaying the recovery and habitat potential of the upper river. Although adult sockeye spend a limited amount of time in the Ozette River, habitat simplification reduces refuge areas, making adult sockeye more susceptible to predation. Reduced LWD and habitat complexity also reduce refuge areas for emigrating juvenile sockeye. Sediment inputs from Coal Creek may degrade spawning habitat quality by increasing the levels of fine sediment in spawning gravels; however, sockeye have not been documented spawning in the Ozette River. Excessive sediment inputs can reduce pool volumes and reduce the quantity of high quality pool habitat available to both adult and juvenile sockeye.

Processes and inputs: Processes and inputs affecting Ozette River habitat conditions include:

- LWD recruitment
- Sediment inputs and routing
- Streamflow

Activities affecting inputs/processes: Activities affecting Ozette River habitat conditions include: historical LWD removal, historical riparian logging and clearing along the Ozette River, watershed-scale logging and road building (especially in Coal Creek), and, to a lesser degree, ONP riparian infrastructure and maintenance. Other activities identified that affect streamflow also affect habitat quality in the Ozette River (see Hypothesis 3).

4.2.2.4 Marine Survival (H#5-MS)

Hypothesis 5: Survival in the marine environment is driven by large-scale climatic processes, which are not controllable. Variability in marine survival rates for sockeye salmon is significant, but not likely a key limiting factor at present. Large-scale changes in marine conditions should be monitored and may be significant in the future.

Life stages affected: Ocean rearing

Rationale: Mortality of large southern (< 55°N longitude) sockeye smolts in the marine environment averages 83 percent (Koenings et al. 1993). Mortality in the marine environment is likely the largest single mortality factor affecting juvenile and sub-adult sockeye. However, it is important to recognize that: 1) very high mortality rates in the marine environment are natural, and 2) there are no known direct actions that can be taken in the marine environment to improve survival for Ozette sockeye. While marine survival is a critical component in determining the ultimate abundance of Lake Ozette sockeye, broad-scale, regional studies of decadal scale productivity indicate that changes in marine survival played a limited role in the decline of Ozette sockeye (for additional details see LFA Sections 3.1.10, 4.1, 5.2, 5.6, 6.1.13, and 7.13) (Haggerty et al. 2009)

In the future, marine survival has the potential to limit the marine distribution of sockeye salmon and ultimately the viability of the species within the southern range. Welch et al. (1998) found that, "At the current rates of greenhouse gas emissions, predicted temperature increases under a doubled CO_2 climate are large enough to shift the position of the thermal limits [of sockeye salmon] into the Bering Sea by the middle of the next century [~2050]. Such an increase would potentially exclude sockeye salmon from the entire Pacific Ocean and severely restrict the overall area of the marine environment that would support growth."

Processes and inputs: Processes and inputs affecting marine survival include climate, natural patterns and variations in upwelling and ocean productivity, and marine predator-prey balances.

Activities affecting inputs/processes: Global and broad-scale regional degradation of the marine environment caused by pollution, fisheries, and climate change is likely to adversely affect future marine survival rates and marine distribution of all Northeast Pacific-origin sockeye salmon populations.

4.2.2.5 Estuary Alterations

Changes in the tidal prism and estuarine habitat conditions appear to have occurred during the last 50 years. The cause of these apparent changes is poorly understood, as are the potential effects on Lake Ozette sockeye. Changes in the estuarine habitat conditions have an unknown impact on sockeye smolt and adult survival. This potential limiting factor remains a data gap, but it may be a contributing limiting factor because changes in the estuary can affect predator-prey interactions, water depths and estuary/ocean accessibility, estuary nutrient supply, and salinity gradients and osmoregulation. Marine survival data for Ozette are limited but suggest that mortalities occurring in the estuary-ocean entry phase are within the limits experienced by other sockeye salmon smolts within the southern range of the species.

4.2.3 Factors Not Likely Limiting Sockeye

The following factors were evaluated and determined not likely to limit sockeye salmon VSP parameters.

4.2.3.1 Ocean Fisheries

Section 6.1.13 in the LFA reviews the major Alaska, British Columbia, and Washington marine area fisheries that harvest sockeye salmon migrating in Northeast Pacific Ocean areas. The review presented in the LFA indicates that fisheries directly and incidentally affecting sockeye salmon in the ocean are not likely to be substantial risk factors for Ozette sockeye salmon survival and recovery to a viable status. The review of ocean fisheries effects on Ozette sockeye presented in LFA Section 6.1.13 is summarized below.

Commercial net and troll fisheries extending from Dixon Entrance in southeast Alaska to the Strait of Juan de Fuca were reviewed for the timing and duration of fishery openings relative to the estimated migration time of Ozette sockeye through harvest areas. The evaluation of these ocean fisheries in the LFA concludes that there are no directed commercial sockeye fisheries in the marine environment when and where the Ozette sockeye population is present during the ocean rearing and migration period. The early-return timing of Ozette sockeye (May through late June entry into freshwater) substantially limits their presence in marine migratory areas when and where commercial and sport fisheries directed at other Washington and British Columbia-origin sockeye populations occur. The only ocean fishery for sockeye reviewed in the LFA that occurs when the later portion of the Ozette sockeye return may be present is a single boat test gillnet fishery on the southwest coast of Vancouver Island. The test fishery commences during the third week of June each year (near the end of the Ozette sockeye migration period into the Ozette River), and is conducted to assess Fraser River sockeye run size abundance. Sockeye racial identification data collected through the test fishery indicate that one Ozette sockeye may have been encountered during test fishing several years ago. All other sockeye that have been captured in the fishery originated from the Fraser River, with some contribution of Lake Washington fish. Harvest impacts on Ozette sockeye from directed sockeye salmon fisheries in the ocean are not risk factors limiting population recovery.

There is a potential for incidental harvest of Ozette sockeye resulting from interceptions in ocean sport, commercial, and tribal fisheries directed at other salmon species and groundfish. However, mortality of Ozette sockeye from such fisheries is likely to be extremely low. Review of Washington State and tribal catch information for Washington ocean Chinook and coho salmon and groundfish fisheries that occur during the Ozette sockeye migration period indicates that the fisheries rarely encounter sockeye salmon. Incidental harvest resulting from other salmon fisheries, or from groundfish fisheries, is not a substantial factor affecting Lake Ozette sockeye salmon recovery. There is also no evidence that high seas flying squid fisheries are currently adversely affecting Lake Ozette sockeye salmon and other Northeast Pacific salmon stocks. Illegal squid fishing in the past may have affected abundances of salmon returning to Washington waters; however, increased enforcement of fishing boundaries by the US Coast Guard and enactment of bans on the sale of salmon captured in squid fisheries by Japan and Korea appear to have substantially diminished salmon bycatch in squid fisheries.

4.2.3.2 Freshwater Fisheries

4.2.3.2.1 Ozette River Fisheries

The Ozette River is closed to all sport fishing until August 1. Very few sockeye are still in the river after August 1. When the river is open, selective fishery rules apply and all sockeye must immediately be released. There are no likely impacts from permitted fisheries during the adult migration or juvenile emigration periods. No tribal salmon fisheries are conducted within the watershed. Some poaching may occur, but no actual incidents of poaching have been documented by the NPS. Dense riparian undergrowth makes it difficult to reach the river, and park rangers are present at the access points at the river mouth and upper river.

4.2.3.2.2 Lake Ozette Fisheries

Under National Park Service regulations, the lake is open to catch and release salmonid fishing, but the fish must be immediately released. The smolt emigration period begins before the annual sport fishery opens, and the majority of sockeye smolts are in the lake during the first few weeks of the fishery. However, fingerling (age 0) sockeye are unlikely to be susceptible to fishing because of their small size. There are no empirical data regarding fishing pressure (e.g., angler days) or targeted or untargeted sockeye encounters within the lake. However, field observations indicate that Lake Ozette has low fishing pressure, which further reduces the potential impact of incidental sockeye encounters. Fisheries impacts on sockeye in the lake are unlikely. These conclusions are consistent with information provided by members of the Limiting Factors Rating

Workgroup who have direct experience and knowledge regarding Lake Ozette sport fisheries.

4.2.3.3 Research and Monitoring

No direct adult sockeye mortalities at the weir in the Ozette River caused by physical injury from weir and smolt trapping equipment have been documented. However, adult sockeye migrating into the lake are especially susceptible to predators as they transit the weir. The weir acts as a bottleneck for migrating adult sockeye, and harbor seals and river otters appear to use the weir as a hunting aid. Seals and otters have frequently been observed working the face of the weir, swimming back and forth across the river in search of sockeye. It appears that the susceptibility of adult sockeye to predation at the weir increases as lake level declines. The counting weir may also delay migrants from entering the lake and increase their exposure time to elevated stream temperatures and/or high SSC. Since 1998, weir operations have been conducted with the weir left open 24 hours a day to allow free fish passage into the lake in order to minimize impacts of high water temperatures and potentially enhanced predation efficiency associated with the weir (for a complete description of weir operations see the LFA). Smolt trapping data indicate that very few direct mortalities result from smolt trapping (<1 percent of all smolts encountered). The indirect effects of smolt trapping are discussed in Hypothesis 1 above.

4.2.3.4 Disease

Sockeye health in the river is not systematically monitored. Observations of infections and fungus growth are occasionally included in weir observation notes, but no systematic inventory data are collected. The disposition of adult sockeye entering the lake and holding for several months prior to spawning is not fully known. During RY 2000, 899 sockeye were trapped and visually examined for external tags and physical condition. Less than 1 percent of the sockeye transiting the weir had visible fungal growth. However, at least some individual sockeye have been observed with severe external infections, and these fish likely die before reaching the spawning grounds. Assessment of population status and mortality rates during the holding period is complicated by the relatively large size of the lake, the small size of the population, sockeye holding behavior, and limnological conditions that limit direct observations of sockeye mortalities and the number of sockeye surviving to spawn in the lake. The degree that disease limits sockeye salmon survival during holding is thought to be minimal, based upon observations of external conditions of sockeye entering the lake. However, more data are needed. It is possible that high water temperatures or other factors (e.g. predator wounds, gill abrasion) increase susceptibility to disease.

4.2.3.5 Hatchery Practices

Hatchery practices implemented as part of the Lake Ozette HGMP include measures to minimize potential disease and genetic impacts on all spawning aggregations. Annual sockeye salmon egg take and fry production levels are maintained at conservative levels to ensure that fry are not overproduced. Unlimited hatchery production of fry could result in cropping and depletion of zooplankton species important for sockeye growth and survival during the lake rearing period. Ozette hatchery practices are appropriately limited in scope and scale, minimizing the risks of adverse hatchery impacts on natural-origin juvenile sockeye rearing in the lake.

4.2.4 Other Potential Limiting Factors Not Previously Considered

Recent studies conducted by the Washington State Department of Ecology have found elevated levels of mercury in lake sediments (Furl 2007) and in fish tissues (Sieders et al. 2007; Furl and Meredith 2008). High and/or increasing mercury concentrations in freshwater fish tissues may be an indicator of other possible heavy metals or other pollutants that could negatively affect Lake Ozette sockeye. At this time the effect of potentially elevated mercury or other heavy metal concentrations on Lake Ozette sockeye is unknown. Researchers should continue and expand upon investigative studies of mercury and other environmental toxins entering the Lake Ozette food web. Research should determine and monitor the levels of mercury and other environment toxins in Lake Ozette sockeye at all freshwater life history stages.

4.3 LIMITING FACTORS AFFECTING BEACH SPAWNERS

The Lake Ozette Sockeye LFA identified and characterized limiting factors by life stage and degree of impact of each limiting factor within each life stage for Lake Ozette beach spawning sockeye. As detailed in Section 4.2, all Lake Ozette sockeye experience similar conditions while holding and rearing in the lake and migrating to or from the ocean via the Ozette River. Beach spawning sockeye experience habitat conditions and limiting factors different from those affecting tributary spawners during four life history stages: adult staging, beach spawning, egg incubation, and emergence and dispersal. The results of the LFA for all beach spawning subpopulations are included below in Figure 4.5. Each limiting factor was assessed based upon the life stage affected, the process or input influencing the limiting factor, and activities that affect each process and input. A summary of this assessment is included in Figure 4.6. A detailed narrative of key and contributing limiting factors is included in Sections 4.3.1 and 4.3.2.

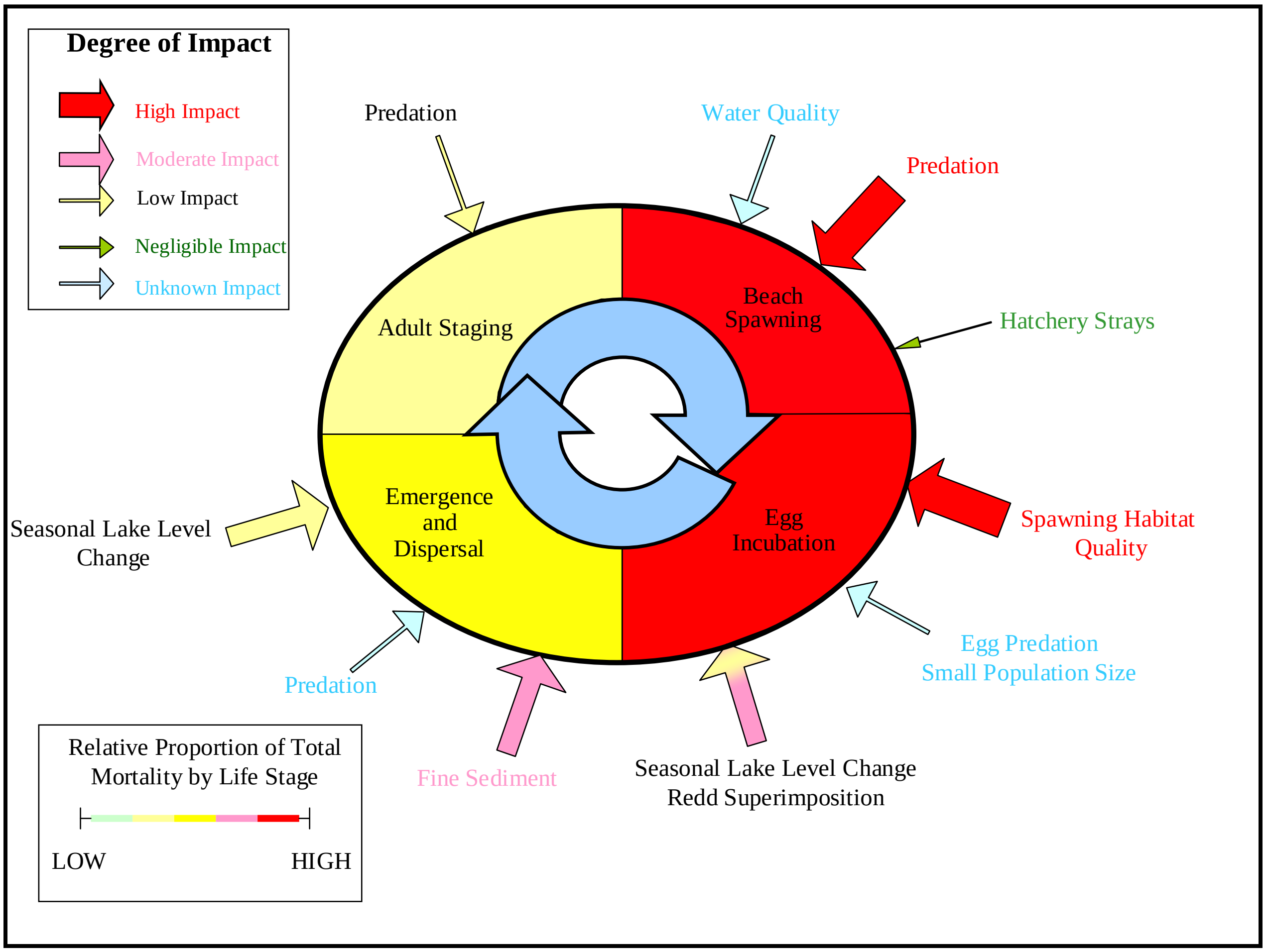

Figure 4.5. Conceptualization of hypothesized limiting factors affecting beach spawning Lake Ozette sockeye subpopulations. Arrows depict the degree of impact for each limiting factor and colored polygons depict the relative proportion of total mortality by life stage.

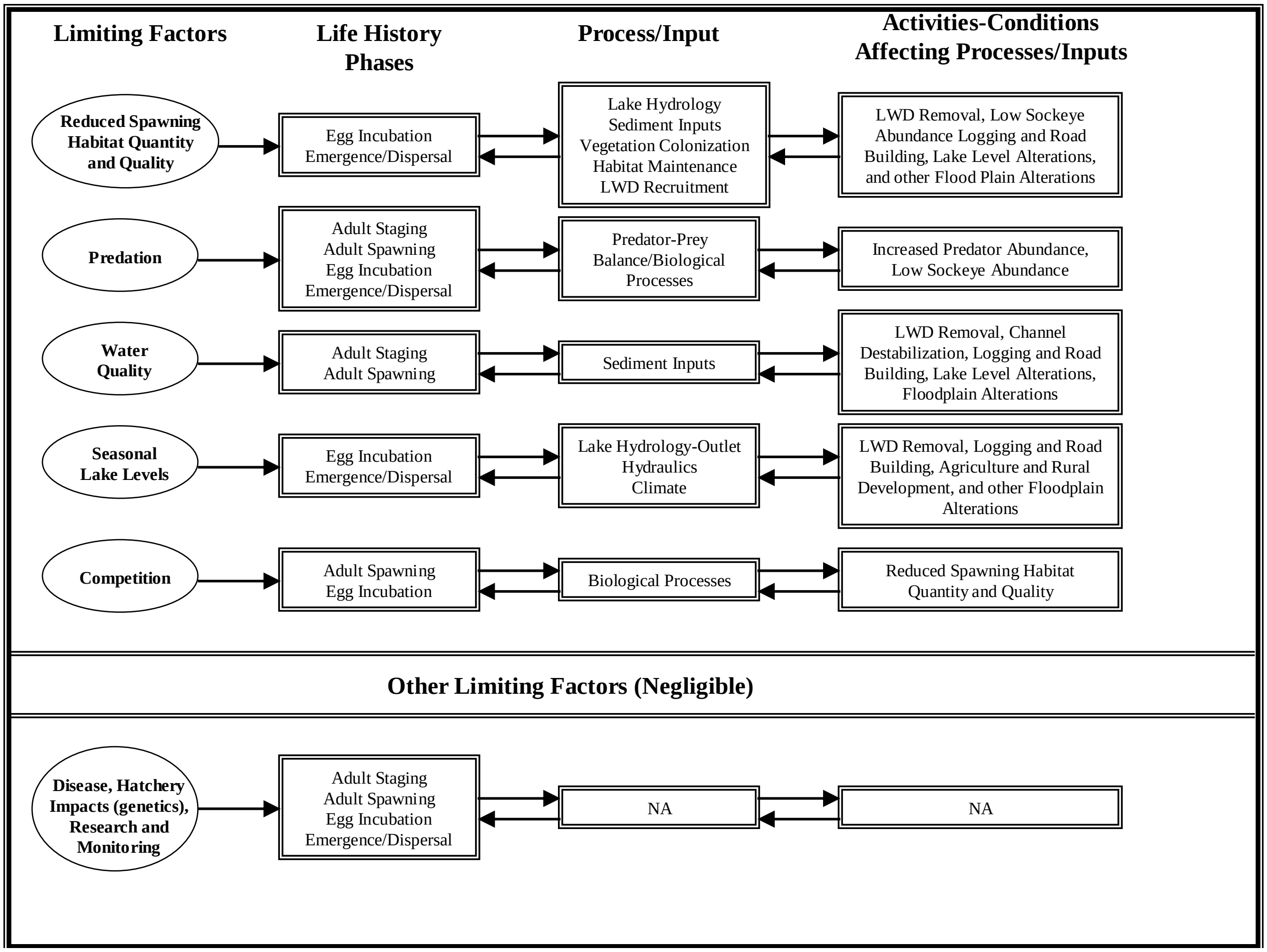

Figure 4.6. Hypothesized limiting factors affecting only beach spawning subpopulations, life history phases affected, processes and inputs regulating limiting factors, and activities/conditions affecting processes and inputs.

4.3.1 Key Limiting Factors

Key limiting factors affecting beach spawners are reduced quantity and quality of spawning habitat and predation.

4.3.1.1 Reduced Quantity and Quality of Spawning Habitat (H#6-BSH)

Hypothesis 6: Reduced quality and quantity of beach spawning habitat in Lake Ozette has decreased egg-to-emergence survival, resulting in reduced fry production from the beach spawning aggregations.

Life stages affected: Egg incubation and emergence/dispersal.

Rationale: The quality and quantity of beach spawning habitat varies by spawning beach and site within each of the extant (and historically existent) spawning beaches. The results of egg incubation studies on Olsen's Beach strongly suggest that egg survival after deposition is extremely poor (<<10 percent) within most of the primary spawning area. Not all egg mortality in the studies could be explained by fine sediment concentrations alone. Several environmental variables are likely at work collectively reducing egg survival. Sockeye salmon egg-to-fry survival on Lake Ozette beaches is limited by lack of adequate oxygen exchange from incubation water to the eggs, caused independently by two primary factors and their synergistic interactions: 1) reduced intergravel flows, and 2) high levels of fine sediment (i.e. < 0.85mm). Fine sediment levels and intergravel flows are partially controlled by lake level, wave energy, tributary sediment inputs, vegetation, seasonal groundwater levels, and other mechanisms. The synergistic effects of multiple variables (inputs/processes/actions) that interact to limit egg-to-emergence survival make it extremely difficult to link each specific process or input to a specific level of impact. Cumulatively, incubation conditions (lake level, fine sediment, vegetation, intra-gravel flow, etc.) on the spawning beaches are poor and the impact on sockeye productivity and survival was therefore rated high (LFA, Haggerty et al. 2009), making this a key limiting factor.

Fine Sediment. Fine sediment levels exceed 25 percent (dry method; wet sieve equivalent ~37 percent) on the remaining spawning beaches. Fine sediment levels exceed 50 percent at Umbrella Beach (from Herrera 2006). Excessive sediment production in tributaries (from a combination of land use, LWD removal, and base level incision) and subsequent delivery to spawning beaches has decreased the quantity and quality of spawning habitat available. The total quantity of spawning habitat eliminated as a result of increased fine sediment deposition altering substrate size and character is unknown, but at least one entire historically used spawning beach has been lost (Umbrella Beach). Egg incubation studies conducted in 2000 and 2001 found that fine sediment deposition on redds located at the two known sockeye spawning beaches occurred during the egg incubation period. Fine sediment deposition during incubation can form an impenetrable layer of fine sediment, impeding emergence. *In situ* studies demonstrating poor survival from eyed egg to pre-emergence indicate that the majority of mortality occurs prior to emergence.

Shoreline Vegetation. Quantification of potential lost spawning habitat resulting from lake level alterations is presented in detail in the LFA. A major change visible in photographs between 1953 and 2003 is the increase of vegetation around the lake's shoreline – a 56 percent net *decrease* in the quantity of *un*vegetated shoreline. Much of the increased vegetation along the shoreline has been attributed to lower average lake levels (or lower growing season lake levels) and increased fine sediment. In addition, it has been hypothesized that alterations in lake level variability from removal of wood at the lake outlet and tributary-inflow hydrologic change, coupled with tributary sedimentation and wood removal, have altered hyporheic and groundwater hydraulics, hydrology, and inter-gravel flow along the lake shoreline.

Historically, LWD was also removed from portions of the lake shoreline. This removal affected the shoreline hydraulics, resulting in reduced localized turbulence around wood. Shoreline wood functions to cleanse gravel locally and scour colonizing vegetation through turbulence. Without wood, vegetation can more effectively colonize bare soil and trap fine sediment, reducing substrate size and habitat suitability.

Lake Level. As described in Section 2.4, seasonal lake level changes are known to directly result in sockeye redd dewatering. Further, through modeling studies using the available data, Herrera (2005, 2006) found it likely that mean lake level during the beach sockeye spawning period has been lowered by 1.5 to 3.3 feet from historical levels.

Processes and inputs: Processes and inputs affecting the quantity and quality of beach spawning habitat in Lake Ozette include: lake hydrology, sediment inputs, vegetation colonization, LWD recruitment, and habitat maintenance.

Activities affecting inputs/processes: Activities affecting the quantity and quality of beach spawning habitat include:

- Historical tributary and lake outlet LWD removal and resulting channel destabilization and altered lake levels.
- LWD removal from beaches.
- Past and present land use activities (logging, road building, agriculture and rural development) that result in changes to water quantity and quality and sediment production.
- Sockeye fisheries and other activities that directly or indirectly reduce sockeye abundance may also contribute to the degradation of spawning habitat by reducing the ability of sockeye salmon to maintain productive habitat through gravel cleaning and coarsening during the act of spawning.

4.3.1.2 Predation (H#7-Pred)

Hypothesis 7: Changes in relative predator-prey abundances on Ozette spawning beaches have increased the proportion of adult sockeye, eggs, and newly emerged fry consumed by predators, resulting in decreased freshwater survival.

Life stages affected: Adult staging, adult spawning, egg incubation, and emergence and dispersal.

Rationale: Indirect observational data suggest that sockeye salmon are much less vulnerable to predation during the pre-spawning staging period because the fish hold off-shore, in deeper water, and at lower densities, making them less susceptible to predation. However, no direct estimates of predation-related mortality during the sockeye staging period have been made. High impacts on sockeye are attributed to predation on the spawning grounds. Data collected during the spawning season in 2000 suggest that 40 percent or more of the sockeye at Allen’s Beach were killed by harbor seals and river otters before completing spawning. Data from Olsen’s Beach during the same year indicates that approximately 10 percent of the spawners were killed by seals and otters.

Both predatory mammal species have been observed foraging at known beach spawning areas during the sockeye spawning period. Continued monitoring is needed to fully document the degree of predation occurring, but the limited data collected to date indicates the potential for substantial predation on the spawning grounds.

Egg predation occurs at unknown levels on the spawning beaches. Known predators of viable sockeye eggs at Lake Ozette include sculpins and aquatic insects. Currently there is no evidence that suggests that egg predation has increased relative to historical baseline levels. However, at low spawning escapement levels egg predation could play an important role in limiting population growth because of potential depensatory effects.

The level of impact of predation occurring at the sockeye fry emergence life stage is unknown. A number of species of aquatic predators exist throughout the littoral zone. Directly upon emergence, sockeye fry are vulnerable to non-native piscivorous species such as largemouth bass and yellow perch, as well as native piscivorous species (e.g. cutthroat trout). Small numbers of beach spawners and poor egg-to-fry survival can make juvenile sockeye vulnerable to the depensatory effects of predation at reduced abundance. Predator interactions at this early life history stage remain a data gap, but it is possible that significant levels of predation occur in the vicinity of the spawning beaches.

Processes and inputs: Processes and inputs affecting predator-prey balance have been altered from pre-European contact conditions.

Activities affecting inputs/processes: Activities affecting or that have affected the predator-prey balance in the Ozette watershed include: introduction of non-native fish species; past directed Ozette sockeye fisheries that resulted in decreased sockeye abundance; selective habitat alterations that negatively affected sockeye habitat (resulting in reduced sockeye abundance) but had a negligible effect (or positive effect) on predator's key habitat; increases in local pinniped populations caused by a combination of disruption and alteration in the marine ecosystem resulting in a reduction in the number of apex predators (e.g., orcas) that feed on pinnipeds; abandonment of the Ozette Village and resulting loss of local pinniped hunting; and implementation of the Marine Mammal Protection Act and other regulations that limit removal of predators and promote their increase while failing to recognize the effects of the regulations on the abundance of sockeye salmon (e.g., ONP fishing regulations, hunting and trapping restrictions inside and outside the boundaries of ONP).

4.3.2 Contributing Limiting Factors

Contributing limiting factors affecting beach spawners are water quality, seasonal lake level changes, and competition.

4.3.2.1 Water Quality (H#8-WQ)

Hypothesis 8: Turbidity and suspended sediment concentration at Olsen's and Allen's Beaches have a limited effect on sockeye salmon because of the substantial distance of these beach spawning areas from major sediment sources. However, at historical spawning sites near major tributary outfalls, such as Umbrella Beach, the effects of turbidity and SSC would be expected to be similar to those described in Hypothesis 13.

Life stages affected: Adult staging, adult spawning, egg incubation, and emergence and dispersal.

Rationale: The effects of water quality on sockeye salmon during the staging period are unknown and remain a data gap. However, limited water quality data collected in the offshore environment suggest that conditions there are favorable for sockeye and that water quality is not likely a significant limiting factor during this life history stage. Sockeye are exposed to less optimal water quality conditions closer to the shoreline and near tributary outfalls.

High turbidity and SSC levels in tributaries to the lake can result in high turbidity levels along the lake shoreline. The frequency of high turbidity events and the direct effect on spawning sockeye are unknown but may include moderate physiological stress, habitat avoidance, and spawning habitat degradation. Turbidity and SSC data are lacking on the extant spawning beaches and are considered an important data gap. In general, existing beach spawning habitats, especially Allen's Beach, are less susceptible to stream derived turbidity and SSC because of their distance from major sediment sources in eastern tributaries. However, at historical beach spawning sites, such as Umbrella Beach, turbidity impacts are expected to be similar to those in Umbrella Creek.

Processes and inputs: Processes and inputs affecting Lake Ozette water quality include sediment inputs and routing.

Activities affecting inputs/processes: Activities affecting Lake Ozette water quality include LWD removal and channel destabilization, logging and road building, and floodplain alterations.

4.3.2.2 Seasonal Lake Level Changes (H#9-LL)

Hypothesis 9: Seasonal lake level changes result in redd dewatering, decreasing egg-to-fry survival rates.

Life stages affected: Egg incubation and emergence and dispersal.

Rationale: The impact of lake level changes varies depending upon redd elevations relative to water surface elevation at emergence. Detailed redd mapping on Olsen's Beach during the winter of 2000/01 indicated that approximately 3 percent of the total redd surface area (7 total redds) was completely dewatered at the time of emergence.

Spawning surveys conducted between 1999 and 2004 did not indicate high amounts of redd dewatering. However, high lake levels early in the spawning season followed by drought conditions would likely result in moderate amounts of dewatered redds if the winter lake level goes below 33 ft (MSL- NGVD 1929). Additional monitoring of redd dewatering is needed.

Beyond natural climate variability, cumulative land use activities have likely altered seasonal lake level changes away from the natural state. Historical wood removal from the Ozette River has altered the hydraulic efficiency of the lake outlet and changed the backwater influence of river wood on lake stage. The increased efficiency of outlet drainage has increased rates of change in lake stage (e.g., how quickly the lake level falls) and reduced the average lake level and absolute low lake stages (see LFA and Herrera 2005). However, recent sedimentation of Ozette River near Coal Creek has partially offset (by ~1 foot) these reduced low lake levels, through control on water discharge into Ozette River, especially during summer months. The combination of these altered hydraulic factors, in addition to lake inflow hydrology, needs to be researched further to determine the exact consequences of anthropogenic lake level changes on sockeye redd dewatering on the beaches.

Lack of long-term hydrologic data sets in Ozette tributaries prohibits the exact quantification of any potential changes to tributary hydrology and flow regimes from land use and channel modifications. The high road densities in sockeye tributaries (averaging >6.0 mi/mi^2), extensive clear-cutting (>95 percent of sockeye watersheds clear-cut at least once), and lack of floodplain connectivity (because of channelization and wood removal) cumulatively lead to the hypothesis that hydrologic change has occurred in Ozette tributaries, but with an unknown magnitude. This is consistent with the voluminous literature showing that water yield changes begin following a significant (10 to 25 percent) reduction of forest vegetation cover, with the highest impacts in conifer forests in high precipitation zones. However, quantification of this potential limiting factor locally remains a data gap.

Processes and inputs: Processes and inputs affecting Lake Ozette seasonal lake level changes include lake outlet hydraulics (Ozette River), tributary watershed hydrology, and climate variability.

Activities affecting inputs/processes: Activities affecting seasonal lake level changes beyond natural climate variability are those that affect watershed hydrology and lake hydro-period, e.g., historical LWD removal from the Ozette River, sedimentation in the Ozette River, current and past logging and road building, agriculture, and floodplain alterations.

4.3.2.3 Competition (H#10-Comp)

Hypothesis 10: Reduced spawning habitat quality and quantity have increased the competition for suitable habitat at low to moderate spawning escapement levels, resulting in increased redd superimposition and decreased egg-to-fry survival.

Life stages affected: Adult spawning and egg incubation.

Rationale: The LFA rated the impact of competition as moderate for the Olsen's Beach core spawning area and low for all other beach spawning sites. Redd superimposition on the spawning beaches is thought to significantly reduce the survival of previously deposited eggs. The degree to which this occurs is difficult to measure, but Olsen's Beach seems to be especially prone to multiple sockeye spawning events in the same location. During the 2000 sockeye spawning season, sockeye were observed spawning in the same location over an 89-day period. More than 90 percent of the redd surface area measured had been spawned in multiple times during the spawning season. These observations provide additional evidence that suitable/preferred spawning area is limited.

Processes and inputs: Competition for suitable spawning habitat at low to moderate spawner abundance is directly linked to reduced habitat quality and quantity. The processes that have reduced habitat quantity are the same processes responsible for increased competition. Since Ozette sockeye appear to prefer areas with springs and seeps for spawning, it is thought that alterations to the location, degree, and depth of upwelling could negatively affect beach spawning, although no such alterations have been documented.

Activities affecting inputs/processes: See Hypothesis 6 (reduced quantity and quality of beach spawning habitat).

4.3.3 Factors Not Likely Limiting Sockeye

The following factors were evaluated and determined not likely to limit sockeye salmon VSP parameters. A brief narrative is included summarizing why each factor is not likely to limit sockeye salmon population viability.

4.3.3.1 Research and Monitoring

Spawning ground surveys are conducted approximately every 7 to 10 days within the primary sockeye spawning areas. Spawning ground surveys are conducted by boat, snorkel, and/or SCUBA survey techniques. Surveyors are trained to identify and record all types of spawning activity, even under difficult or cryptic situations. Surveyors are also trained to avoid disturbing areas suitable for spawning and minimize disturbance to the lake bottom. Most redds remain visible during the entire spawning season, making avoidance of these areas especially easy for trained surveyors. It is highly unlikely that beach spawning ground surveys have any substantial direct effects on spawning sockeye.

4.3.3.2 Hatchery Impacts (Genetics)

Hatchery practices implemented through the HGMP include measures to minimize potential disease and genetic impacts on beach spawning aggregations. Imprinting juvenile sockeye by using on-station rearing in release watersheds reduces the risk of hatchery-origin sockeye straying onto beaches. Mark and recapture data collected at

Olsen's and Allen's beaches indicates that few if any Umbrella Creek Hatchery releases return to spawn on Lake Ozette beaches. Approximately 25 percent of the brood year 1995 Umbrella Creek fed fry released were adipose fin clipped and in 1999 (at the time of their return), 121 adult sockeye salmon were sampled on Olsen's Beach and none were adipose fin clipped. This suggests that straying from tributary releases onto spawning beaches was nonexistent or at least very low (MFM 2000). Spawning adults returning from hatchery releases after 1999 were mass marked using thermal otolith marks (100 percent marking), as well as fin clips (45 percent of all fry and fingerlings released since BY 1999 have been fin clipped), allowing for monitoring of hatchery-origin fish distribution throughout the watershed. The results from otolith sampling are not yet available. Also, note that sockeye straying onto Olsen's Beach are likely to have a limited genetic impact if successful spawning occurs, since Olsen's and Umbrella Creek sockeye share common genetics (Hawkins 2004).

4.3.3.3 Disease

See Section 4.2.3.4

4.4 LIMITING FACTORS AFFECTING TRIBUTARY SPAWNERS

All Lake Ozette tributary spawning sockeye experience similar habitat conditions and limiting factors during four life history stages: tributary migration and holding, spawning, egg incubation, and emergence and dispersal. The Lake Ozette Sockeye LFA identified and characterized limiting factors specifically affecting the tributary subpopulations by life stage and degree of impact of each limiting factor within each life stage. The results of the LFA for all tributary spawning subpopulations are illustrated below in Figure 4.7. Each limiting factor was assessed based upon the sockeye life stage affected, the process or input influencing the limiting factor, and activities that affect each process and input. A summary of this assessment is presented in Figure 4.8. A detailed narrative of key and contributing limiting factors is included in Sections 4.4.1 and 4.4.2.

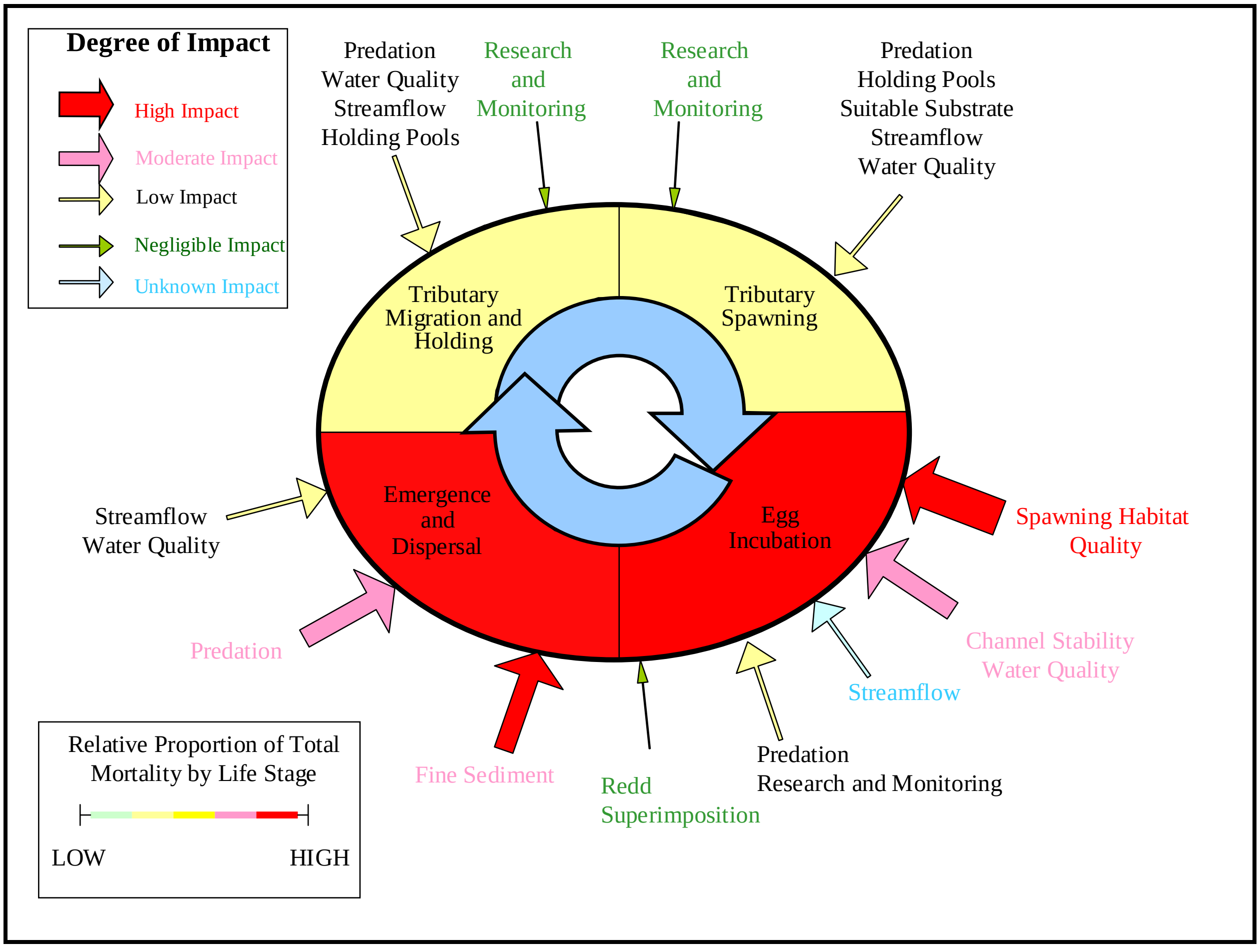

Figure 4.7. Conceptualization of hypothesized limiting factors affecting tributary spawning Lake Ozette sockeye subpopulations. Arrows depict the degree of impact for each limiting factor and colored polygons depict the relative proportion of total mortality by life stage.

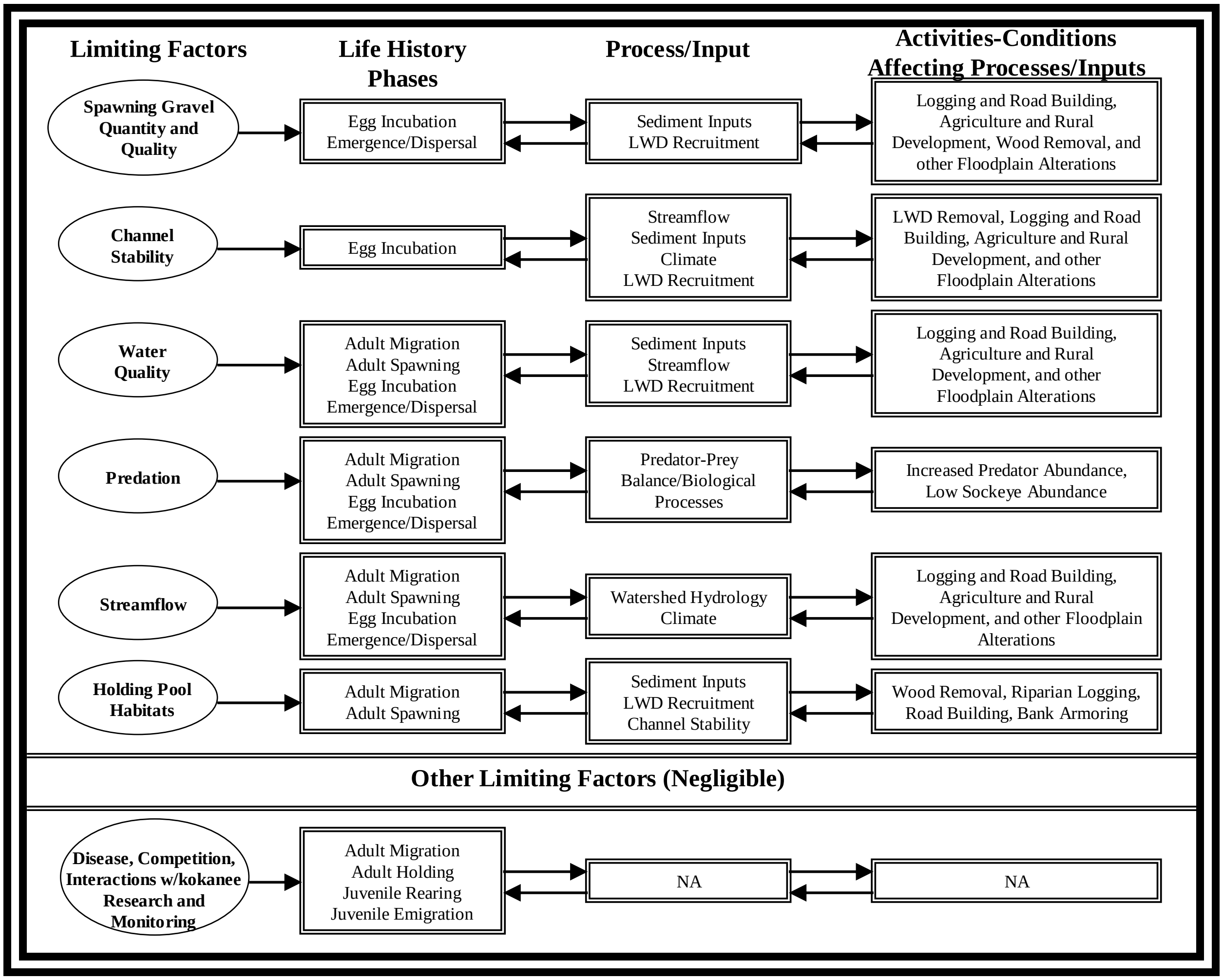

Figure 4.8. Hypothesized limiting factors affecting only tributary spawning subpopulations, life history phases affected, processes and inputs regulating limiting factors, and activities/conditions affecting processes and inputs.

4.4.1 Key Limiting Factor

The key limiting factor affecting tributary spawners is spawning gravel quantity and quality.

4.4.1.1 Spawning Gravel Quantity and Quality (H#11-TSH)

Hypothesis 11: Channel simplification and increased sediment production and delivery to streams have decreased the quantity of suitable spawning habitat (i.e., gravel) available to tributary spawning sockeye. Increased levels of fine sediment (<0.85mm) in spawning gravels reduces intra-gravel flow and oxygenation of redds, resulting in decreased egg-to-fry survival.

Life stages affected: Egg incubation and emergence/dispersal.

Rationale: Gravel storage behind large woody debris has been systematically reduced from historical levels throughout sockeye spawning tributaries. This has been coupled with increased fine sediment delivery to mainstem spawning reaches, together altering the distribution and availability of suitable spawning gravel. Some mainstem sections (e.g., lower Big River) have been entirely transformed from gravel bed to sand bed (see Kramer's [1953] substrate description). At the watershed scale, gravel quantity is still high, but with reduced quality and stability. Currently the effect of reduced gravel quantity on tributary spawning sockeye is low, but as the population increases the effects of lost habitat will result in increased competition for suitable spawning areas and reduced freshwater productivity.

High levels of fine sediment have been documented in sediment core sample data from spawning gravels in Lake Ozette tributaries. During incubation, salmonid eggs require sufficient water flow to supply egg pockets with oxygen and carry away waste products (Bjornn and Reiser 1991). Water circulation through salmon redds is a function of redd porosity, permeability, and hydraulic gradient (Bjornn and Reiser 1991). Fine sediment that settles into redds during the egg incubation period can impede water circulation and fry movement, which can result in decreased egg-to-emergence survival (Bjornn and Reiser 1991). Studies throughout the Pacific Northwest have found that increased levels of fine sediment (<0.85mm) in spawning gravels decreases egg-to-emergence survival (Cederholm et al. 1981; Bjornn and Reiser 1991; McHenry et al. 1994). McHenry et al. (1994) found that coho and steelhead egg-to-alevin survival decreased drastically when fine sediment (<0.85mm) exceeded 13 percent (volumetric method) in Olympic Peninsula streams. Numerous other researchers have also found that survival to emergence relates negatively to the percentage of fines in gravel (McNeil and Ahnell 1964; Koski 1966; Cederholm et al. 1981; Cederholm et al. 1982; Tappel and Bjornn 1983; Tagart 1984; Chapman 1988).

The high density of often poorly constructed, surfaced, and maintained roads, along with extensive, frequent timber clear-cutting in most subbasins from the 1950s to present, has resulted in increased sediment production and delivery to tributaries. Additionally, mass wasting, channel and bed destabilization, wood removal, decreased bank stability, and channel incision have increased sediment production and delivery to the stream network within the primary sockeye spawning tributaries. The exact degree that each input specifically increases or alters fine sediment levels in spawning gravel remains unknown. Duplicating sediment sampling conducted by McHenry et al. (1994) could help answer important questions regarding current and past fine sediment levels, as well as aid in predicting actions and timeframes required for gravel quality to reach desired conditions for adequate fry production.

Processes and inputs: Sediment inputs and routing and LWD recruitment.

Activities affecting inputs/processes: Past and present logging and road building, agriculture, rural development, floodplain alterations, bank armoring, and historical wood removal.

4.4.2 Contributing Limiting Factors

The contributing limiting factors affecting tributary spawners are channel stability, water quality, predation, streamflow, and holding pool habitat.

4.4.2.1 Channel Stability (H#12-Stab)

Hypothesis 12: Decreased channel stability and floodplain alterations have reduced egg-to-fry emergence survival in sockeye tributaries.

Life stages affected: Egg incubation and emergence/dispersal.

Rationale: The bed and banks of sockeye spawning tributaries have been destabilized by land use and stream management practices over the last 100 years. Channel destabilization and/or morphologic changes in channel form can result in lowered egg-to-fry survival during the egg incubation period. The degree that channel changes in Ozette sockeye tributaries have lowered egg-to-fry survival remains unquantified. Sediment transport and scour depth data have not been systematically collected along with fine sediment data at representative sockeye spawning locations. These data gaps need to be filled in order to assess the impact of wood removal, base level changes, incision, channelization, watershed sediment delivery, movement of sediment pulses, and streamflow magnitude on egg-to-fry survival. For a complete discussion on channel stability see the LFA.

Processes and inputs: Streamflow, climate, LWD recruitment, and sediment inputs.

Activities affecting inputs/processes: Past and present logging and road building, floodplain alterations (including agriculture, rural development, bank armoring), and historical wood removal.

4.4.2.2 Water Quality (H#13-WQ)

Hypothesis 13: Elevated turbidity and suspended sediment concentrations increase stress and reduce adult sockeye fitness, resulting in increased egg retention rates and pre-spawning mortalities. High levels of turbidity and SSC result in fine sediment deposition in sockeye redds, decreasing egg survival. High levels of turbidity and SSC during the sockeye fry emigration period result in reduced sockeye fry survival, fitness, increased gill abrasion, and altered oxygen uptake.

Life stages affected: Adult staging, adult spawning, egg incubation, and emergence and dispersal.

Rationale: High turbidity levels, which are an indicator of SSC, have been recorded in Ozette spawning tributaries, especially Umbrella Creek and Big River (peak values >500 NTU). Peak streamflow and turbidity events are common during the sockeye migration, spawning, and egg incubation periods. In Umbrella Creek, for the duration of the 2005 sockeye migration and spawning period, 85 hours had turbidity values greater than 100 NTU. Elevated turbidity and SSC can have negative behavioral and physiological effects on adult sockeye, including negative effects on predator avoidance, territory selection, mate selection, homing and migration, gill function and integrity, respiration, and blood physiology.

Peak streamflow and turbidity events are slightly less common during the sockeye fry emigration period. During the 2005 sockeye fry emigration period, a total of 15 hours had turbidity values greater than 100 NTU. In 2005, the spawning period was shown to have greater turbidity levels than the fry emigration period. Generally, due to reduced average monthly precipitation, flood events carrying high sediment loads will be less frequent during fry emigration compared to adult spawning. However, high turbidity and sediment levels still occur during emigration. Elevated turbidity and SSC can have negative behavioral and physiological effects on juvenile sockeye, including negative effects on predator avoidance, swimming and emigration efficiency, gill function and integrity, respiration, and blood physiology.

Improper construction, maintenance and use of roads, increased channel instability, mass wasting events triggered by roads or clear-cut timber harvest on unstable slopes, and other land use activities (e.g., agriculture) all contribute to elevated turbidity and SSC levels in tributaries. Dozens of observations of sediment inputs violating Washington State Department of Ecology water quality standards have been made during the last decade within the primary sockeye spawning tributaries. (Note: The impacts of SSC levels on other species may be significantly different from the impacts on adult sockeye.)

Processes and inputs: Sediment inputs, streamflow, and LWD recruitment.

Activities affecting inputs/processes: Activities affecting water quality during tributary residency include past and present logging and road building, floodplain alterations (including agriculture, rural development, bank armoring), and historical wood removal (reduced floodplain connectivity resulting in more fine sediment storage in the active channel rather than on the floodplain).

4.4.2.3 Predation (H#14-Pred)

Hypothesis 14: Predation of sockeye fry by piscivorous fish during emergence, emigration, and dispersal significantly reduces the number of fry rearing in the pelagic zone of the lake. However, predation on adult sockeye and eggs in tributaries occurs at low levels and is not likely a significant limiting factor.

Life stages affected: Adult staging, adult spawning, egg incubation, and emergence and dispersal.

Rationale: Hughes et al. (2002) concluded that there is very little evidence of pre-spawning predation mortality in Umbrella Creek, based on tagging, tracking, genetic sampling, and spawning ground surveys. In 2000, seven adult sockeye tagged with CART tags were tracked in Umbrella Creek and all were observed to have successfully spawned. Egg predation in tributaries has not been thoroughly investigated, but the potential impacts are thought to be low. Hydraulic sampling of sockeye redds conducted in 1998 and 1999 to assess egg survival did not indicate that significant egg predation was occurring in Umbrella Creek. The standing of tributary egg predation as a limiting factor largely remains a data gap.

Estimates of post-release survival for the 1998 brood year Umbrella Creek Hatchery released fingerlings moving downstream from RM 4.8 to RM 0.8 ranged from 74 percent to 40 percent. Burgner (1991) reviewed several studies conducted to determine fry predation rates for riverine spawned sockeye fry emigrating to nursery lakes and found widely ranging values: 63 to 84 percent (Scully Creek, Lake Lakelse, 4-year study), 66 percent (Six Mile Creek, Babine Lake, 1-year study), 13 to 91 percent (Karymaiskiy Spring, Kamchatka Peninsula, 8-year study), and 25 to 69 percent (Cedar River, Lake Washington). Large numbers of predators (cottids, cutthroat, coho yearlings) were captured incidentally in fyke net trapping of natural-origin fry in Umbrella Creek during the spring of 1999. Predators consumed sockeye fry relative to coho fry at a ratio of 8.3 to 1, even though there were many more coho fry available, suggesting that sockeye fry were the preferred prey species during the months of April and May.

Processes and inputs: Processes and inputs affecting predator-prey balance have been altered from pre-European contact conditions.

Activities affecting inputs/processes: Activities affecting or that have affected the predator-prey balance in the Ozette tributaries include introduction of non-native fish species, historical directed Ozette sockeye fisheries that resulted in decreased sockeye abundance, and selective habitat alterations that negatively affected sockeye habitat (resulting in reduced sockeye abundance) but had a negligible effect (or positive effect) on predators' key habitat.

4.4.2.4 Streamflow (H#15-Q)

Hypothesis 15: Natural and anthropogenically influenced streamflow variability (magnitude, frequency, and timing of low and high flows) affects sockeye mortality by: 1) delaying adult migration into tributaries (resulting in more predation, egg retention); 2) limiting where adults spawn in a cross-section (e.g., sequestering spawners in areas where egg scour or desiccation is likely); and/or 3) increasing emigrating fry exposure times in tributaries (affecting predation, water quality).

Life stages affected: Adult migration, adult spawning, egg incubation, and emergence and dispersal.

Rationale: Delayed migration of sockeye into tributaries during October and November has been observed during extreme low base flow conditions and a delay in the onset of the wet season. The population impact of delayed migration because of streamflow is thought to be low, however, because unlike sockeye spawning in shallow water at beaches, sockeye congregating near tributary mouths are more flexible in their holding depths and locations, enabling fish to minimize predator interactions. Climatic variability in precipitation timing is a natural phenomenon that sockeye salmon have adjusted to. However, land use could lower the magnitude of base flows to a currently unknown degree. Under natural conditions, higher sustained base flows may have allowed sockeye to migrate into tributaries earlier in the spawning season. Climate change into the future could alter the timing of the onset of the wet season (i.e., the first few rains), combining with lower base flows to create a more significant impact on migration timing.

Extended periods of high streamflow (caused by high storm frequency and intensity) can shift the distribution of spawning from “normal” positions in the channel to the margins where velocity and depth more closely match the preferred conditions (e.g., Ames and Beecher 2001). When this occurs and is followed by normal or low flows, eggs in redds constructed along the channel margins or in less optimal positions in the channel may experience increased mortality during incubation because of redd dewatering or fine sediment intrusion. Extended dry periods yielding low flows following more or less normal flow conditions can produce the same effect. Conversely, below-average flows during spawning that force fish to spawn low in the channel (thalweg), followed by large flood events, can increase susceptibility to redd scour (Ames and Beecher 2001; Lapointe et al. 2000). Thus, for sockeye spawning in compound channels under variable discharge regimes, there is a tradeoff between spawning low in the cross-section and risking scour mortality versus spawning high along channel margins and risking redd desiccation or sedimentation-related mortality.

Lack of long-term hydrologic datasets in the Ozette Watershed prohibit the exact quantification of any potential changes to hydrology and flow regimes from land use and channel modifications. The high road densities in sockeye tributaries (averaging >6.0 mi/mi^2), extensive clear-cutting (>95 percent of sockeye watersheds clear-cut at least once), and lack of floodplain connectivity (e.g., channelization and wood removal) cumulatively support the hypothesis that hydrologic change has occurred in Ozette tributaries, but with an unknown magnitude. This is consistent with the voluminous literature indicating that water yield changes begin following a significant (10 to 25 percent) reduction of forest vegetation cover, with the highest impacts in conifer forests in high precipitation zones. The quantification of this potential limiting factor remains a data gap.

Sockeye salmon emerge from the spawning gravel in Ozette tributaries from March to May. This is generally a period of decreasing discharge because of reduced precipitation. As discussed above in relation to the timing of adult sockeye migration into the tributaries, climatic variability in precipitation timing and the stochastic nature of weather events are phenomena that sockeye salmon have generally adjusted to under natural conditions and population levels. However, unusually low streamflow and precipitation can affect the rate of sockeye emigration (e.g., spring 2004) and likely their mortality. Tabor et al. (1998) suggested that predation rates were low in most sites studied in the Cedar River during the 1997 fry emigration to Lake Washington because of high streamflow. They found that at mid-channel sites, where velocities were moderate or high, little predation of sockeye salmon was observed. Seasonal droughts and reduced streamflow could be exacerbated by land use changes. These changes may affect the magnitude, but not the timing, of base flows. Land use (including channel modifications) could affect low base flow magnitudes to an unknown degree. Natural conditions with higher sustained base flows may have allowed sockeye to emigrate into Lake Ozette during a shorter time period. Climate change into the future could alter the timing and magnitude of flows needed to transport sockeye fry down into Lake Ozette.

Processes and inputs: watershed hydrology and climate variability.

Activities affecting inputs/processes: logging and road building, agriculture, and other floodplain alterations resulting in reduced floodplain connectivity and function.

4.4.2.5 Holding Pool Habitats (H#16-HP)

Hypothesis 16: Current holding pool frequency and volume, reduced from historical conditions, appear to be adequate in relation to the current numbers of adult sockeye salmon. However, as the tributary population continues to expand, this factor may begin to exert an influence.

Life stages affected: Adult migration and adult spawning.

Rationale: Female sockeye preparing to spawn will frequently be attacked by adjacent territorial females. Therefore, females preparing to spawn will often hold in pools prior to moving onto the spawning grounds (Quinn 2005). Downstream of the primary spawning areas in Umbrella Creek and Big River, holding pool frequency is good or fair in most channel segments; however, some segments in Big River have reduced pool volume because of lack of wood and the resultant sediment aggradation. Other pool attributes (e.g., percent woody cover) have reduced quality in many channel segments within Umbrella Creek and Big River. As tributary sockeye population sizes increase, the quantity and quality of pool habitat will become more important.

Within the primary spawning areas in Umbrella Creek and Big River, holding pool frequency ranges from poor to good depending upon the channel habitat segment. Pool habitat quality (frequency, complexity, depth, size) can be characterized as fair. Once sockeye salmon begin the spawning process, they become territorially focused on protecting their respective redds, and pool habitat becomes much less important than during the holding period. Pool quality within the primary tributary spawning grounds is therefore thought to have a negligible impact on sockeye salmon spawning success.

Processes and inputs: LWD recruitment, sediment inputs, and channel stability.

Activities affecting inputs/processes: Activities affecting holding pool quantity and quality include past and present riparian logging, past and present riparian road building and maintenance, and floodplain alteration (agriculture, rural development, bank armoring, stream-crossings).

4.4.3 Factors Not Likely Limiting Sockeye

The following factors were evaluated and determined not likely to limit sockeye salmon VSP parameters. A brief narrative is included summarizing why each factor is not likely to limit sockeye salmon population viability.

4.4.3.1 Competition (Redd Superimposition)

Within Umbrella Creek, competition for suitable spawning sites and mates is more intense than in Big River and Crooked Creek. In recent years, large numbers (1,000 to 4,000) of spawning sockeye have used habitat in a fairly discrete section of Umbrella Creek (most spawning has been observed in a 2.2-mile-long stream reach). Competition for spawning habitat within this reach can be intense, and redd superimposition plays a significant role in determining the number of fertilized eggs that are ultimately deposited into the spawning gravels to incubate. During the peak spawning period, downstream of mass spawning areas in Umbrella Creek, hundreds of sockeye eggs can be observed along the bottom of the stream or being transported downstream. The degree of redd superimposition likely varies depending upon the number of spawners returning to Umbrella Creek, as well as how they distribute themselves. Redd superimposition at levels occurring in Umbrella Creek likely reduces the overall egg-to-fry survival rate, but net production is not thought to be reduced; that is, if fewer sockeye spawned in Umbrella Creek, the net fry production would be reduced, not increased. However, if sockeye were distributed evenly throughout all suitable habitats, egg-to-fry survival would increase, as would net fry production. Redd superimposition likely has a negligible impact on overall egg-to-fry survival in Big River and Crooked Creek.

4.4.3.2 Interactions with Kokanee

Kokanee-sockeye interactions are thought to be minimal in Umbrella Creek and Big River but common when sockeye are present in Crooked Creek.

Few kokanee spawn in Umbrella Creek. However, sockeye spawning with kokanee-size *O. nerka* in Umbrella Creek have been observed and documented on several occasions. Kokanee spawning in the mainstem of Big River is very rare. A review of nearly 200 spawning ground surveys (1970-2005) conducted in the mainstem of Big River during the kokanee spawning season yielded only one observation of kokanee, and these fish were not observed spawning. The impact of kokanee-sockeye interactions in Umbrella Creek and Big River was rated as negligible in the LFA.

Within Crooked Creek, kokanee abundance is far greater than sockeye abundance. Peak kokanee counts per mile averaged 100-500 during years with complete surveys. Competition and interaction between kokanee and any sockeye present in Crooked Creek is expected to be fairly common. Kokanee spawn timing is slightly earlier than observed sockeye spawn timing, which may act to minimize interaction and gene flow between these populations. Hatchery releases designed to introduce sockeye into Crooked Creek no longer occur because of concerns over sockeye-kokanee interactions and the fact that the two groups represent discrete ESUs of *O. nerka*.

4.4.3.3 Research and Monitoring

Spawning ground surveys are conducted approximately every 7 to 10 days within the primary sockeye spawning reaches. Surveyors are trained to identify and record all types of spawning activity, even under difficult or cryptic situations. Surveyors are also trained to avoid walking in areas suitable for spawning and to walk along channel margins and dry bars. Observed redds are flagged on the nearest branch or tree for future reference. Over time, redds can become masked in appearance as a result of algae growth, water depth, or bedload transport. It remains possible that surveyors could still walk or step on redds and crush eggs. However, years of experience and the precautions mentioned above likely keep impacts negligible.

4.4.3.4 Disease

See Section 4.2.3.4

5 RECENT AND ONGOING CONSERVATION EFFORTS

During the last 25 years, numerous efforts have taken place within the Lake Ozette watershed to protect, conserve, and restore the sockeye salmon population. A significant portion of adult sockeye returning during the last 10 years result from past conservation efforts. For example, from 2000 to 2004, sockeye spawning escapement in Umbrella Creek made up more than 50 percent of the total annual escapement for the ESU (Haggerty et al. 2009), and Umbrella Creek spawners are a product of the Makah Tribe's tributary sockeye reintroduction program.

While many conservation efforts have directly focused on recovery and conservation of Lake Ozette sockeye salmon, other efforts not designed and/or implemented specifically with this intention have also benefited the sockeye. The following list of conservation efforts was developed with input from the Lake Ozette Sockeye Steering Committee. Although the list is not all-inclusive, it indicates the scale of local efforts and resources for the task. The list contains programmatic actions (e.g., changes in forest practice regulations) and site-specific actions (e.g., Big River LWD enhancement projects), as well as research and monitoring projects implemented with the intent to better understand limiting factors and/or to develop management actions necessary to restore Lake Ozette sockeye salmon.

- Forest Practice Act enacted (1946).
- Current Forest Practices Act enacted (1974) and partially amended (1975).
- Development and implementation of increasingly protective State forest practices regulations prior to and since the 1970s.
- Rule changes in response to environmental review, including threatened and endangered species, forest roads, reforestation, and debris disposal (1980-1981).
- Creation of the Lake Ozette Sockeye Steering Committee (1982).
- Makah Tribal fisheries regulations prohibiting commercial, subsistence, and ceremonial harvest of Lake Ozette sockeye (1982-present).
- Pre-HGMP sockeye hatchery supplementation efforts (1982-1999).
- SEPA Rules developed requiring environmental review (1984).
- Development and implementation of the Timber/Fish/Wildlife agreement on private forest lands (1987).
- Class IV General Rules (1991) identifying certain areas proposed for timber harvest that, because of their particular characteristics, need additional evaluation and site review.
- Rule changes addressing wetlands, cumulative effects analysis, critical wildlife habitat, and stream temperatures (1992).
- Creation and implementation of Washington State Department of Natural Resources Habitat Conservation Plan for State Lands (provides minimum guidelines for forest practice activities on State Lands; 1994).
- Olympic Coast National Marine Sanctuary established in 1994.
- Forest and Fish legislation passed (1999).

- Creation of the North Olympic Peninsula Lead Entity Group (NOPLE) and WRIA 20 Citizen Facilitation Group (CFG), whose purpose is to identify and prioritize restoration actions, seek funding for projects, and oversee project implementation (1999).
- Creation of the North Pacific Coast Lead Entity (NPCLE) in 2007, as well as the Washington Coast Sustainable Salmon Partnership.
- Forest Practices emergency rules adopted addressing water typing, unstable slopes, roads, and wetlands (2000).
- Development and implementation of the Lake Ozette Sockeye Salmon Hatchery and Genetic Management Plan (2000).
- Revised permanent rules per Forests and Fish Report (2001).
- Development and implementation of the Forests and Fish report (WDNR 1999) and subsequent Forest Practice Regulations (2001), Forest Practices Habitat Conservation Plan (regulates forest practices on private land) (WDNR 2005).
- State fishing regulations prohibiting salmon fishing in all streams within the Lake Ozette watershed.
- National Park Service fishing regulations restricting the harvest of Lake Ozette sockeye salmon.
- Clallam County conservation programs, ordinances, and plans:
    - Clallam County Shoreline Master Program (1989)
    - Clallam County Interim Critical Areas Ordinance (1992)
    - Clallam County-Wide Planning Policies (1993)
    - Clallam County Comprehensive Plan and Sub-Area Plan (1995)
    - Clallam County Shoreline Code Amendment (1997)
    - Clallam County Critical Areas Code (1999)
    - Critical Areas GIS Mapping and Map Updates (1992, 1995, 1999, 2000)
- Several in-stream and floodplain enhancement projects:
    - Road-derived sediment control by cross drain construction, in Umbrella, Crooked, Siwash, and South Creek, and three Lake Ozette sites (Quileute Natural Resources and Rayonier, 1999).
    - LWD placement Solberg Creek (Green Crow/Makah Tribe, 1999)
    - LWD placement Umbrella Creek (Crown Pacific/Makah Tribe, 2000)
    - LWD placement and riparian planting Big River, Cross property (Makah Tribe, 2005)
    - LWD placement Big River, Boe property (Makah Tribe, 2006)
    - Big River knotweed eradication and riparian planting (local citizens and private property owners/Makah Tribe/Clallam County/Olympic National Park, 2005 and 2006)
- Numerous reports and research and monitoring projects focused on better understanding and/or conserving and restoring Lake Ozette sockeye salmon can be broadly grouped within the following categories:
    - <u>Juvenile and Adult Abundance Projects</u> (see-Blum 1998; Crewson 2003; Dlugokenski et al. 1981; Drange and LaRiviere 1991; Good et al. 2005; Gustafson et al. 1997; Haggerty 2004; Haggerty 2005a,

2005b, 2005c, and 2005d; Haggerty et al. 2009; Hinton et al. 2002; Jacobs et al. 1996; Kemmerich 1926, 1939, 1945; LaRiviere 1990, 1991; MFM 1981a, 1981b, 1981c, 1982a, 1982b, 1983a, 1983b, 1983c, 1984a, 1984b, 1986, 1987, 1991, 1992, and 2000; McHenry et al. 1996; Nehlsen et al. 1991; NMFS 1998; Peterschmidt 2005; Peterschmidt and Hinton 2005; Ward et al.1976; WDF 1994; WDF 1955)

- Sockeye Stock Status Reviews (see-Nehlsen et al. 1991; WDF 1994; McHenry et al. 1996; Gustafson et al. 1997; NMFS 1998; MFM 2000; WDFW 2002; Good et al. 2005; Haggerty et al. 2009).
- Population Identification and Viability Analyses (Currens et al. 2006; Rawson et al. 2008)
- Habitat Conditions and Habitat Limiting Factors Reports (Adamire 2000; Beauchamp et al. 1995; Beauchamp and LaRiviere 1993; Blum 1988; Bortleson and Dion 1979; Crewson 2002; Dlugokenski et al. 1981; Gearin et al. 1999, 2000, 2002; Golder 2005; Haggerty et al. 2009; Haggerty and Ritchie 2004; Herrera 2005, 2006; Hughes et al. 2002; Jacobs et al. 1996; Klinge 1991; Kramer 1953; Lieb and Perry 2004; MFM 2000; Martin Environmental 1999; McHenry et al. 1994; Meier 1998; Meyer and Brenkman 2001; PWA 2002; Ritchie 2005, 2006, Shellberg 2003; Smith 2000; USFWS 1965; NMFS 2006)
- Hatchery and Genetic Management Plans and Reports (MFM 2000 and subsequent annual reports on HGMP activities; NMFS 2003, 2004; Crewson et al. 2001; Hawkins 2004)

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6 RECOVERY STRATEGY

In this chapter, an overall recovery strategy is presented that describes the connection between ecosystem processes, limiting factor hypotheses, and a broad range of goals and approaches to recover the Lake Ozette sockeye salmon. Thirty-three diverse recovery strategies are presented which address the limiting factor hypotheses described in Chapter 4. These recovery strategies are broad in scope and include habitat restoration, assessing hydrologic conditions, implementing the hatchery program HGMP, eliminating or strictly limiting fishing-related mortalities, and restoring predator-prey balance within the Ozette watershed. Chapter 7 then identifies the programmatic and site-specific recovery actions that are linked to one or more of these recovery strategies. Further, Appendix D provides a synthesis that links each programmatic and site-specific action with the primary and secondary limiting factor hypotheses, articuluated in Chapter 4, and the appropriate recovery strategies delineated in this chapter.

This recovery strategy presents a comprehensive framework for identifying recovery actions that address the limiting factors that are believed to be impeding the survival of Lake Ozette sockeye. Embedded in this framework is an understanding of ecosystem processes and how past and current activities affect these processes. If, as we believe, Lake Ozette sockeye limiting factors are affected by habitat degradation, impaired water quality and stream flow, predation, and competition, then actions taken to improve, change, and reduce the effects of these factors will result in increased survival and improvements in abundance, productivity, spatial structure, and diversity over time for Lake Ozette sockeye salmon.

The recovery strategy is based on current research and is related to what is known about Lake Ozette sockeye mortality by life stage and the hypotheses about limiting factors. The result is a hierarchy of types of recovery strategies that can form the basis for setting priorities among potential actions.

The Lake Ozette watershed has an unusual potential for protection and restoration of landscape processes to support long-term salmon survival. The Lake Ozette sockeye salmon ESU is unique among all other ESA-listed salmon ESUs, in that the entire ESU is contained within a single watershed, and, futher, the ESU contains only one population, making the population and ESU viability criteria the same. There are relatively few individual landowners and a low human population density throughout the watershed, which remains relatively undeveloped compared to other watersheds closer to the metropolitan areas of Puget Sound.

Several scientific studies have illustrated the principle that habitat condtions and aquatic ecosystem function are a result of the interaction between watershed controls (such as geology and climate), watershed processes (such as hydrology and sediment transport), and land use. Scientists and resource managers have recognized that restoration planning that carefully integrates watershed or ecosystem processes is more likely to be successful at restoring depleted salmonid populations (Beechie et al. 2003). The strategy used in this recovery plan focuses on the concepts presented in several salmonid habitat recovery planning documents and scientific studies (e.g., Beechie and Boulton 1999; Roni et al. 2002; Beechie et al. 2003; Roni et al. 2005; Stanley et al. 2005). Habitat, harvest, and hatchery factors affecting Lake Ozette sockeye are included in the recovery strategy. Hatchery and harvest management issues are presented and addressed within the context of biological processes. For example, Section 6.2.2, Biological Processes, identifies strategies to address predation through harvest of non-native fish species, eliminating and/or strictly limiting fishing-related mortalities on Lake Ozette sockeye, and improving predator avoidance through improved weir and smolt trapping techniques. Chapter 7 then identifies recovery actions based on these strategies. The recovery strategy framework is comprehensive and addresses all factors believed to be limiting Lake Ozette sockeye surivival. It prioritizes recovery actions, from habitat, hydro, hatchery, harvest, and predation, to meet the recovery needs of the species.

The strategy uses a multi-parameter approach to develop specific, process-based goals and strategies for each landscape and/or biological process that is linked to a specific limiting factor hypothesis. Section 6.1 describes the framework used to develop process and habitat condition-specific recovery goals and strategies. Sections 6.2 through 6.4 present the goals and strategies used to develop the recovery actions identified in Chapter 7.

The following recovery strategies provide the framework for the recovery actions delinated in Chapter 7. The voluntary proposed recovery actions used to implement these strategies will be carried out by the agencies, entities, landowners, and others that have authority and resources to implement recovery actions. This recovery plan is non-regulatory. It does not supplant or override any existing authorities or permitting processes. All future actions will need to be implemented in cooperations with all appropriate permitting authorities and in the context of exisiting permits, regulations, agreements and public processes.

6.1 STRUCTURE USED IN RECOVERY GOAL AND STRATEGY DEVELOPMENT

The Lake Ozette sockeye recovery strategy framework contains three key elements:

1. Recovery strategies are based upon protection, restoration, and/or rehabilitation of critical processes, inputs, and habitat conditions associated with *identified* limiting factors affecting Lake Ozette sockeye.
2. Recovery strategies are based upon three hierarchical recovery flow charts that integrate geography, sockeye life history, and subpopulations. In these recovery flow charts, all recovery strategies and actions fall within a hierarchical pyramid containing tiers that can be used to sequence and aid in prioritization of strategies and actions needed to restore processes, inputs, and/or conditions affecting sockeye subpopulations.
3. Recovery strategies across the watershed can be categorized by importance based upon subbasin prioritization; priorities are based, in

turn, on the spatial extent of sockeye habitat utilization and critical habitat designation, sockeye spawning distribution goals, inter-species competition and hybridization concerns, proximity to key sockeye salmon habitats, and hydrologic influence on Lake Ozette.

Development of recovery goals and strategies incorporated the results of the LFA and the hypotheses presented in Chapter 4. The limiting factors figures presented in the introductions to Sections 4.2, 4.3, and 4.4 were simplified into Figure 6.1. The relative mortalities depicted in Figure 6.1 were used as the initial inputs to develop the recovery strategies presented in Sections 6.2 through 6.4. The status of landscape processes and inputs, biological processes, and habitat conditions was then evaluated and incorporated into the development of three independent recovery flow charts (see Sections 6.2, 6.3, and 6.4). Based on these recovery planning flow charts, a hierarchical approach to recovery planning strategies and actions was developed specifically for Lake Ozette sockeye recovery. Finally, a system of subbasin prioritization was developed to determine which subbasins had the most significant influences on the watershed processes, which, in turn, drive habitat conditions and limiting factors affecting Lake Ozette sockeye. These recovery planning elements are integrated in Chapter 9, where recovery actions and strategies are prioritized and an implementation schedule is presented.

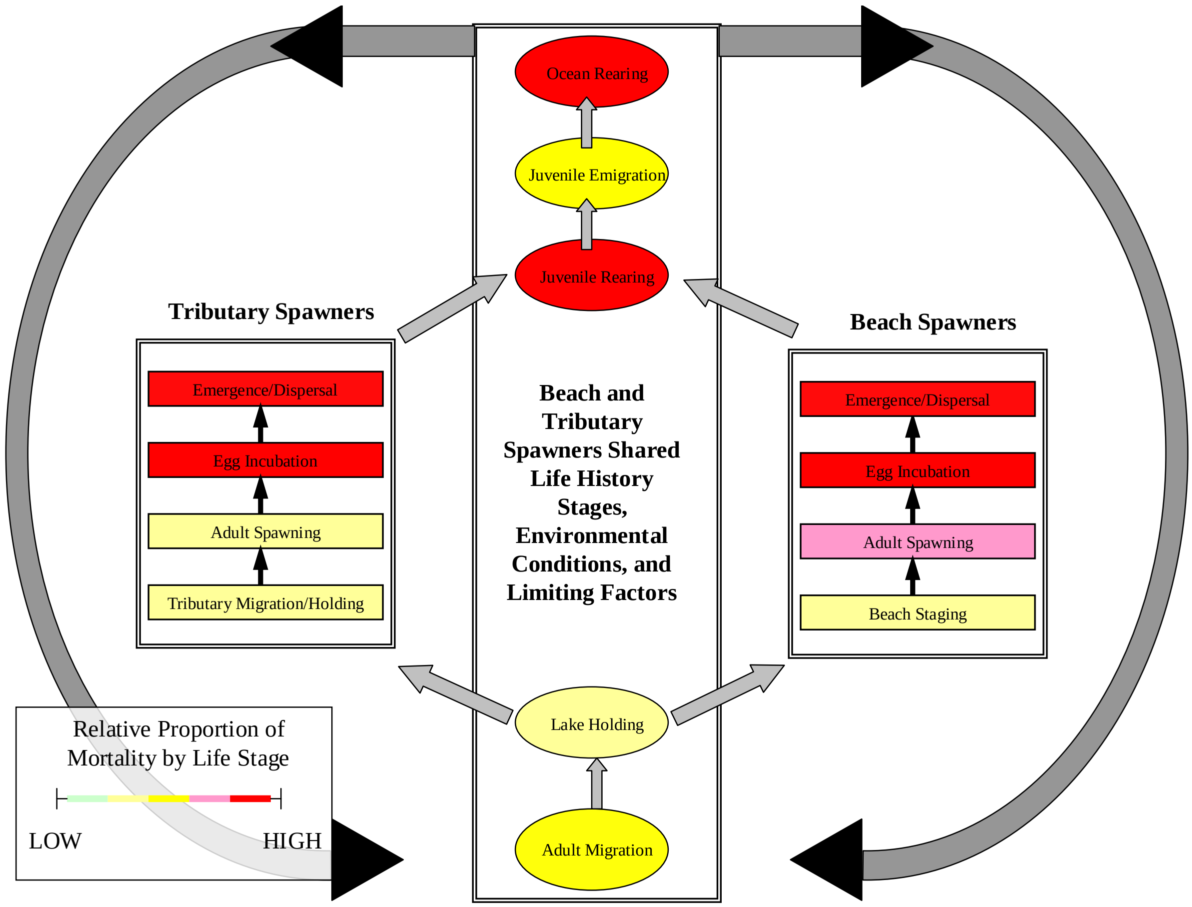

Figure 6.1. Schematic diagram depicting the relative proportion of sockeye mortality by life stage.

6.1.1 Landscape Processes and Inputs, Biological Processes, and Habitat Conditions

Figure 6.2 illustrates the basic concept of the interaction between watershed controls, watershed processes, habitat effects, and fish population responses. Diagrams were developed to illustrate how these interactions specific to the Ozette watershed are related to the limiting factor hypotheses and relevant activities (see Figure 6.7, Figure 6.9, and Figure 6.11).

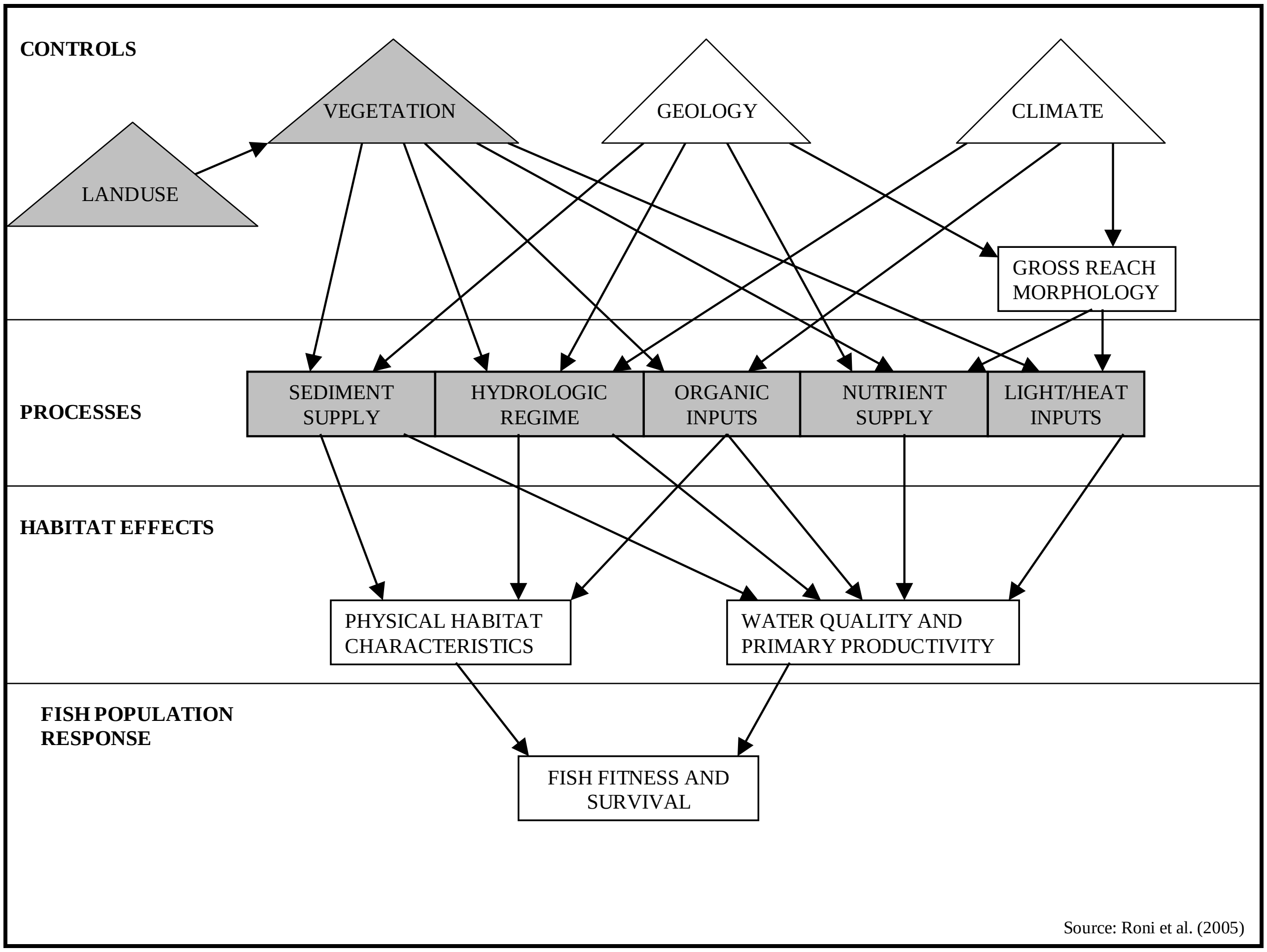

Figure 6.2. Schematic depicting the linkage between landscape controls and land use, habitat-forming processes, habitat conditions, and resulting fish population responses (modified from Roni et al. 2005).

6.1.2 Hierarchical Approach to Sockeye Salmon Population Segment Recovery Strategies

The planning processes started with a general approach to watershed processes and recovery strategy hierarchy developed in the scientific literature by a number of watershed scientists. Figure 6.3 contains a flow chart depicting a general hierarchical approach for prioritizing habitat restoration, protection, and enhancement activities with regard to habitat (Roni et al. 2002). This model was then adapted for conditions specific to Lake Ozette and sockeye salmon recovery.

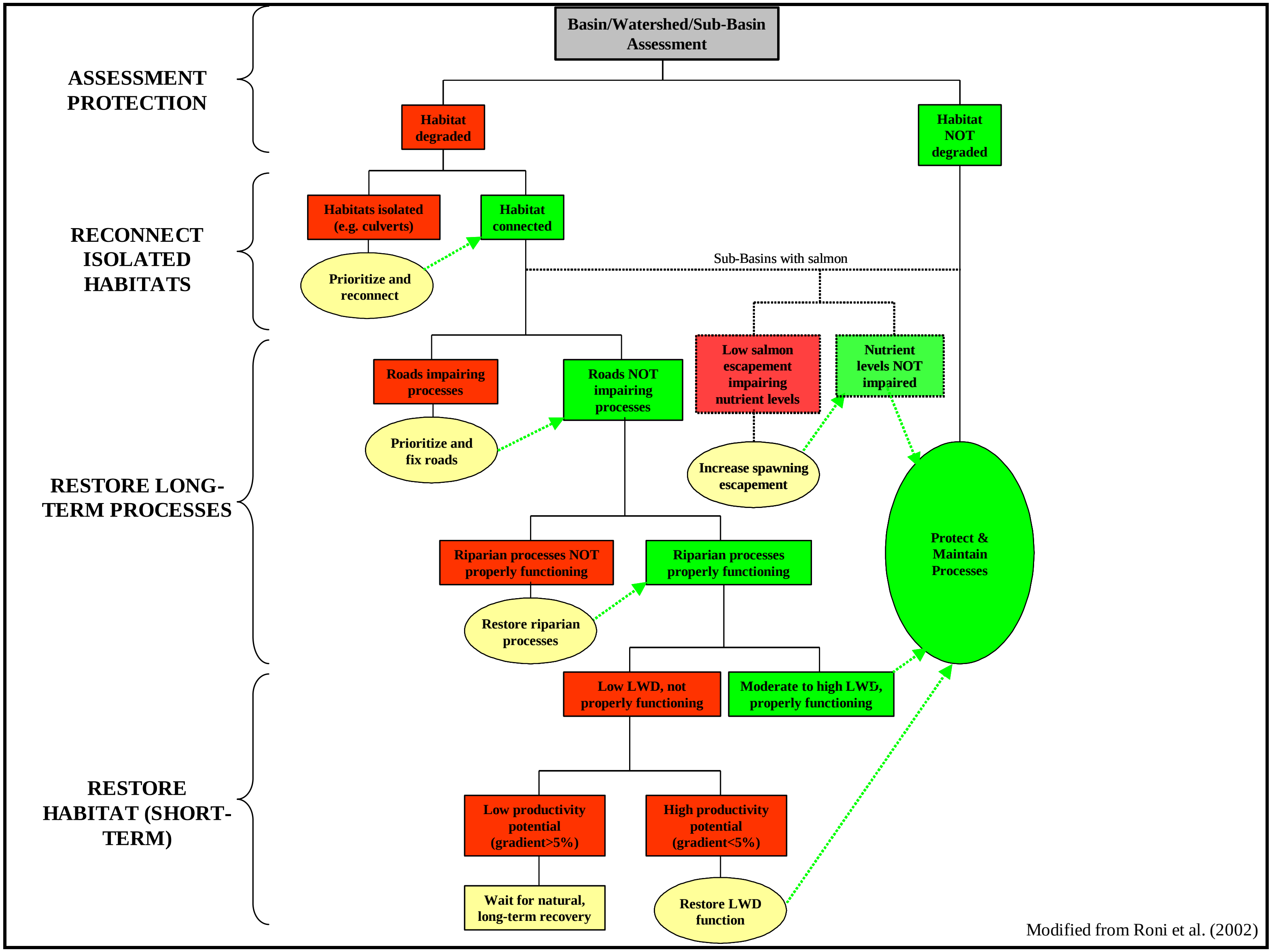

Figure 6.3. Flow chart depicting hierarchical strategy for prioritizing protection, restoration, and enhancement activities. (Note: red rectangles represent impaired processes or conditions, yellow ovals represent the need to develop strategies and implement actions, green rectangles represent restored processes where planners can then move down through the flow chart).

Within the Lake Ozette watershed, some limiting factors, habitat conditions, and life histories are shared among all population segments (subpopulations), while others apply to some segments and not others. As described in previous chapters, subpopulations can be grouped based on similarities of spawning environments (e.g., tributary vs. beach spawning). The recovery goals and strategies presented here are based on geographic factors, sockeye life history, and recovery flow charts for all population segments, beach spawners only, and tributary spawners only. Ozette-specific flow charts are included in the introductions to Sections 6.2 through 6.4.

Figure 6.4 provides a visual representation of the recovery strategy priorities, beginning with the protection and maintenace of habitat processes. The second priority strategy is to increase spatial structure by reconnecting isolated habitats such as restablishing spawning aggregations at historical spawning beaches. The third priority is to restore biological and habitat forming processes which include a broad range of strategies to address predators, non-native fish, restoring spawning habitat, limiting sockeye harvest, and improving water quality and hydrological conditions. The recovery strategy is comprehensive, addressing all limiting factor hypotheses, and allowing for a full range of habitat, harvest, and hatchery recovery actions. All recovery strategies and actions fall within the hierarchical pyramid presented below. The pyramid includes tiers that can be used to sequence and aid in the prioritization of strategies and actions needed to restore processes, inputs, and conditions affecting sockeye within each of the the population segments.

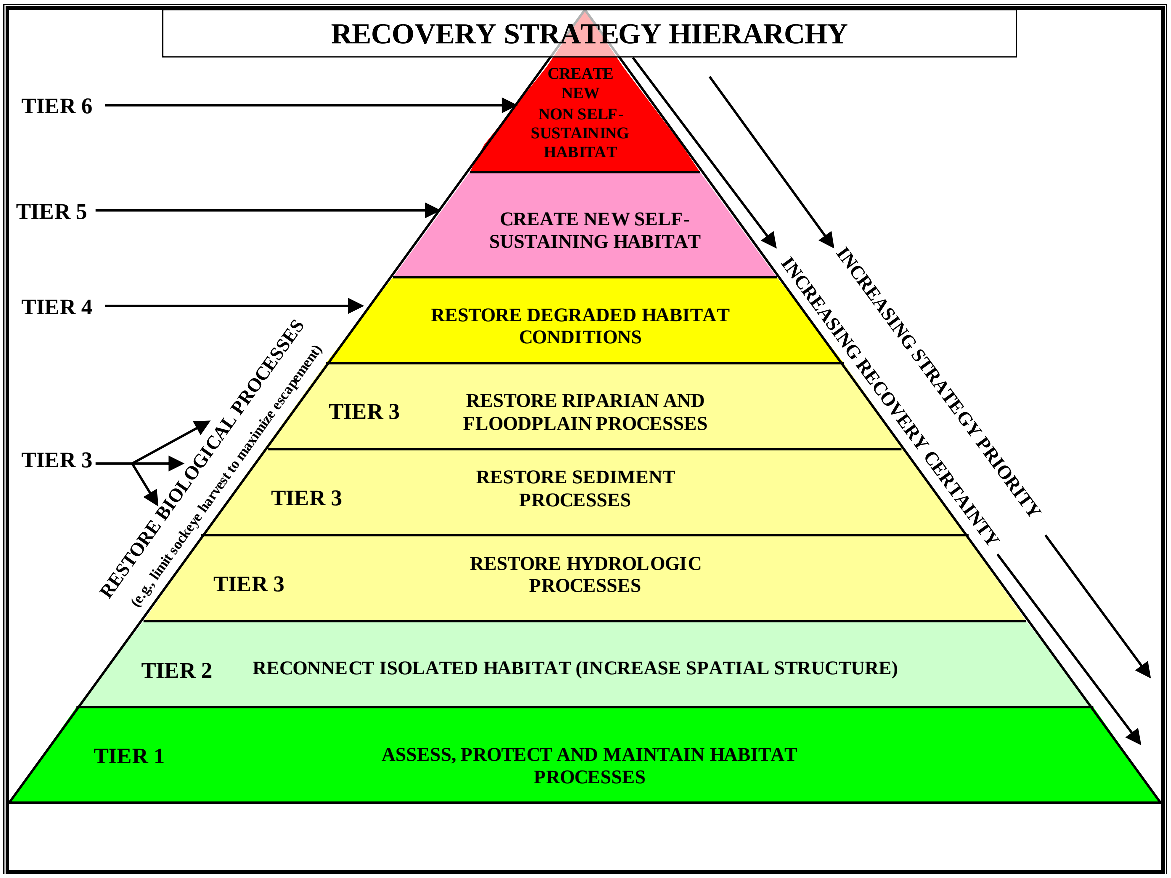

Figure 6.4. Ozette sockeye-specific recovery strategy and action hierarchy.

In summary, the key principles of the recovery strategy which form the basis for salmon recovery actions include:

1. Assess, protect, and maintain habitat processes
2. Reconnect isolated habitat to increase spatial structure
3. Maintain and restore ecological processes
4. Restore degraded habitat
5. Create new self-sustaining habitat
6. Create new non self-sustaining habitat

6.1.3 Subbasin Prioritization Used in Strategy Development

Recovery strategies across the watershed can be ranked according to subbasin priority. Subbasins were prioritized based on the spatial extent of sockeye habitat utilization and critical habitat designation, sockeye spawning distribution goals, concerns about inter-species competition (e.g., with coho) and inter-species hybridization (with kokanee), proximity to key sockeye salmon habitats, and hydrologic influence on Lake Ozette. Each subbasin within the Ozette watershed was evaluated based on the flow chart below (Figure 6.5). The following yes-no questions were answered for each subbasin:

- Is the subbasin or stream used by sockeye salmon?
- Is the subbasin or stream, in whole or part, designated critical habitat?
- Is the subbasin or stream system in a location where sockeye spawning is one of the recovery goals (see Appendix B)?
- Is the subbasin or stream system in a location where interspecies competition and/or hybridization are concerns?
- Does the subbasin or stream provide critical habitat to the entire sockeye population at one or more life history stages?
- Is the stream or subbasin confluence located in close proximity to utilized or potential beach spawning habitat?
- Does the subbasin or stream supply 10 percent or more of the lake inflow?

The results of the subbasin prioritization questions are presented in Table 6.1. Figure 6.6 depicts the spatial extent of the subbasin prioritization. All recovery strategies and actions will be evaluated and prioritized at a minimum based upon the limiting factors rating, the hierarchical tier of the strategy or action, and subbasin priority rating (see Section 7.7, Action Integration).

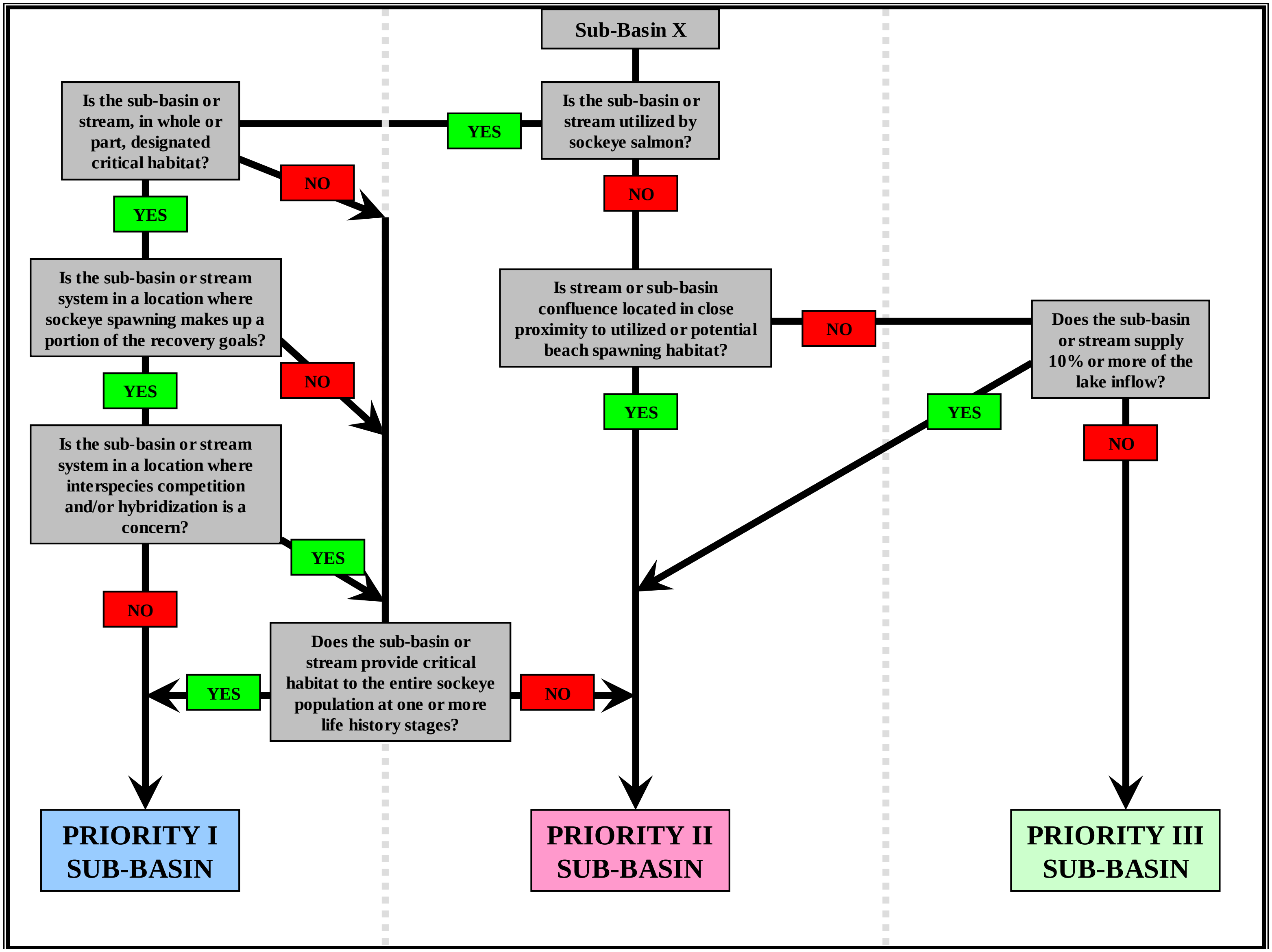

Figure 6.5. Schematic diagram depicting system used for prioritizing Lake Ozette subbasins.

Table 6.1. Responses to subbasin prioritization questions and subsequent subbasin priority ratings.

Subbasin/Stream System	Is the subbasin or stream used by sockeye salmon?	Is the subbasin or stream, in whole or part, designated critical habitat?	Is the subbasin or stream system in a location where sockeye spawning makes up a portion of the recovery goal production?	Is the subbasin or stream system in a location where interspecies competition and/or hybridization is a concern?	Does the subbasin or stream provide critical habitat to the entire sockeye population at one or more life history stages?	Is stream or subbasin confluence located in close proximity to utilized or potential beach spawning habitat?	Does the subbasin or stream supply 10 percent or more of the lake inflow?	Subbasin Prioritization
Lake Ozette	Yes	Yes	Yes	No	Yes	NA	Yes	**Priority I**
Ozette River	Yes	Yes	No	No	Yes	NA	NA	**Priority I**
Umbrella Creek	Yes	Yes	Yes	No	No	Yes	Yes	**Priority I**
Big River	Yes	Yes	Yes	No	No	No	Yes	**Priority I**
Coal Creek	Yes	Yes	No	No	No	No	No	Priority II
Crooked Creek	Yes	Yes	Yes	Yes	No	No	Yes	Priority II
Siwash Creek	No	No	No	Yes	No	Yes	No	Priority II
Elk Creek	No	No	No	Yes	No	Yes	No	Priority II
WRIA# 20.0073	No	No	No	Yes	No	Yes	No	Priority II
WRIA# 20.0078	No	No	No	No	No	Yes	No	Priority II
Unnamed west- and east-side streams	No	No	No	No	No	Yes	No	Priority II
Palmquist Creek	No	No	No	Yes	No	No	No	Priority III
Quinn Creek	No	No	No	Yes	No	No	No	Priority III
South Creek	No	No	No	No	No	No	No	Priority III
Allen Slough	No	No	No	No	No	No	No	Priority III
WRIA# 20.0079	No	No	No	No	No	No	No	Priority III
All other unnamed streams flowing into Lake Ozette or the Ozette River	No	No	No	No	No	No	No	Priority III

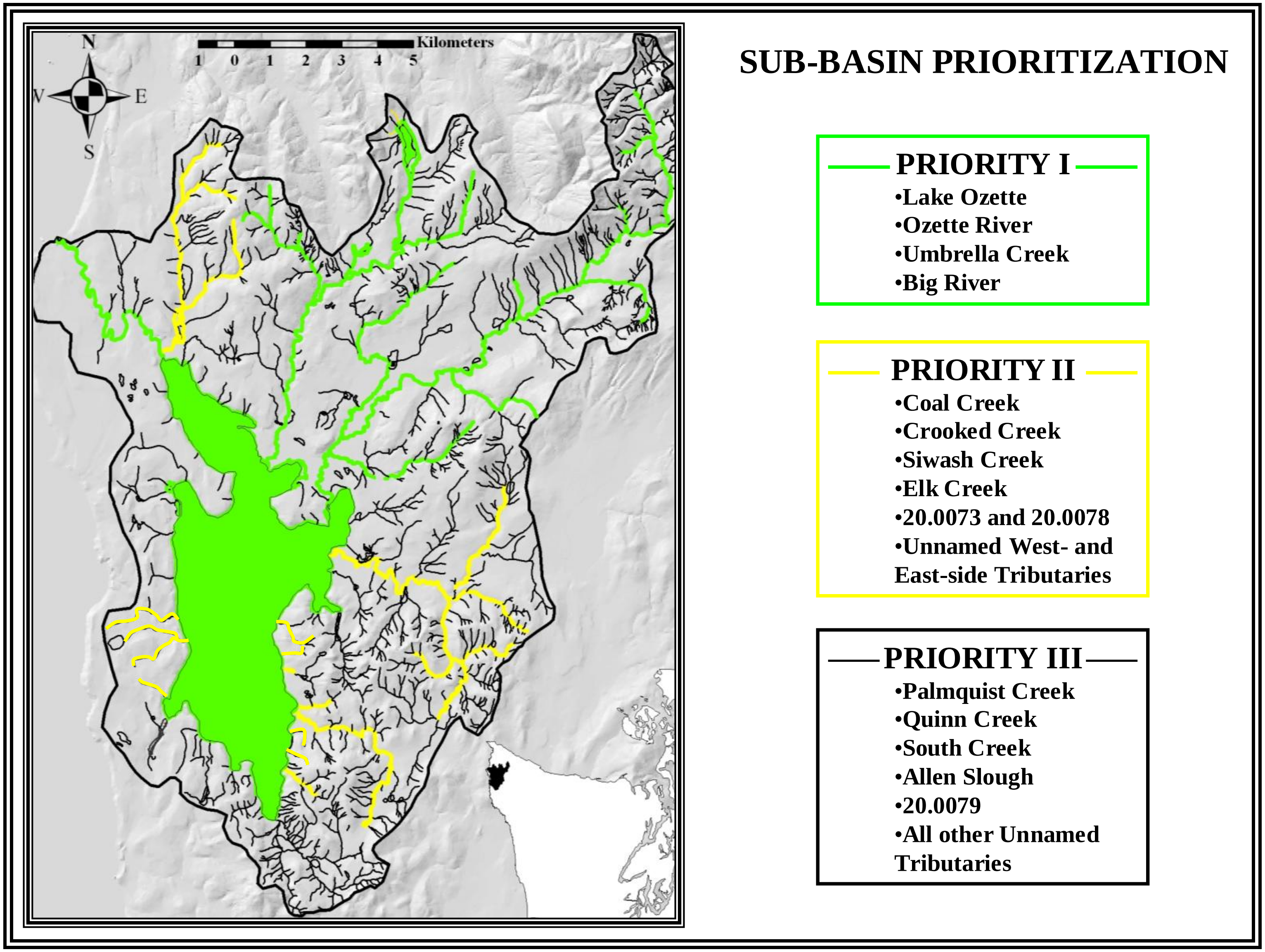

Figure 6.6. Lake Ozette subbasin prioritization. Green lines depict priority I subbasins, yellow lines depict priority II subbasins, and black lines entering Lake Ozette and the Ozette river depict priority III subbasins.

6.2 GOALS AND STRATEGIES TO RESTORE PROCESSES AND CONDITIONS AFFECTING ALL POPULATION SEGMENTS

Section 4.2 identifies and describes limiting factors affecting all population segments. All Lake Ozette sockeye experience the same habitat conditions and limiting factors during five life history stages: adult migration (Ozette River), adult holding (Lake Ozette), juvenile rearing (Lake Ozette), smolt emigration to the ocean (Ozette River), and marine rearing (Pacific Ocean). Each limiting factor was assessed based upon the sockeye life stage affected, the process or input influencing the limiting factors, and activities that affect each process and input. Figure 6.7 illustrates the interconnectedness between processes and limiting factors relative to all population segments. It is important to note how complex and interconnected the processes and limiting factors are, because the following subsections present this information in a highly simplified manner. Figure 6.8 depicts a hierarchical strategy for prioritizing protection, restoration, and enhancement activities for all population segments.

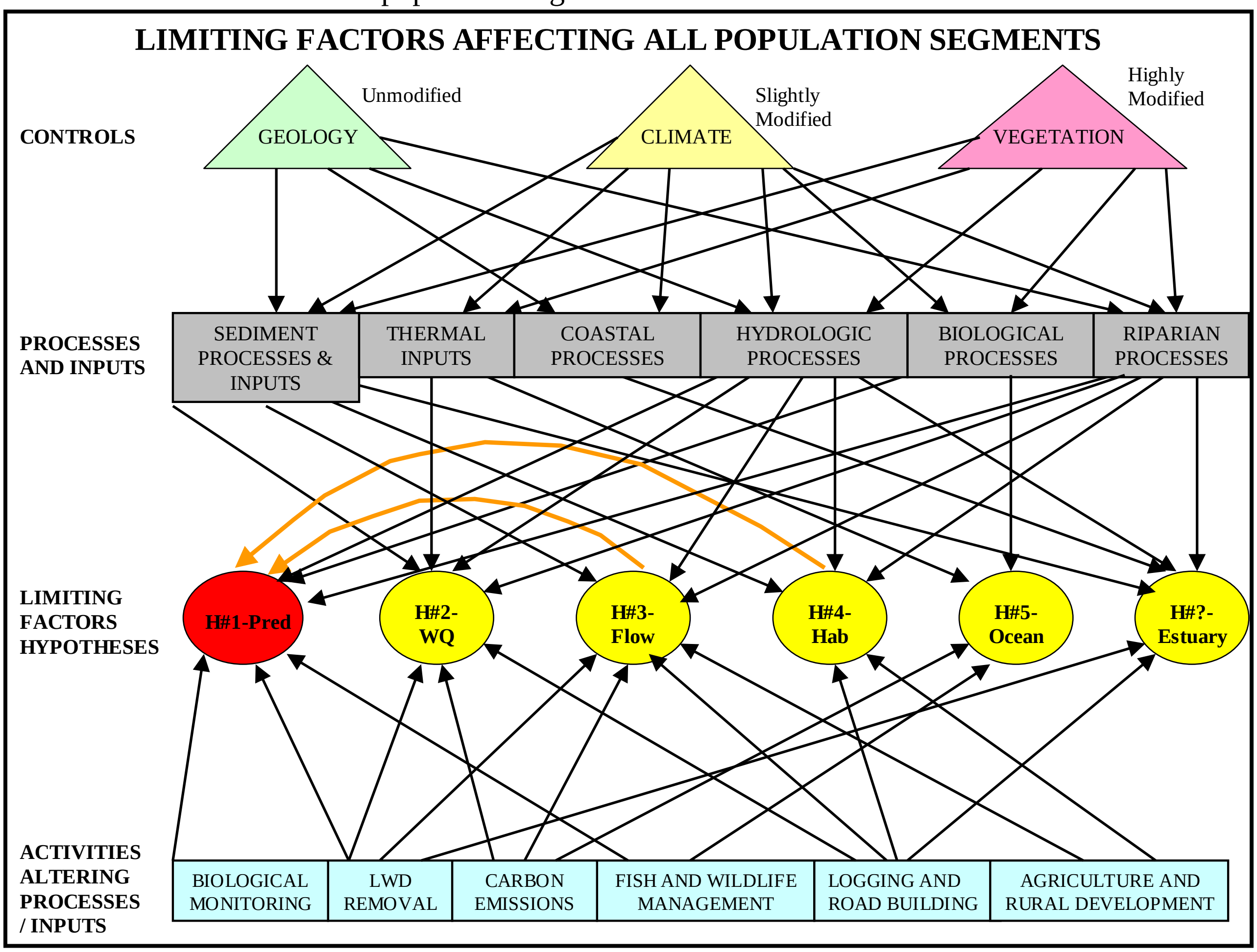

Figure 6.7. Schematic diagram depicting the linkages between watershed controls, watershed-scale processes and inputs, limiting factors hypotheses, and activities that alter processes and inputs.

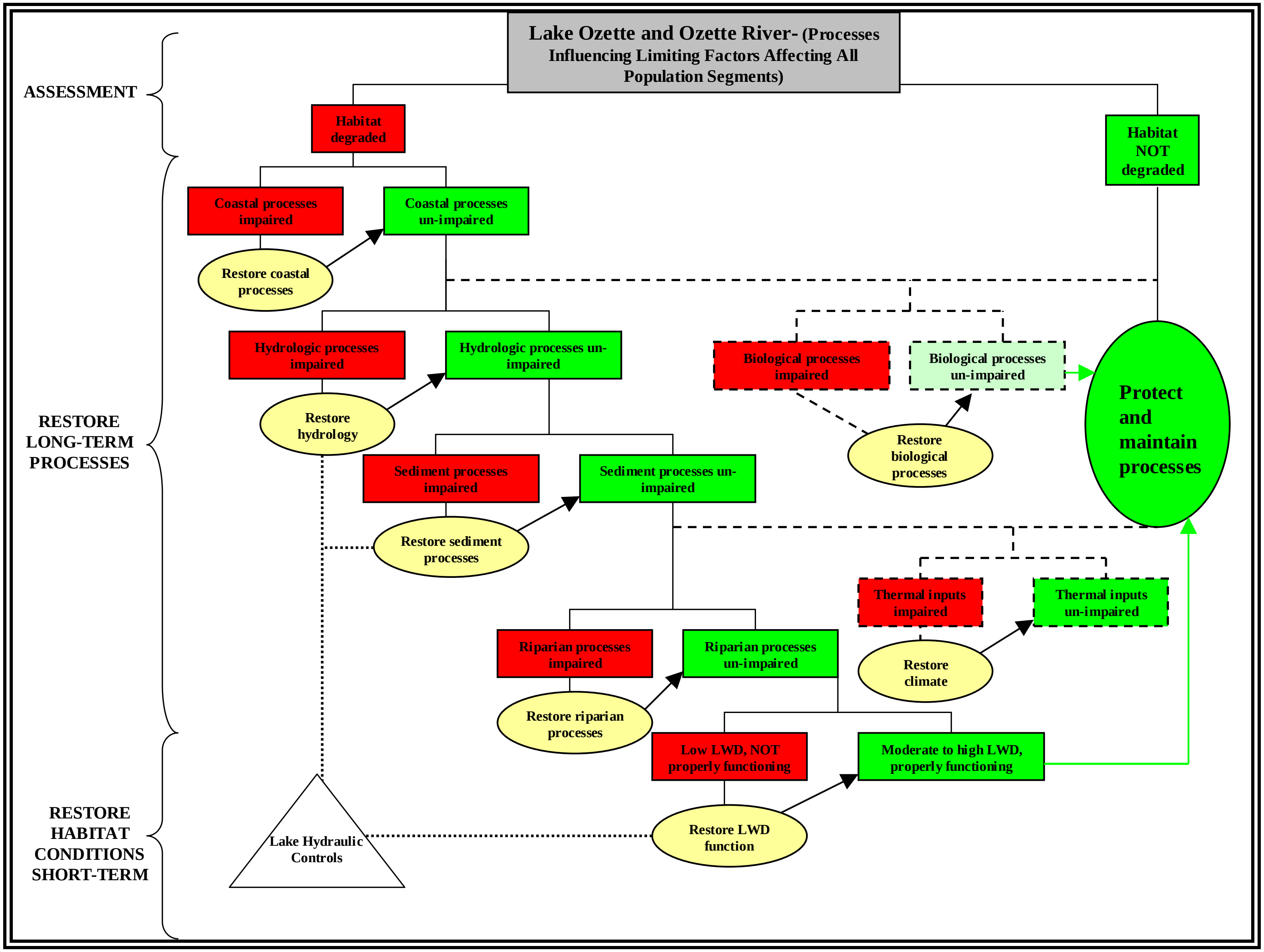

Figure 6.8. Flow chart depicting hierarchical strategy for prioritizing protection, restoration, and enhancement activities for factors affecting all population segments (adapted from Roni et al. 2002).

6.2.1 Coastal Processes

Within the context of this subsection, coastal processes are those processes that deliver and route sediment along the coastal shoreline and act to develop the landforms found near the mouth of the Ozette River, as well as influence physical estuarine conditions. Landscape processes and inputs occurring upstream of the mouth of the Ozette River, along with coastal processes, strongly influence the conditions at the transition from the riverine environment to the marine environment (e.g., the river is currently open and accessible to migrating adults and emigrating juvenile sockeye year-round, and the outlet has never been observed to be bar-bound). Table 6.2 is a summary of the status (impaired/unimpaired) of coastal processes, linkage to limiting factors hypotheses, and activities affecting coastal processes.

Table 6.2. Summary of coastal process condition, linkage to limiting factors hypotheses, and activities affecting coastal processes.

Process/input condition status:	Unimpaired
Primary limiting factor hypothesis Associated with Process/Input:	NA (potential alterations of estuary habitat)
Life history stages affected:	Juvenile emigration, adult migration
Degree of impact of primary limiting factor hypothesis:	Unknown
Secondary limiting factors hypotheses associated with process/input:	NA
Activities and/or conditions affecting process/input:	None identified

Recovery goal: Maintain and protect coastal processes to prevent the development of future limiting factors associated with coastal processes (e.g., loss of estuary habitat, seasonal bar-bound conditions at the mouth of the Ozette River).

Recovery strategy 1: Protect coastal processes and estuary habitat from degradation by implementing ONP, tribal, and National Marine Sanctuary regulations and management plans. Implement the Coast Guard's Northwest Area Contingency Plan in response to any oil spill within the Sanctuary.
Recovery strategy hierarchy: Tier 1.
Priority subbasin rating: Priority I

6.2.2 Biological Processes (H#1-Pred)

Within the context of this subsection, biological processes are those that occur in Lake Ozette, the Ozette River, and the Pacific Ocean. Limiting factor Hypothesis 1 (Section 4.2.1.1) is the primary limiting factor hypothesis related to biological processes affecting all population segments. Biological processes in fresh water are complex, since many watershed scale processes, habitat conditions, and management activities may affect biological processes and ultimately the predator-prey balance within the ecosystem. Activities and/or conditions that currently affect predation include: LWD removal and habitat conditions in Ozette River, biological monitoring, and fish and wildlife management. Table 6.3 is a summary of the status (impaired/unimpaired) of biological processes, linkage to limiting factors hypotheses, and activities affecting predation.

Table 6.3 Summary of biological process condition, linkage to limiting factors hypotheses, and activities affecting biological processes.

Process/input condition status:	Impaired
Primary limiting factor hypothesis associated with process/input:	Hypothesis 1 (Pred)
Geographic location of limiting factor:	Lake Ozette, Ozette River
Life history stages affected:	Juvenile rearing, juvenile emigration, adult migration and holding
Degree of impact of primary limiting factor hypothesis:	High Key limiting factor
Secondary limiting factors hypotheses associated with process/input:	Hypothesis 5 (MS)
Activities and/or conditions affecting predation:	LWD removal and habitat conditions in Ozette River, biological monitoring, fish and wildlife management

Recovery goal: Restore and protect biological process so the balance between predators and prey is restored and is no longer limiting Lake Ozette sockeye VSP parameters.

Recovery strategy 2: Implement strategies and actions to increase egg-to-fry survival of beach and tributary spawners so that the habitat can produce abundant sockeye salmon, reducing the overall percent impact of predation on the population.
Recovery strategy hierarchy: Tier 1-4.
Priority subbasin rating: Priority I-III.

Recovery strategy 3: Restore natural predator-prey balance by eliminating non-native fish species.
Recovery strategy hierarchy: Tier 3.
Priority subbasin rating: Priority I.

Recovery strategy 4: Restore natural predator-prey balance by eliminating and/or strictly limiting fishing-related mortalities on Lake Ozette sockeye.
Recovery strategy hierarchy: Tier 3.
Priority subbasin rating: Priority I.

Recovery strategy 5: Improve predator avoidance opportunities in the Ozette River (e.g., improved weir and smolt trapping techniques, large wood placement) (see also RS#16).
Recovery strategy hierarchy: Tier 3.
Priority subbasin rating: Priority I.

Recovery strategy 6: Implement actions that restore the hydraulic and hydrologic conditions of the Ozette River (e.g., LWD and sediment deposition) to provide favorable flow conditions for sockeye migration and predator avoidance.
Recovery strategy hierarchy: Tier 1-4.
Priority subbasin rating: Priority I.

Recovery strategy 7: Work at local, regional, and international scales to maintain favorable ocean conditions that support sockeye salmon.
Recovery strategy hierarchy: Tier 3.
Priority subbasin rating: Priority I.

6.2.3 Hydrologic Processes (H#3-Q)

Within the context of this subsection, hydrologic processes are those processes that store, deliver, and route water into the Ozette River. Limiting factor Hypothesis 3 (Section 4.2.2.2) is the primary limiting factor hypothesis related to hydrologic processes affecting all population segments. Ozette River hydrology is largely controlled by: a) climate, b) lake and tributary hydrology, c) sediment input, routing, and storage in the upper half-mile of the Ozette River, and d) LWD recruitment and storage (in logjams) in the upper one mile of the Ozette River. Activities affecting hydrologic processes include: historical LWD removal (affecting lake hydrology), ONP facilities operation and maintenance in Ozette River riparian zone (affecting LWD recruitment and lake hydrology), logging and road building throughout the watershed (affecting tributary hydrology and lake hydrology) and specifically in Coal Creek (affecting sediment processes), agriculture and rural development in the Big River valley (affecting tributary and lake hydrology), and other floodplain alterations in major tributaries to the lake (affecting tributary and lake hydrology). Table 6.4 is a summary of the status (impaired/unimpaired) of hydrologic processes, linkage to limiting factors hypotheses, and activities affecting hydrologic processes.

Table 6.4 Summary of hydrologic process condition, linkage to limiting factors hypotheses, and activities affecting hydrologic processes.

Process/input condition status:	Impaired
Primary limiting factor hypothesis associated with process/input:	Hypothesis 3 (Q)
Geographic location of limiting factor:	Ozette River
Life history stages affected:	Adult migration and juvenile emigration
Degree of impact of primary limiting factor hypothesis:	Unknown Contributing limiting factor
Secondary limiting factors hypotheses associated with process/input:	Hypotheses 1 (Pred), 2 (WQ), 4 (Hab)
Activities and/or conditions affecting process/input:	LWD removal, ONP facilities, logging and road building, agriculture and rural development, and other floodplain alterations

Recovery goal: Restore hydrologic processes and natural hydrologic variability in the Ozette River to the extent that hydrologic influences according to Hypotheses 1, 2, 3, and 4 are no longer limiting Lake Ozette sockeye VSP parameters.

Recovery strategy 8: Quantitatively assess hydrologic impacts from land use and LWD removal activities and develop a distributed hydrologic model calibrated for each tributary in conjunction with Ozette River hydraulic model to prioritize actions needed to improve natural hydrologic functions.
Recovery strategy hierarchy: Tier 1.
Priority subbasin rating: Priority I

Recovery strategy 9: Restore natural hydraulic controls (both LWD and sediment) in the upper one mile of the Ozette River based on guidance from watershed hydrologic modeling.
Recovery strategy hierarchy: Tier 3/4.
Priority subbasin rating: Priority I.

Recovery strategy 10: Implement hydrologic strategies for sockeye spawning subbasins based on outcome of hydrologic modeling (see Section 6.4.2 recovery strategies).
Recovery strategy hierarchy: Tier 3.
Priority subbasin rating: Priority I.

Recovery strategy 11: Based on the results of watershed hydrologic modeling, implement hydrologic strategies to restore Lake Ozette inflow hydrology in priority II and III subbasins.
Recovery strategy hierarchy: Tier 3.
Priority subbasin rating: Priority I, II, and III.

6.2.4 Sediment Processes (H#2-WQ; H#3-Q)

Within the context of this subsection, sediment processes are those processes that store, deliver, and route sediment into the Ozette River. Limiting factor Hypotheses 2 and 3 (Sections 4.2.2.1 and 4.2.2.2) are the primary limiting factor hypotheses related to sediment processes affecting all population segments. For the discussion regarding hydrologic impacts of sediment processes, see Section 6.2.3. Water quality conditions in the Ozette River are primarily controlled by sediment inputs (SSC) and thermal inputs (high stream temperatures). For the discussion regarding thermal input-related water quality impacts, see Section 6.2.5. Activities affecting sediment processes include: a) LWD removal or losses in LWD volume, which have caused channel destabilization resulting in increased sediment delivery to the Ozette River; b) logging and road building (in tributaries to the Ozette River), which have increased sediment inputs, reduced sediment storage, and resulted in more frequent SSC events in the Ozette River; c) channel alterations and sediment mobilizing events, which have increased coarse sediment deposition at the confluence of Coal Creek and the Ozette River. Increased sediment deposition has resulted in an increase in the lake’s outlet control elevation, thereby reducing the Ozette River's streamflow (see Hypothesis 3), which results in reduced water quality. Table 6.5 is a summary of the status (impaired/unimpaired) of sediment processes, linkage to limiting factors hypotheses, and activities affecting sediment processes.

Table 6.5 Summary of sediment process condition, linkage to limiting factors hypotheses, and activities affecting sediment processes.

Process/input condition status:	Impaired
Primary limiting factor hypotheses associated with process/input:	Hypotheses 2 (WQ) and 3 (Q)
Geographic location of limiting factor:	Ozette River
Life history stages affected:	Adult migration and juvenile emigration
Degree of impact of primary limiting factor hypothesis:	Moderate[1] Contributing limiting factor
Secondary limiting factors hypotheses associated with process/input:	Hypotheses 1 (Pred), 4 (Hab)
Activities and/or conditions affecting process/input:	LWD removal and losses, logging and road building

[1]Moderate rating is based mainly on temperature impacts; SSC impacts are thought to have a lower overall level of impact on sockeye.

Recovery goals: a) Restore natural sediment production and transport processes in the Ozette River subbasin to the extent that sediment influences on streamflow no longer result in reduced streamflows that may limit Lake Ozette sockeye VSP parameters. b) Restore natural sediment production and transport processes in the Ozette River subbasin so that limiting factors per hypotheses 1, 2, 3, and 4 are no longer limiting Lake Ozette sockeye VSP parameters.

Recovery strategy 12: Within the Coal Creek subbasin, quantitatively assess sediment production impacts from logging (gully creation, landslides), road building, and LWD removal. Develop program to reduce land use related sediment inputs. Implement sediment reduction program including programmatic actions such as Road Maintenance and Abandonment Plans (RMAPS) and other watershed-wide sediment reduction activities (see Section 7.1.1.1.4).
Recovery strategy hierarchy: Tier 1/3.
Priority subbasin rating: Priority I, II

Recovery strategy 13: Restore natural hydraulic controls (both LWD and sediment) in the upper one mile of the Ozette River based on guidance from watershed hydrologic modeling.
Recovery strategy hierarchy: Tier 3/4.
Priority subbasin rating: Priority I.

6.2.5 Thermal Inputs (H#2-WQ; H#3-Q; H#5-MS)

This subsection concerns thermal inputs to the Pacific Ocean, Lake Ozette, and the Ozette River. Limiting factor Hypotheses 2 (Section 4.2.2.1), 3 (Section 4.2.2.2) and 5 (Section 4.2.2.4) are relevant to thermal inputs affecting all population segments.

Lake Ozette is the primary source of high water temperatures in the Ozette River during the sockeye smolt and adult migration periods. The lake naturally has no effective shading, and stream temperatures are naturally warm during spring and summer months. The physical processes that contribute to lake and stream temperature are complex; however, considerable evidence exists to suggest that the primary mechanism that contributes to elevated water temperatures in the Ozette River and Lake Ozette is climate change. As stated in Section 4.2.2.1, during the past 90 years, air temperatures during the adult sockeye migration period are estimated to have increased by 1-2ºC, based on climate data from a nearby monitoring station. Air temperature is arguably the most important meteorological variable affecting lake surface temperature, as it is causally involved in all heat exchange processes except the absorption of solar radiation and the emission of long-wave radiation from the lake surface (Kettle et al. 2004). Thus, the increase in average air temperature suggests an increase in average lake temperature since the early 1900s.

Other possible sources of higher temperatures, such as lack of riparian vegetation and shading, do not appear to be significant here. Recent-year tributary inputs to the lake may be warmer than in the previous century as a result of watershed changes from forestry and agriculture, but the amount of water going into the lake in summer months of low flow is too small to affect overall lake temperature. Further, riparian conditions are mostly excellent along the Ozette River, yet typically little downstream cooling occurs there. It would be possible to increase shade levels in only one location, where riparian conditions are degraded.

As the lake temperature rises, evaporation increases. Because of the inverse relationship between evaporation and discharge to the Ozette River, a warmer lake also results in lower streamflow, in addition to other factors cumulatively affecting streamflow (Hypothesis 3).

Climate change may also affect biological processes and sockeye survival in the ocean (Hypothesis 5). Limited Lake Ozette sockeye smolt-to-adult survival data currently suggest that marine survival is within the expected range for large, southern latitude sockeye smolts. However, in the future, significant climate change (doubling of atmospheric CO2) has the potential to severely limit the marine distribution of sockeye salmon and ultimately the viability of the species within the southern range. Therefore, activities that produce and emit greenhouse gases at levels capable of influencing global climate are a serious threat to Lake Ozette sockeye. Table 6.6 is a summary of the status (impaired/unimpaired) of thermal input processes, linkage to limiting factors hypotheses, and activities affecting coastal processes.

Table 6.6. Summary of thermal input process condition, linkage to limiting factors hypotheses, and activities affecting thermal inputs.

Process/input condition status:	Impaired
Primary limiting factor hypotheses associated with process/input:	Hypothesis 2 (WQ)
Geographic location of limiting factor:	Lake Ozette, Ozette River
Life history stages affected:	Adult migration and juvenile emigration
Degree of impact of primary limiting factor hypothesis:	Moderate[1] Contributing limiting factor
Secondary limiting factors hypotheses associated with process/input:	Hypothesis 5 (MS)
Activities and/or conditions affecting process/input:	Greenhouse gas emissions/climate change

[1]Moderate rating is based mainly on temperature impacts.

Recovery goal: Restore and protect thermal input processes in Lake Ozette and the Ozette River.

Recovery strategy 14: Develop a watershed mitigation plan to improve the capacity for Lake Ozette sockeye salmon to survive in a rapidly changing climate.
Recovery strategy hierarchy: Tier 3.
Priority subbasin rating: Priority I

Recovery strategy 15: Protect Ozette River riparian corridor and reestablish riparian forest where degraded conditions exist.
Recovery strategy hierarchy: Tier 1/3.
Priority subbasin rating: Priority I/III.

6.2.6 Riparian-Floodplain Processes

Within the context of this subsection, riparian and floodplain processes are limited in geographic scope to the Ozette River. Since riparian conditions are excellent throughout most of the Ozette River, riparian processes have no primary linkage to any of the limiting factor hypotheses. However, degraded riparian conditions do exist near the lake's outlet. These degraded conditions influence the rate of recovery of limiting factors described in Hypotheses 1, 3, and 4. The primary activity that contributes to degraded riparian conditions, where they exist, is the development and maintenance of ONP facilities, which affect about a third of a mile in length of riparian area/floodplain. Floodplain processes are likely affected by the reduced number, size, and quality of logjams in the Ozette River, which reduce the frequency and duration of floodplain inundation. However, floodplain processes are unlikely to affect sockeye during their emigration and migration in the Ozette River because of the timing of sockeye presence relative to streamflows required to activate floodplains and floodplain habitats where they exist. Table 6.7 is a summary of the status (impaired/unimpaired) of riparian-floodplain processes, linkage to limiting factors hypotheses, and activities affecting riparian-floodplain processes.

Table 6.7 Summary of riparian-floodplain process condition, linkage to limiting factors hypotheses, and activities affecting riparian-floodplain processes.

Process/input condition status:	Impaired (slightly)
Primary limiting factor hypotheses associated with process/input:	NA
Geographic location of limiting factor:	Ozette River
Life history stages affected:	Adult migration and juvenile emigration
Degree of impact of primary limiting factor hypothesis:	NA
Secondary limiting factors hypotheses associated with process/input:	Hypotheses 1 (Pred), 3 (Q), and 4 (Hab)
Activities and/or conditions affecting process/input:	Development and maintenance of ONP facilities

Recovery goals: Restore, maintain and protect riparian/floodplain processes to the extent that riparian-floodplain influences on limiting factors hypotheses 1, 3, and 4 are no longer limiting Lake Ozette sockeye VSP parameters.

Recovery strategy 15: Protect Ozette River riparian corridor and reestablish riparian forest where degraded conditions exist.
Recovery strategy hierarchy: Tier 1/3.
Priority subbasin rating: Priority I/III.

6.2.7 Habitat Conditions (H#4-Hab)

Within the context of this subsection, habitat conditions are limited in geographic scope to the Ozette River. Limiting factor Hypothesis 4 (Section 4.2.2.3) is the primary limiting factor hypothesis related to habitat conditions affecting all population segments. Ozette River habitat conditions are controlled by: a) climate, b) lake and tributary hydrology, c) sediment input, routing, and storage in the upper Ozette River, d) LWD, and e) floodplain connectivity. Activities affecting habitat conditions include: historical LWD removal, ONP facilities operation and maintenance in Ozette River riparian zone (affecting LWD recruitment), logging and road building in the Ozette River subbasin (affecting sediment processes) and specifically in Coal Creek (affecting sediment processes).

Table 6.8 is a summary of the status (impaired/unimpaired) of habitat conditions, linkage to limiting factors hypotheses, and activities affecting habitat conditions.

Table 6.8 Summary of habitat conditions, linkage to limiting factors hypotheses, and activities affecting habitat conditions.

Process/input condition status:	Impaired (slightly)
Primary limiting factor hypotheses associated with process/input:	Hypothesis 4 (Hab)
Geographic location of limiting factor:	Ozette River
life history stages affected:	Adult migration and juvenile emigration
Degree of impact of primary limiting factor hypothesis:	Low Contributing limiting factor
Secondary limiting factors hypotheses associated with process/input:	Hypotheses 1 (Pred) and 3 (Q)
Activities and/or conditions affecting process/input:	Historical LWD removal, ONP facilities operation and maintenance in Ozette River riparian zone, past logging and road building in the Ozette River subbasin

Recovery goals: Restore LWD habitat conditions in the Ozette River to the extent that habitat influences on limiting factors hypotheses 1, 3, and 4 are no longer limiting Lake Ozette sockeye VSP parameters.

Recovery strategy 16: Use large wood placement techniques to restore LWD habitat conditions in the lower 4 miles of the Ozette River. Re-establishment of large wood structures in the lower reaches of Ozette River should focus on improving conditions for avoidance of pinniped predation and adult migration success.
Recovery strategy hierarchy: Tier 3/4.
Priority subbasin rating: Priority I.

6.3 GOALS AND STRATEGIES TO RESTORE PROCESSES AND CONDITIONS AFFECTING BEACH SPAWNERS

Section 4.3 identifies and describes limiting factors affecting only beach spawners. All beach spawning sockeye experience similar habitat conditions and limiting factors during four life history stages: adult staging (Lake Ozette beaches), adult spawning (beaches), egg incubation (beaches), and emergence and dispersal (beaches). Each limiting factor was assessed based upon the sockeye life stage affected, the process or input influencing the limiting factors, and activities that affect each process and input. Figure 6.9 illustrates the interconnectedness between different processes and limiting factors relative to the beach spawning population segment. It is important to note how complex and interconnected the processes and limiting factors are, because the following subsections present this information in a highly simplified manner. Figure 6.10 depicts a hierarchical strategy for prioritizing protection, restoration, and enhancement activities for beach spawning sockeye.

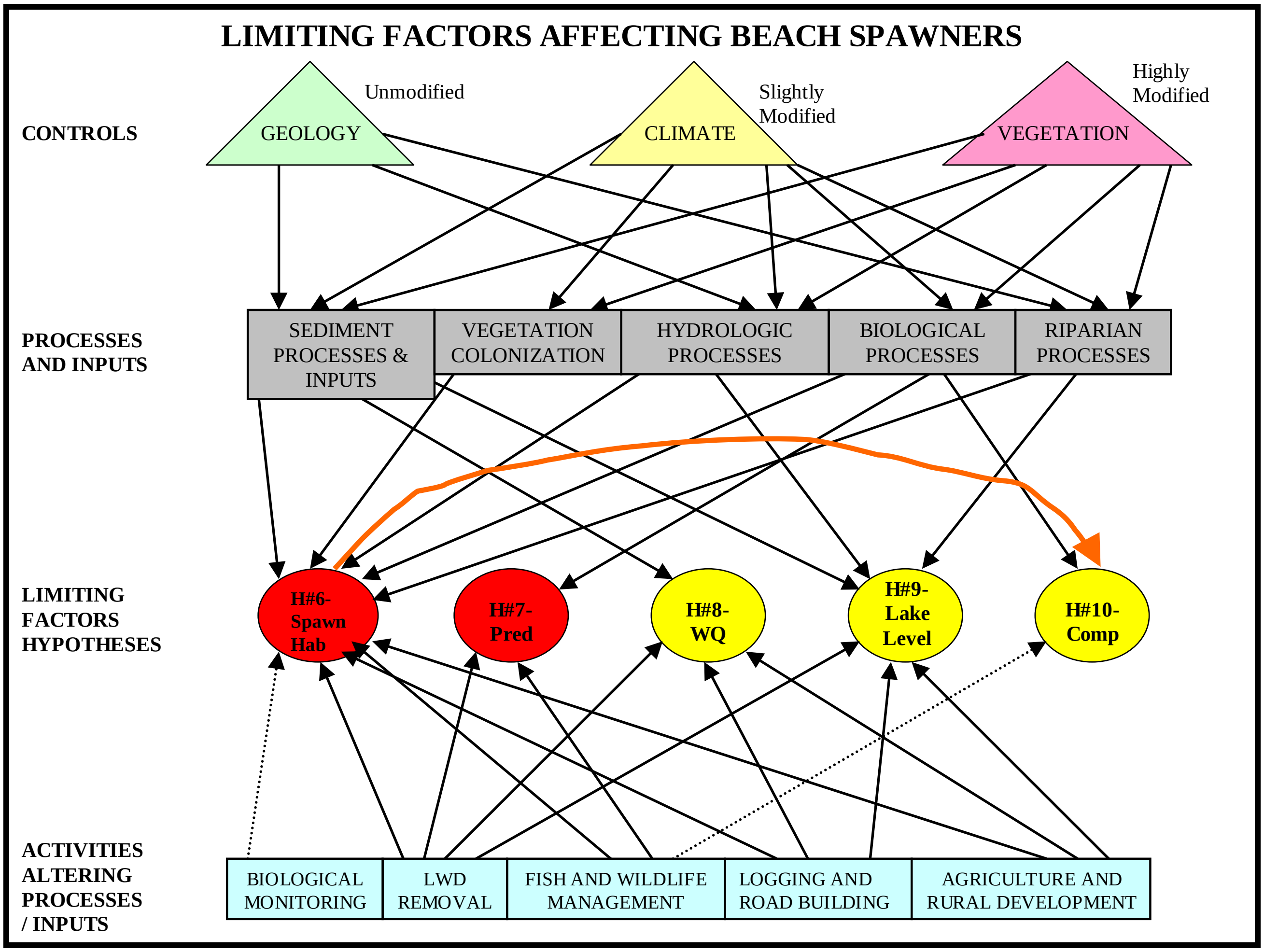

Figure 6.9. Schematic diagram depicting the linkage between watershed controls, watershed scale processes and inputs, limiting factors hypotheses, and activities that alter processes and inputs for beach spawning sockeye.

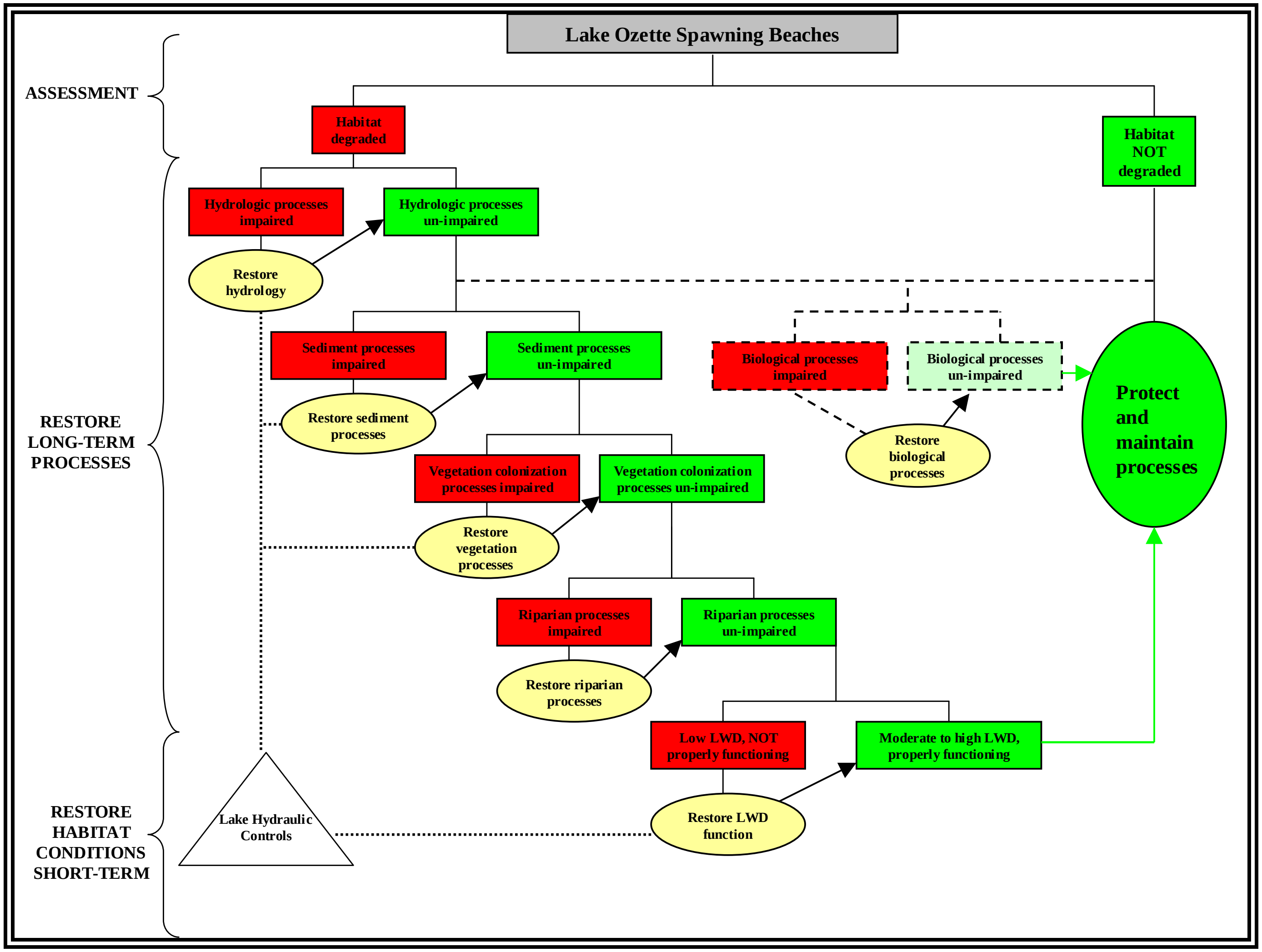

Figure 6.10. Flow chart depicting hierarchical strategy for prioritizing protection, restoration, and enhancement activities for factors affecting beach spawners (adapted from Roni et al. 2002).

6.3.1 Hydrologic Processes (H#6-BSH; H#9-LL)

Within the context of this subsection, hydrologic processes are those processes that store, deliver, and route water into Lake Ozette. Limiting factor Hypotheses 6 (Section 4.3.1.1) and 9 (Section 4.3.2.2) are the primary limiting factor hypotheses related to hydrologic processes affecting beach spawners. Hypothesis 6 is a key limiting factor hypothesis and is highly influenced by two primary processes: hydrology and sediment. Secondary processes, such as vegetation colonization, may be strongly influenced by the primary processes, as well as other secondary processes such as biological processes (e.g., habitat maintenance caused by the act of spawning, elk browsing). Figure 6.9 depicts the complexity and interconnectivity among controls, processes and inputs, hypotheses, and activities that affect processes and inputs.

Lake Ozette hydrology is largely controlled by: a) climate, b) lake and tributary hydrology, and c) LWD recruitment and storage (in logjams) in the upper one mile of the Ozette River. Activities affecting hydrologic processes include: historical LWD removal (affecting lake hydrology), ONP facilities operation and maintenance in Ozette River riparian zone (affecting LWD recruitment and lake hydrology), logging and road building throughout the watershed (affecting tributary hydrology and lake hydrology), agriculture and rural development in the Big River valley (affecting tributary and lake hydrology), and other floodplain alterations in major tributaries to the lake (affecting tributary and lake hydrology). Table 6.9 is a summary of the status (impaired/unimpaired) of hydrologic processes, linkage to limiting factors hypotheses, and activities affecting hydrologic processes.

Table 6.9 Summary of hydrologic process condition, linkage to limiting factors hypotheses, and activities affecting hydrologic processes.

Process/input condition status:	Impaired
Primary limiting factor hypotheses associated with process/input:	Hypotheses 6 (BSH) and 9 (LL)
Geographic location of limiting factor:	Lake Ozette
Life history stages affected:	Egg incubation and emergence and dispersal
Degree of impact of primary limiting factor hypothesis:	High (H#6-BSH) Key limiting factor Low (H#9-LL) Contributing Limiting Factor
Secondary limiting factors hypotheses associated with process/input:	NA
Activities and/or conditions affecting process/input:	LWD removal, ONP facilities, logging and road building, agriculture and rural development, and other floodplain alterations

Recovery goal: Restore hydrologic processes and natural hydrologic variability in the Ozette River to the extent that hydrologic influences on limiting factors (hypotheses 6 and 9) are no longer limiting Lake Ozette sockeye VSP parameters.

Recovery strategy 8: Quantitatively assess hydrologic impacts from land use and LWD removal activities and develop a distributed hydrologic model calibrated for each tributary in conjunction with Ozette River hydraulic model to prioritize actions needed to improve natural hydrologic functions.
Recovery strategy hierarchy: Tier 1.
Priority subbasin rating: Priority I.

Recovery strategy 9: Restore natural hydraulic controls (both LWD and sediment) in the Ozette River based on guidance from watershed hydrologic modeling.
Recovery strategy hierarchy: Tier 3/4.
Priority subbasin rating: Priority I.

Recovery strategy 11: Based on the results of watershed hydrologic modeling implement hydrologic strategies to restore Lake Ozette inflow hydrology in priority II and III subbasins.
Recovery strategy hierarchy: Tier 3.
Priority subbasin rating: Priority I, II, and III.

6.3.2 Sediment Processes (H#6-BSH; H#8-WQ)

Within the context of this subsection, sediment processes are those processes that store, deliver, and route sediment into Lake Ozette. Limiting factor Hypotheses 6 (Section 4.3.1.1) and 8 (Section 4.3.2.1) are the primary limiting factor hypotheses related to sediment processes affecting beach spawners. As described above, Hypothesis 6 is a key limiting factor hypothesis and is strongly influenced by two primary processes: groundwater and surface hydrology and sediment routing. Beach spawning habitat conditions are highly variable around Lake Ozette. Spawning habitat quality and quantity impacts related to sediment processes vary by location due to differences in local sediment inputs and perhaps transport. It has been hypothesized that increased sediment load in tributaries came in part from past logging, road building, and LWD removal, and resulted in delivery of sediment to some lake beaches. These high levels of small-sized sediments are believed to have decreased the quality and quantity of beach spawning habitat that is available for successful egg incubation, contributing to the elimination of one of the historical spawning subpopulations at Umbrella Creek (Haggerty et al. 2009). Sediment processes are a legacy of logging and road building throughout the watershed (affecting sediment supply), agriculture and rural development in the Big River valley (affecting sediment supply and Lake Ozette water quality), and other floodplain alterations (e.g., wood removal in Big River) in tributaries to the lake. Table 6.10 is a summary of the status (impaired/unimpaired) of sediment processes, linkage to limiting factors hypotheses, and activities affecting sediment processes.

Table 6.10 Summary of sediment process condition, linkage to limiting factors hypotheses, and activities affecting sediment processes.

Process/input condition status:	Impaired
Primary limiting factor hypotheses associated with process/input:	Hypotheses 6 (BSH) and 8 (WQ)
Geographic location of limiting factor:	Lake Ozette
Life history stages affected:	Adult staging and spawning (H#8-WQ only) egg incubation and emergence and dispersal
Degree of impact of primary limiting factor hypothesis:	High (H#6-BSH) Key limiting factor Low (H#8-WQ) Contributing Limiting Factor
Secondary limiting factors hypotheses associated with process/input:	Hypothesis 10 (Comp)
Activities and/or conditions affecting process/input:	LWD removal and altered lake levels, logging and road building, agriculture and rural development, and other floodplain alterations

Recovery goal: Restore natural sediment production, storage, and transport processes in Lake Ozette tributaries to the extent that sediment (per limiting factors hypotheses 6, 8, and 10) is no longer limiting Lake Ozette sockeye VSP parameters.

Recovery strategy 17: Within the Umbrella Creek subbasin, quantitatively assess sediment level impacts from logging (gully creation, landslides), road building, LWD removal, channel instability, and floodplain connectivity. Develop program to reduce landuse-related sediment inputs to levels that create properly functioning conditions at Umbrella Beach. Implement sediment reduction program including programmatic actions such as Road Maintenance and Abandonment Plans (RMAPS; see section 7.2.1.1.4) and other watershed-wide sediment reduction activities.
Recovery strategy hierarchy: Tier 3.
Priority subbasin rating: Priority I

Recovery strategy 18: Within the Big River subbasin, quantitatively assess sediment impacts from logging (gully creation, landslides), road building, LWD removal, channel instability, floodplain connectivity, and other land use activities. Develop program to reduce landuse-related sediment inputs to levels that do not create water quality problems within the lake. Implement sediment reduction program including programmatic actions such as Road Maintenance and Abandonment Plans (RMAPS; see section 7.2.1.1.4) and other watershed-wide sediment reduction activities.
Recovery strategy hierarchy: Tier 3.
Priority subbasin rating: Priority I.

Recovery strategy 19: Within priority II and III subbasins, quantitatively assess sediment impacts from logging (gully creation, debris flows, landslides), road building, LWD removal, channel instability, and floodplain connectivity. Develop program to reduce landuse-related sediment inputs that have the potential to deliver sediment to lakeshore spawning habitats or areas identified as potential habitat. Implement sediment reduction program including programmatic actions such as Road Maintenance and Abandonment Plans (RMAPS; see section 7.2.1.1.4) and other watershed-wide sediment reduction activities.
Recovery strategy hierarchy: Tier 3.
Priority subbasin rating: Priority I.

6.3.3 Riparian Processes and Vegetation Colonization (H#6-BSH)

Within the context of this subsection, riparian processes are limited in geographic scope to the perimeter of Lake Ozette. Limiting factor Hypothesis 6 is the primary hypothesis related to riparian processes affecting beach spawners. Aerial photo evidence indicates that most stable LWD along the shoreline is locally recruited from erosion or windfall. Large woody debris in and adjacent to spawning habitat provides cover from predators. Additionally, shoreline wood functions to cleanse gravel locally and scour colonizing vegetation through turbulence. Riparian conditions are excellent around most of the lake; however, an unknown quantity of LWD was historically removed from the perimeter of the lake. Vegetation colonization of spawning habitat has also been identified as a factor affecting the quantity and quality of beach spawning habitat in Lake Ozette. Vegetation colonization processes are thought to be affected primarily by lake levels, which are controlled by the lake's hydrologic processes, which are strongly influenced by LWD inputs and conditions in the upper Ozette River. Sediment inputs and changes in substrate particle size can also affect vegetation's ability to colonize the lake's shoreline. The primary activities that contribute to degraded riparian conditions, where they exist, are the development and maintenance of ONP facilities, past construction and maintenance of infrastructure on private property within the boundaries of ONP, and historical homesteading. Table 6.11 is a summary of the status (impaired/unimpaired) of riparian input processes, linkage to limiting factors hypotheses, and activities affecting riparian processes.

Table 6.11 Summary of riparian processes condition, linkage to limiting factors hypotheses, and activities affecting riparian processes.

Process/input condition status:	Impaired
Primary limiting factor hypotheses associated with process/input:	Hypothesis 6 (BSH)
Geographic location of limiting factor:	Lake Ozette
Life history stages affected:	Egg incubation and emergence and dispersal; adult staging and spawning (H#9-LL only)
Degree of impact of primary limiting factor	High

hypothesis:	Key limiting factor
Secondary limiting factors hypotheses associated with process/input:	Hypothesis 9 (LL)
Activities and/or conditions affecting process/input:	LWD removal, logging and road building, agriculture and rural development, and other floodplain alterations

Recovery goal: Maintain and protect the lake's riparian forest. Restore riparian and shoreline vegetation colonization processes around Lake Ozette where conditions are degraded, to the extent that riparian and shoreline vegetation influences on limiting factors are no longer limiting Lake Ozette sockeye VSP parameters.

Recovery strategy 20: Maintain and protect the lake's riparian forest. Determine where degraded riparian forests exist that may affect spawning habitat quality, and re-establish native riparian vegetation. Implement recovery strategies to restore hydrologic processes (RS#8-11) and sediment processes (RS#17-19).
Recovery strategy hierarchy: Tier 1 and 3.
Priority subbasin rating: Priority I

Recovery strategy 21: Survey and eradicate non-native invasive plant species colonizing the lake's beaches and riparian areas. This may require non-native species eradication in all tributaries to be successful over the long-term.
Recovery strategy hierarchy: Tier 4.
Priority subbasin rating: Priority I.

6.3.4 Biological Processes (H#7-Pred)

Within the context of this subsection, biological processes are those biological processes that occur in Lake Ozette that affect only beach spawners. Limiting factor Hypothesis 7 (Section 4.3.1.2) is the primary limiting factor hypothesis related to biological processes affecting the beach spawning population segment. However, biological processes also have the potential to alter habitat conditions, e.g. sockeye salmon can maintain habitat quality along the beaches through the process of spawning, where young vegetation and fine sediment can be displaced from the spawning gravels. The reduced quantity of high quality spawning habitat at Olsen's Beach results in significant levels of competition during periods of moderate abundance. Biological processes in fresh water are complex, since many watershed-scale processes, habitat conditions, and management activities may affect biological processes and ultimately the predator-prey balance within the ecosystem. Activities and/or conditions that currently affect predation include: past LWD removal, current habitat conditions on spawning beaches, biological monitoring, and fish and wildlife management. Table 6.12 is a summary of the status of biological processes, linkage to limiting factors hypotheses, and activities affecting predation

Table 6.12. Summary of biologic process condition, linkage to limiting factors hypotheses, and activities affecting biological processes.

Process/input condition status:	Impaired
Primary limiting factor hypothesis associated with process/input:	Hypothesis 7 (Pred)
Geographic location of limiting factor:	Lake Ozette
Life history stages affected:	Egg incubation and emergence and dispersal; adult staging and spawning
Degree of impact of primary limiting factor hypothesis:	High Key limiting factor
Secondary limiting factors hypotheses associated with process/input:	Hypotheses 6 (BSH) and 10 (Comp)
Activities and/or conditions affecting predation:	Past LWD removal, current habitat conditions at spawning beaches, biological monitoring, fish and wildlife management

Recovery goal: Restore and protect biological processes so that freshwater predation, habitat maintenance, and competition are no longer limiting Lake Ozette sockeye viability.

Recovery strategy 22: Implement strategies and actions to increase egg-to-fry survival of beach and tributary spawners so that the habitat can produce abundant sockeye salmon, reducing the overall percent impact of predation on the population.
Recovery strategy hierarchy: Tier 3-4.
Priority subbasin rating: Priority I.

Recovery strategy 23: Increase the spatial distribution of Lake Ozette beach spawning sockeye.
Recovery strategy hierarchy: Tier 2.
Priority subbasin rating: Priority I.

Recovery strategy 24: Restore natural predator-prey balance by reducing pre-spawn predation mortalities.
Recovery strategy hierarchy: Tier 3.
Priority subbasin rating: Priority I.

6.3.5 Habitat Conditions (H#6-BSH)

Within the context of this subsection, habitat conditions are limited in geographic scope to beach spawning habitat along the shoreline of the lake. Limiting factor Hypothesis 6 (Section 4.3.1.1) is the primary limiting factor hypothesis related to habitat conditions affecting beach spawners. Lake Ozette beach spawning habitat conditions are controlled by: a) lake and tributary hydrology, b) tributary sediment processes, and c) vegetation colonization processes. Riparian and biological processes also influence beach spawning habitat quantity and quality. Activities affecting habitat conditions include: historical LWD removal (Ozette River), ONP facilities operation and maintenance in Ozette River riparian zone (affecting LWD recruitment), logging and road building throughout the watershed, past and current agriculture and rural development, and fish and wildlife management. Table 6.13 is a summary of the status (impaired/unimpaired) of habitat conditions, linkage to limiting factors hypotheses, and activities affecting habitat conditions.

Table 6.13 Summary of habitat conditions, linkage to limiting factors hypotheses, and activities affecting habitat conditions.

Habitat condition status:	Impaired
Primary limiting factor hypotheses associated with process/input:	Hypothesis 6 (BSH)
Geographic location of limiting factor:	Lake Ozette shoreline
Life history stages affected:	Egg incubation, emergence and dispersal
Degree of impact of primary limiting factor hypothesis:	High Key limiting factor
Secondary limiting factors hypotheses associated with process/input:	NA
Processes affecting habitat conditions:	• Hydrologic processes • Sediment processes • Riparian processes • Vegetation colonization • Biological processes

Recovery goals: Increase the quantity and quality of beach spawning habitat in Lake Ozette so that habitat quantity and quality are no longer limiting factors affecting sockeye VSP parameters.

Recovery strategy 25: Develop a comprehensive understanding of the conditions, factors, and processes controlling egg-to-fry survival on sockeye spawning beaches. Investigate several different methods of beach spawning habitat rehabilitation, including: vegetation removal, gravel cleaning, LWD introduction, and others. Include sockeye egg survival studies with habitat manipulations.
Recovery strategy hierarchy: Tier 3/4.
Priority subbasin rating: Priority I.

6.4 GOALS AND STRATEGIES TO RESTORE PROCESSES AND CONDITIONS AFFECTING TRIBUTARY SPAWNERS

Section 4.4 identifies and describes limiting factors affecting only tributary spawning sockeye. All tributary spawning sockeye experience similar habitat conditions and limiting factors during four life history stages: adult migration (Ozette sockeye spawning tributaries), adult holding (tributaries), egg incubation (tributaries), and emergence and dispersal (tributaries). Each limiting factor was assessed based upon the sockeye life stage affected, the process or input influencing the limiting factors, and activities that affect each process and input. Figure 6.11 illustrates the interconnectedness between different processes and limiting factors relative to the tributary spawning population segment. It is important to note how complex and interconnected the processes and limiting factors are, because the following subsections present this information in a highly simplified manner. Figure 6.10 depicts a hierarchical strategy for prioritizing protection, restoration, and enhancement activities for tributary spawning sockeye.

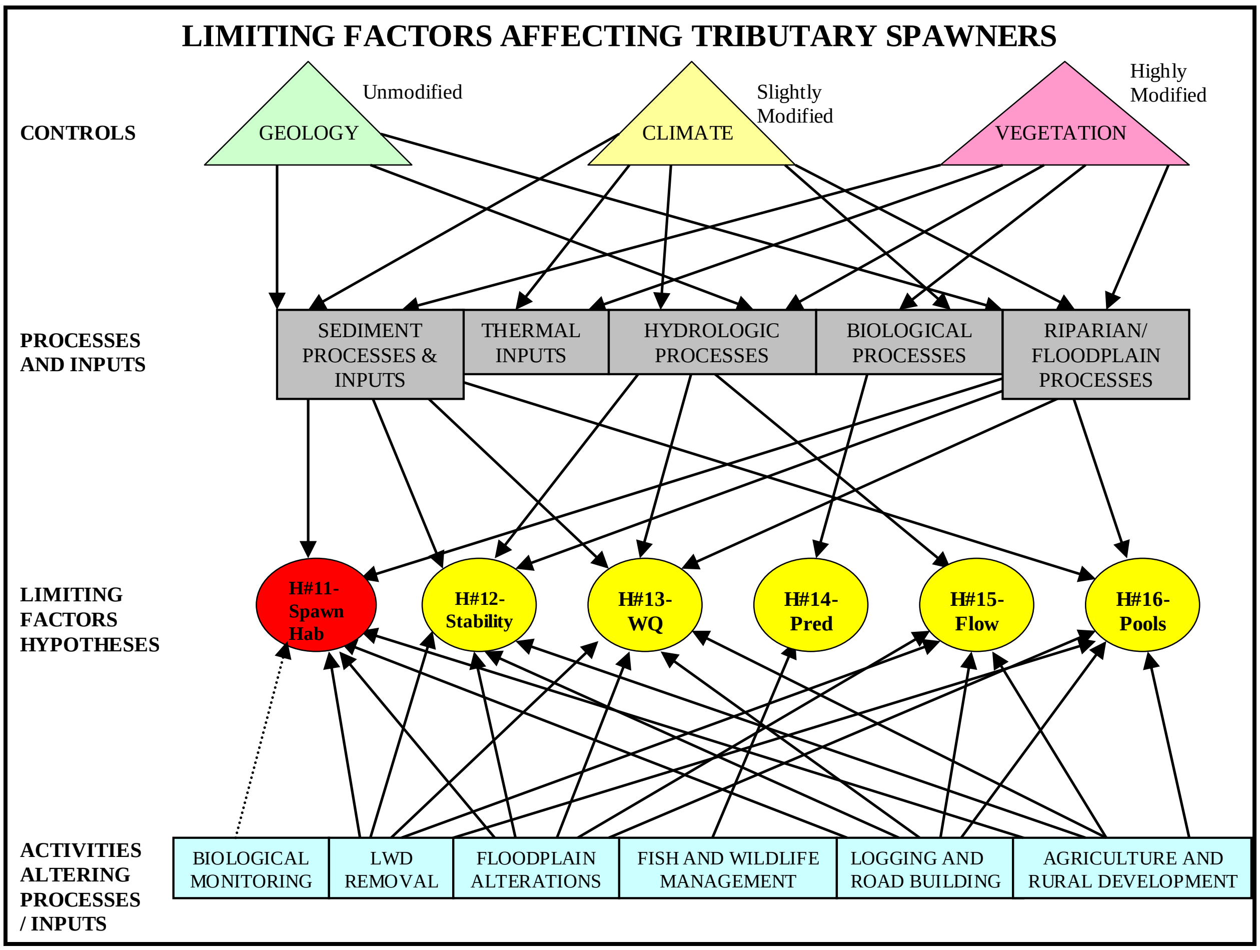

Figure 6.11. Schematic diagram depicting the linkage between watershed controls, watershed scale processes and inputs, limiting factors hypotheses, and activities that alter processes and inputs for tributary spawning sockeye.

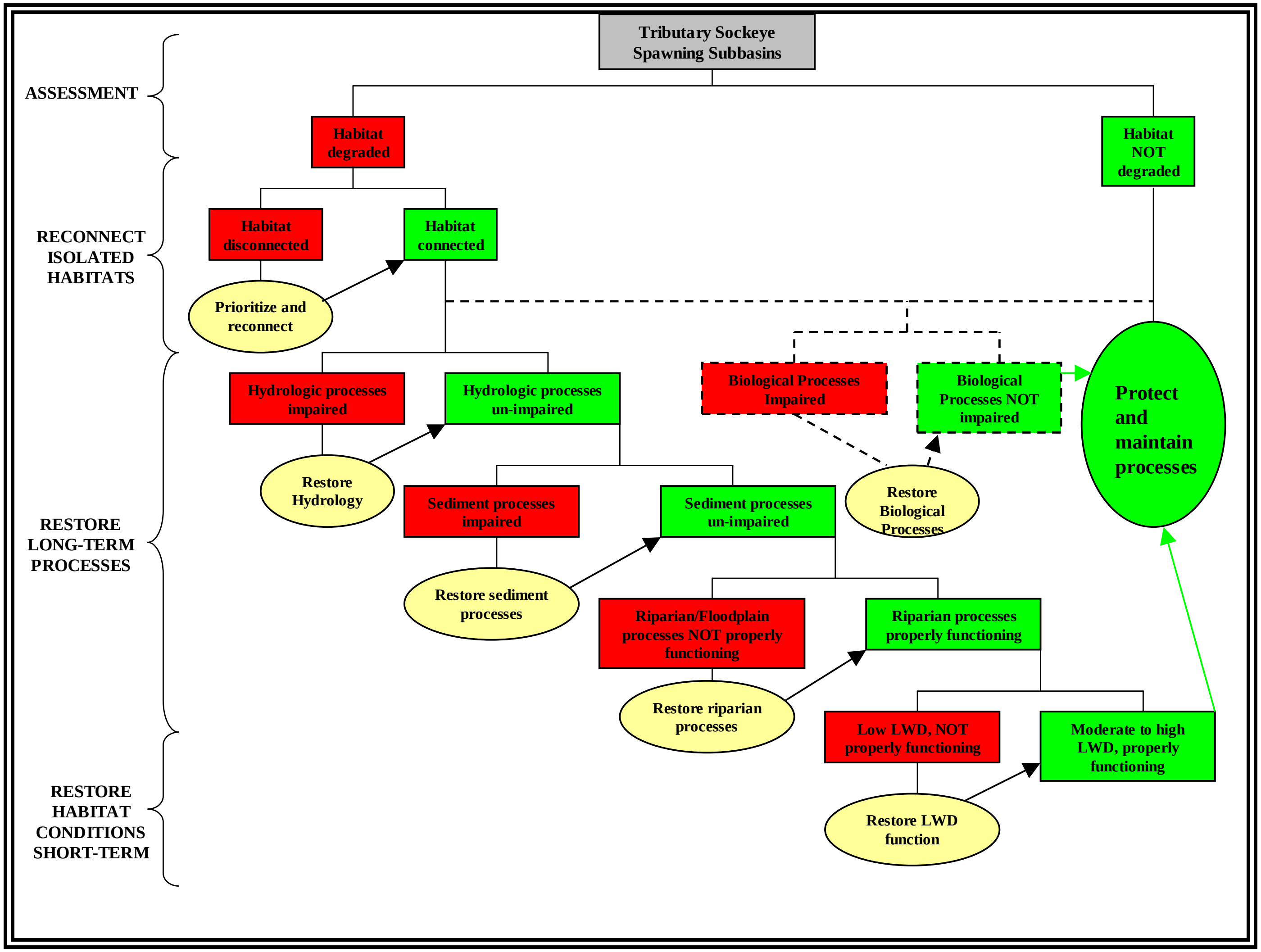

Figure 6.12. Flow chart depicting hierarchical strategy for prioritizing protection, restoration, and enhancement activities for factors affecting tributary spawners (adapted from Roni et al. 2002).

6.4.1 Habitat Connectivity

Within the context of this subsection, habitat connectivity relates to Lake Ozette tributary sockeye migration barriers created by humans. Currently there are no migration barriers to Lake Ozette sockeye within tributaries that are currently utilized by sockeye. However, as the spatial distribution of spawning sockeye changes during the population rebuilding period, areas currently unoccupied may become occupied. Barriers, if they exist or if new ones are created, could limit the spatial distribution of sockeye. Table 6.14 is a summary of the status of habitat connectivity, linkage to limiting factors hypotheses, and activities affecting habitat connectivity.

Table 6.14 Summary of habitat connectivity condition, linkage to limiting factors hypotheses, and activities affecting habitat connectivity.

Process/input condition status:	Unimpaired
Primary limiting factor hypothesis associated with process/input:	NA
Geographic location of limiting factor:	Ozette sockeye tributaries
Life history stages affected:	None
Degree of impact of primary limiting factor hypothesis:	NA
Secondary limiting factors hypotheses associated with process/input:	NA
Activities and/or conditions affecting process/input:	None identified

Recovery goal: Maintain and protect habitat connectivity.

Recovery strategy 26: Implement programmatic actions (e.g., RMAPs) to ensure that habitat connectivity is maintained. As sockeye spawning spatial distribution increases, ensure that fish blockages are corrected within stream reaches suitable for sockeye spawning.
Recovery strategy hierarchy: Tier 1.
Priority subbasin rating: Priority I and II.

6.4.2 Hydrologic Processes (H#15-Q)

Within the context of this subsection, hydrologic processes are those processes that store, deliver, and route water in Lake Ozette sockeye spawning tributaries. Limiting factor Hypothesis 15 (Section 4.4.2.4) is the primary limiting factor hypothesis related to hydrologic processes affecting tributary spawners. Hypothesis 15 is a contributing limiting factor hypothesis and may influence other processes and conditions (e.g., channel stability and water quality). Tributary hydrology is largely controlled by climate; therefore, future threats such as climate change (e.g., decreased summer precipitation and increased winter precipitation) have the potential to further degrade hydrologic conditions for tributary spawning sockeye. Figure 6.9 depicts the complexity and interconnectivity among controls, processes and inputs, hypotheses, and activities that affect processes and inputs. Activities affecting hydrologic processes in tributaries include: logging and road building throughout the watershed, agriculture and rural development, and other floodplain alterations in major tributaries. A summary of the status of hydrologic processes, linkage to limiting factors hypotheses, and activities affecting hydrologic processes is shown in Table 6.15. Tributary hydrologic processes also transcend population segment boundaries and can affect habitat-forming processes and habitat conditions, as well as biological processes influencing all population segments.

Table 6.15. Summary of hydrologic process condition, linkage to limiting factors hypotheses, and activities affecting hydrologic processes.

Process/input condition status:	Impaired
Primary limiting factor hypotheses associated with process/input:	Hypothesis 15 (Q)
Geographic location of limiting factor:	Lake Ozette
Life history stages affected:	Adult migration and pre-spawning holding, egg incubation, and emergence and dispersal
Degree of impact of primary limiting factor hypothesis:	Unknown Contributing limiting factor
Secondary limiting factors hypotheses associated with process/input[1]:	H#12-Stab; H#13-WQ
Activities and/or conditions affecting process/input:	Logging and road building, agriculture and rural development, and other floodplain alterations

[1]Tributary hydrologic processes also influence the following hypotheses: H#1-Pred, H#2-WQ, H#3-Q, H#4-Hab, H#6-BSH, and H#9-LL

Recovery goal: Restore hydrologic processes and natural hydrologic variability in Ozette tributaries to the extent that hydrologic influences on all limiting factors influenced by hydrologic processes are no longer limiting Lake Ozette sockeye VSP parameters.

Recovery strategy 27: Quantitatively assess hydrologic impacts from land use and LWD removal activities and develop a distributed hydrologic model calibrated for each sockeye tributary. Based on modeling results, prioritize actions needed to improve natural hydrologic processes in sockeye spawning streams.
Recovery strategy hierarchy: Tier 1.
Priority subbasin rating: Priority I.

6.4.3 Sediment Processes (H#11-TSH; H#13-WQ)

Within the context of this subsection, sediment processes are those processes that store, deliver, and route sediment in Lake Ozette sockeye spawning tributaries. Limiting factor Hypotheses 11 (Section 4.4.1.1) and 13 (Section 4.4.2.2) are the primary limiting factor hypotheses related to sediment processes affecting tributary spawners. Sediment processes also influence limiting factor Hypotheses 12 and 16. Gravel storage behind large woody debris has been systematically reduced from historical levels; this coupled with increased fine sediment delivery to mainstem spawning reaches has altered the quantity and quality of spawning habitat. Increased sediment inputs into sockeye spawning streams can also contribute to degraded water quality conditions. Improper construction, maintenance and use of roads, increased channel instability, mass wasting events triggered by roads or clear-cut timber harvest on unstable slopes, and other land use activities (e.g., agriculture) all contribute to elevated turbidity and SSC levels in tributaries. Activities affecting sediment processes include: logging and road building throughout the watershed (affecting sediment supply), agriculture and rural development in the Big River valley, and other floodplain alterations (e.g., wood removal in Big River) in tributaries to the lake. Table 6.16 is a summary of the status (impaired/unimpaired) of sediment processes, linkage to limiting factors hypotheses, and activities affecting sediment processes.

Table 6.16 Summary of sediment process condition, linkage to limiting factors hypotheses, and activities affecting sediment processes.

Process/input condition status:	Impaired
Primary limiting factor hypothesis associated with process/input:	Hypotheses 11 (TSH) and 13 (WQ)
Geographic location of limiting factor:	Lake Ozette
Life history stages affected:	Adult staging and spawning (H#8-WQ only) egg incubation and emergence and dispersal
Degree of impact of primary limiting factor hypothesis:	High (H#11-TSH) Key limiting factor Low (H#13-WQ) Contributing limiting factor
Secondary limiting factors hypotheses associated with process/input:	H#12 (Stab) and H#16 (HP)
Activities and/or conditions affecting process/input:	LWD removal, logging and road building, agriculture and rural development, and other floodplain alterations

Recovery goal: Restore natural sediment production, storage, and transport processes in Lake Ozette tributaries to the extent that sediment (per limiting factors Hypothesis 11) is no longer limiting Lake Ozette sockeye VSP parameters.

Recovery strategy 28: Within the sockeye spawning subbasins, quantitatively assess sediment impacts from logging (gully creation, landslides), road building, LWD removal,

and other land use activities. Implement sediment reduction program including programmatic actions such as Road Maintenance and Abandonment Plans (RMAPS; see section 7.2.1.1.4) and other watershed-wide sediment reduction activities.
Recovery strategy hierarchy: Tier 3.
Priority subbasin rating: Priority I.

6.4.4 Riparian and Floodplain Processes (H#11-TSH; H#12-Stab)

Within the context of this subsection, riparian and floodplain processes are limited in geographic scope to the following three watersheds: Umbrella Creek, Big River, and Crooked Creek. Riparian and floodplain processes influence hydrologic and sediment processes, which in turn affect limiting factor Hypotheses 11, 12, 13, and 16. For example, riparian and floodplain processes can affect spawning habitat quantity by recruiting LWD, which then stores spawning gravel. Large wood also maintains floodplain connectivity, which then results in more fine sediment storage on the floodplain versus the active channel. Riparian and floodplain processes also influence channel stability.

Loss of riparian function (including in-channel LWD) and floodplain connectivity results in channel destabilization and/or morphologic changes in channel form and can result in lowered egg-to-fry survival during the egg incubation period. The primary activities that contribute to degraded riparian and floodplain conditions, where they exist, are the historical removal of LWD, logging and road building, agriculture and rural development, and other floodplain alterations (e.g., bank armoring). Table 6.17 is a summary of the status of riparian and floodplain processes, linkage to limiting factors hypotheses, and activities affecting riparian-floodplain processes.

Table 6.17 Summary of riparian and floodplain processes condition, linkage to limiting factors hypotheses, and activities affecting riparian and floodplain processes.

Process/input condition status:	Impaired
Primary limiting factor hypothesis associated with process/input:	H#11-TSH; H#12-Stab
Geographic location of limiting factor:	Lake Ozette
Life history stages affected:	Egg incubation and emergence and dispersal
Degree of impact of primary limiting factor hypothesis:	High (H#11-TSH) Key limiting factor Unknown (H#12-Stab) Contributing limiting factor
Secondary limiting factors hypotheses associated with process/input:	H#13-WQ; H16-HP
Activities and/or conditions affecting process/input:	LWD removal, logging and road building, agriculture and rural development, and other floodplain alterations

Recovery goal: Restore riparian and floodplain processes and conditions in sockeye spawning tributaries to the extent that riparian and floodplain processes are no longer limiting Lake Ozette sockeye VSP parameters.

Recovery strategy 29: Protect riparian forests and reestablish healthy riparian forests where degraded conditions exist within sockeye spawning subbasins.
Recovery strategy hierarchy: Tier 1/3.
Priority subbasin rating: Priority I/II.

Recovery strategy 30: Survey and eradicate non-native invasive plant species colonizing riparian areas.
Recovery strategy hierarchy: Tier 3/4.
Priority subbasin rating: Priority I/II.

Recovery strategy 31: Identify riparian/floodplain infrastructure; where feasible, develop alternatives to mitigate or remove infrastructure-impairing riparian/floodplain processes.
Recovery strategy hierarchy: Tier 3/4.
Priority subbasin rating: Priority I.

Recovery strategy 32: Identify disconnected floodplain surfaces and add LWD to reconnect floodplains to channels to improve connectivity, sediment storage, water retention, and peak flow attenuation.
Recovery strategy hierarchy: Tier 3/4.
Priority subbasin rating: Priority I.

6.4.5 Biological Processes

Within the context of this subsection, biological processes are limited to those that occur in tributaries and affect only tributary spawners. Biological processes within tributary spawning subbasins influence limiting factor Hypothesis 14. Currently biological processes are only slightly impaired. Fish and wildlife management is the activity identified that affects biological processes within Ozette sockeye spawning subbasins. Table 6.18 is a summary of the status of biological processes, linkage to limiting factors hypotheses, and activities affecting biological processes.

Table 6.18 Summary of hydrologic process condition, linkage to limiting factors hypotheses, and activities affecting hydrologic processes.

Process/input condition status:	Slightly impaired
Primary limiting factor hypothesis associated with process/input:	NA
Geographic location of limiting factor:	Ozette sockeye tributaries
Life history stages affected:	Adult migration and holding, egg incubation, emergence and dispersal
Degree of impact of primary limiting factor hypothesis:	NA
Secondary limiting factors hypotheses associated with process/input:	Hypothesis 14 (Pred)
Activities and/or conditions affecting process/input:	Fish and wildlife management

Recovery goal: Maintain and protect biological processes in sockeye spawning subbasins. Increase spatial distribution of sockeye salmon in Umbrella Creek and Big River.

Recovery strategy 32: Increase the spatial distribution of tributary spawning sockeye by implementing the HGMP for the Makah Lake Ozette sockeye hatchery program (see Sections 2.9 and 2.9.2).
Recovery strategy hierarchy: Tier 1.
Priority subbasin rating: Priority I and II.

6.4.6 Habitat Conditions (H#11-TSH)

Within the context of this subsection, habitat conditions are limited in geographic scope to tributary sockeye spawning. Limiting factor Hypothesis 11 (Section 4.4.1.1) is the primary limiting factor hypothesis related to habitat conditions affecting tributary spawners. Lake Ozette tributary spawning habitat conditions are controlled by sediment, hydrologic, and riparian-floodplain processes. Activities affecting habitat conditions include: historical LWD removal (altering lake base level), logging and road building throughout the watershed, past and current agriculture and rural development. Table 6.19 is a summary of the status of habitat conditions, linkage to limiting factors hypotheses, and activities affecting habitat conditions.

Table 6.19 Summary of habitat conditions, linkage to limiting factors hypotheses, and activities affecting habitat conditions.

Habitat condition status:	Impaired
Primary limiting factor hypothesis associated with process/input:	Hypothesis 11 (TSH)
Geographic location of limiting factor:	Ozette sockeye tributaries
Life history stages affected:	Egg incubation, emergence and dispersal
Degree of impact of primary limiting factor hypothesis:	High Key limiting factor
Secondary limiting factors hypotheses associated with process/input:	NA
Processes affecting habitat conditions:	• Sediment processes • Riparian-floodplain processes • Biological processes

Recovery goals: Increase the quantity and quality of spawning habitat in sockeye spawning tributaries so that habitat quantity and quality do not limit sockeye VSP parameters.

Recovery strategy 33: Add LWD structures throughout sockeye spawning streams where gravel deficient conditions exist, to trap and store spawning gravels. This must be done in conjunction with or after sediment and hydrologic processes are addressed.
Recovery strategy hierarchy: Tier 3/4.
Priority subbasin rating: Priority I.

6.5 SUMMARY OF LAKE OZETTE SOCKEYE RECOVERY STRATEGIES

The recovery strategies identified in this plan address the limiting factors hypotheses for Lake Ozette sockeye. Table 6.20 summarizes the recovery strategies presented in the sections above. The goal of the recovery plan is to address limiting factors and implement recovery strategies that will improve the viable salmonid population parameters such that, over time, each parameter will achieve or exceed the PSTRT's proposed viability criteria. In order to track and measure changes in these viability parameters as recovery actions are implemented, a detailed adaptive management, research, monitoring and evaluation plan will be developed in 2009 (see Chapter 8). Based on monitoring results, the adaptive management plan will adjust recovery actions so that viability parameters improve over time. Proposed monitoring will further our understanding of how habitat conditions affect sockeye viability parameters, and will accordingly help identify what recovery actions are needed to improve viability. Thus, the link between recovery strategies and expected viability responses will be better understood as both actions and monitoring proceed.

Table 6.20. Summary of Lake Ozette sockeye salmon recovery strategies.

Recovery Strategy ID	Recovery Flow Chart (Population Segment Addressed)	Process, Input, or Condition	Description	Primary Hypotheses Addressed	Secondary Hypotheses Addressed
RS#1	All Population Segments	Coastal Processes	Protect coastal processes and estuary habitat from degradation by implementing ONP and Marine Sanctuary regulations and management plans.	NA	NA
RS#2	All Population Segments	Biological	Implement strategies and actions to increase egg-to-fry survival of beach and tributary spawners so that the habitat can produce abundant sockeye salmon capable of overwhelming and swamping predators, and thus maintain a natural predator-prey balance.	H#1 (Pred)	NA
RS#3	All Population Segments	Biological	Restore natural predator-prey balance by eliminating non-native fish species.	H#1 (Pred)	NA
RS#4	All Population Segments	Biological	Restore natural predator-prey balance by eliminating and/or strictly limiting fishing related mortalities on Lake Ozette sockeye.	H#1 (Pred)	NA
RS#5	All Population Segments	Biological	Improve predator avoidance opportunities in the Ozette River (e.g., improve weir and smolt trapping techniques).	H#1 (Pred)	NA
RS#6	All Population Segments	Biological	Implement actions that restore the hydraulic and hydrologic conditions of the Ozette River (e.g., LWD and sediment deposition) to provide favorable flow conditions for sockeye migration and predator avoidance.	H#1 (Pred)	NA
RS#7	All Population Segments	Biological	Work at local, regional, and international scales to maintain favorable ocean conditions that support sockeye salmon.	H#1 (Pred)	H#5 (MS)

Recovery Strategy ID	Recovery Flow Chart (Population Segment Addressed)	Process, Input, or Condition	Description	Primary Hypotheses Addressed	Secondary Hypotheses Addressed
RS#8	All Population Segments	Hydrology	Quantitatively assess hydrologic impacts from land use and LWD removal activities and develop a distributed hydrologic model calibrated for each tributary in conjunction with Ozette River hydraulic model to prioritize actions needed to improve natural hydrologic functions where needed.	H#3 (Q)	H#1 (Pred) H#2 (WQ) H#4 (Hab)
RS#9	All Population Segments	Hydrology	Restore natural hydraulic controls (both LWD and sediment) in the Ozette River based on guidance from watershed hydrologic modeling.	H#3 (Q)	H#1 (Pred) H#2 (WQ) H#4 (Hab)
RS#10	All Population Segments	Hydrology	Implement hydrologic strategies for sockeye spawning subbasins based on outcome of hydrologic modeling (see Section 6.4.2 recovery strategies).	H#3 (Q)	H#1 (Pred) H#2 (WQ) H#4 (Hab)
RS#11	All Population Segments	Hydrology	Based on the results of watershed hydrologic modeling, implement hydrologic strategies to restore Lake Ozette inflow hydrology in priority II and III subbasins.	H#3 (Q)	H#1 (Pred) H#2 (WQ) H#4 (Hab)
RS#12	All Population Segments	Sediment	Within the Coal Creek subbasin, quantitatively assess sediment production impacts from logging (gully creation, landslides), road building, and LWD removal. Develop program to reduce land use related sediment inputs. Implement sediment reduction program.	H#2 (WQ) H#3 (Q)	H#1 (Pred) H#4 (Hab)
RS#13	All Population Segments	Sediment	Restore natural hydraulic controls (both LWD and Sediment) in the Ozette River based on guidance from watershed hydrologic modeling.	H#3 (Q)	H#1 (Pred) H#2 (WQ) H#4 (Hab)

Recovery Strategy ID	Recovery Flow Chart (Population Segment Addressed)	Process, Input, or Condition	Description	Primary Hypotheses Addressed	Secondary Hypotheses Addressed
RS#14	All Population Segments	Thermal Inputs	Stop or significantly slow climate change by developing and participating in local, regional, national, and global atmospheric anti-pollution program to reduce emissions of greenhouse gases. If this cannot be accomplished then a comprehensive mitigation plan must be developed.	H#2 (WQ)	H#5 (MS)
RS#15	All Population Segments	Thermal Inputs	Protect Ozette River riparian corridor and reestablish riparian forest where degraded conditions exist.	H#2 (WQ)	NA
RS#15	All Population Segments	Riparian Processes	Protect Ozette River riparian corridor and reestablish riparian forest where degraded conditions exist.	NA	H#1 (Pred) H#3 (Q) H#4 (Hab)
RS#16	All Population Segments	Habitat Condition	Use LWD placement techniques to restore LWD habitat conditions in the Ozette River. This should be conducted in conjunction with strategies to restore lake and river hydrology-hydraulics.	H#4 (Hab)	H#1 (Pred) H#3 (Q)
RS#8	Beach Spawners	Hydrology	Quantitatively assess hydrologic impacts from land use and LWD removal activities and develop a distributed hydrologic model calibrated for each tributary in conjunction with Ozette River hydraulic model to prioritize actions needed to improve natural hydrologic functions where needed.	H#6 (BSH) H#9 (LL)	NA
RS#9	Beach Spawners	Hydrology	Restore natural hydraulic controls (both LWD and sediment) in the Ozette River based on guidance from watershed hydrologic modeling.	H#6 (BSH) H#9 (LL)	NA

Recovery Strategy ID	Recovery Flow Chart (Population Segment Addressed)	Process, Input, or Condition	Description	Primary Hypotheses Addressed	Secondary Hypotheses Addressed
RS#11	Beach Spawners	Hydrology	Based on the results of watershed hydrologic modeling, implement hydrologic strategies to restore Lake Ozette inflow hydrology in priority II and III subbasins.	H#6 (BSH) H#9 (LL)	NA
RS#17	Beach Spawners	Sediment	Within the Umbrella Creek subbasin, quantitatively assess sediment production impacts from logging (gully creation, landslides), road building, and LWD removal. Develop program to reduce land use related sediment inputs to levels that create properly functioning conditions at Umbrella Beach.	H#6 (BSH) H#8 (WQ)	H#10 (Comp)
RS#18	Beach Spawners	Sediment	Within the Big River subbasin quantitatively assess sediment production impacts from logging (gully creation, landslides), road building, LWD removal, and other land use activities. Develop program to reduce land use related sediment inputs to levels that do not create water quality problems within the lake.	H#8 (WQ)	NA
RS#19	Beach Spawners	Sediment	Within Priority II and III subbasins, quantitatively assess sediment production impacts from logging (gully creation, debris flows, landslides) and road building. Develop program to reduce land use related sediment inputs that have the potential to deliver sediment to lake shore spawning habitats or areas of identified as potential habitat.	H#6 (BSH) H#8 (WQ)	H#10 (Comp)

Recovery Strategy ID	Recovery Flow Chart (Population Segment Addressed)	Process, Input, or Condition	Description	Primary Hypotheses Addressed	Secondary Hypotheses Addressed
RS#20	Beach Spawners	Riparian Processes Vegetation Colonization	Maintain and protect the lake's riparian forest. Determine where degraded riparian forests exist that may affect spawning habitat quality and re-establish native riparian vegetation. Implement recovery strategies to restore hydrologic processes (RS#8-11) and sediment processes (RS#17-19).	H#6 (BSH)	H#9 (LL)
RS#21	Beach Spawners	Riparian Processes Vegetation Colonization	Survey and eradicate non-native invasive plant species colonizing the lake's beaches and riparian areas. This may require non-native species eradication in all tributaries to be successful over the long-term.	H#6 (BSH)	H#9 (LL)
RS#22	Beach Spawners	Biological	Implement strategies and actions to increase egg-to-fry survival of beach and tributary spawners so that the habitat can produce abundant sockeye salmon capable of overwhelming and swamping predators, and thus maintain a natural predator-prey balance.	H#7 (Pred)	H#6 (BSH) H#10 (Comp)
RS#23	Beach Spawners	Biological	Increase the spatial distribution of Lake Ozette beach spawning sockeye.	H#7 (Pred)	H#6 (BSH) H#10 (Comp)
RS#24	Beach Spawners	Biological	Restore natural predator-prey balance by reducing pre-spawn predation mortalities.	H#7 (Pred)	H#6 (BSH) H#10 (Comp)
RS#25	Beach Spawners	Habitat Condition	Develop a comprehensive understanding of the conditions, factors, and processes controlling egg-to-fry survival on sockeye spawning beaches. Investigate several different methods of beach spawning habitat rehabilitation including: vegetation removal, gravel cleaning, LWD introduction, etc…Include sockeye egg survival studies with habitat manipulations.	H#6 (BSH)	NA

Recovery Strategy ID	Recovery Flow Chart (Population Segment Addressed)	Process, Input, or Condition	Description	Primary Hypotheses Addressed	Secondary Hypotheses Addressed
RS#26	Tributary Spawners	Habitat Connectivity	Implement programmatic actions to ensure that habitat connectivity is maintained. As sockeye spawning spatial distribution increases, ensure that fish blockages are corrected within stream reaches suitable for sockeye spawning.	NA	NA
RS#27	Tributary Spawners	Hydrology	Quantitatively assess hydrologic impacts from land use and LWD removal activities and develop a distributed hydrologic model calibrated for each sockeye tributary. Based on modeling results, prioritize actions needed to improve natural hydrologic processes in sockeye spawning streams.	H#15 (Q)	H#12 (Stab) H#13 (WQ)
RS#28	Tributary Spawners	Sediment	Within the sockeye spawning subbasins, quantitatively assess sediment production impacts from logging (gully creation, landslides), road building, LWD removal, and other land use activities. Develop program to reduce land use related sediment inputs to levels that create properly functioning conditions within these subbasins (this should be done in conjunction with RS#17-19).	H#11 (TSH) H#13 (WQ)	H#12 (Stab) H#16 (HP)
RS#29	Tributary Spawners	Riparian/Floodplain	Protect riparian forests and reestablish healthy riparian forests where degraded conditions exist within sockeye spawning subbasins.	H#11 (TSH) H#12 (Stab)	H#13 (WQ) H#16 (HP)
RS#30	Tributary Spawners	Riparian/Floodplain	Survey and eradicate non-native invasive plant species colonizing riparian areas.	H#11 (TSH) H#12 (Stab)	H#13 (WQ) H#16 (HP)
RS#31	Tributary Spawners	Riparian/Floodplain	Identify riparian/floodplain infrastructure; where feasible, develop alternatives to mitigate or remove infrastructure impairing riparian/floodplain processes.	H#11 (TSH) H#12 (Stab)	H#13 (WQ) H#16 (HP)

Recovery Strategy ID	Recovery Flow Chart (Population Segment Addressed)	Process, Input, or Condition	Description	Primary Hypotheses Addressed	Secondary Hypotheses Addressed
RS#32	Tributary Spawners	Riparian/Floodplain	Identify disconnected floodplain surfaces and add LWD to reconnect floodplains to channels to improve connectivity, sediment storage, water retention, and peak flow attenuation.	H#11 (TSH) H#12 (Stab)	H#13 (WQ) H#16 (HP)
RS33	Tributary Spawners	Biological	Increase the spatial distribution of tributary spawning sockeye by implementing the LOS HGMP.	NA	H#14 (Pred)
RS#33	Tributary Spawners	Habitat Condition	Throughout sockeye spawning streams where gravel deficient conditions exist, add LWD structures to trap and store spawning gravels. This must be done in conjunction with or after sediment and hydrologic processes are addressed.	H#11 (TSH)	NA

7 RECOVERY PROGRAM ACTIONS

This chapter presents a suite of recommended actions that may be necessary to achieve recovery of the Lake Ozette sockeye salmon ESU. These recommendations were developed by NMFS with input and suggestions from the Lake Ozette Sockeye Steering Committee. At their November 2006 meeting, Steering Committee members proposed a range of strategies and actions (programmatic and site-specific) to restore biological processes and address limiting factors in the Lake Ozette watershed. NMFS refined these suggestions in relation to the scientific process that forms the basis of the plan – the process of forming hypotheses and moving from those to strategy and action. This section contains the combined results. Many of the Committee's suggestions are also included in Chapter 8, Adaptive Management, Research, Monitoring and Evaluation.

The recovery actions are voluntary and are listed here as guidance and for planning purposes only. These actions are proposed for future consideration and are conceptual in nature; they are not required or mandated as a result of being in this recovery plan. Recovery actions will need to be refined during development of an Implementation Schedule (see Section 9.1) and any recovery action will need to be developed and implemented in cooperation with all landowners, requiring prior written permission for any activity on private property. The public will be involved in developing the Implementation Schedule and selecting future projects. To decide whether to implement any of the proposed recovery actions, it will be necessary to develop project budgets, seek funding, get permits from the relevant authorizing agencies, evaluate potential social and economic effects, and coordinate actions with Olympic National Park, NMFS, WDFW, Tribes, County, landowners, and other appropriate entities.

The proposed voluntary actions in the recovery plan are designed to be integrated with current, ongoing programs or regulations that may benefit sockeye and that are also described in this plan, such as the forest HCPs or current fisheries regulations. These ongoing programs or regulations that are currently being implemented have been previously evaluated and approved through appropriate local, state, and Federal environmental impact review processes. Some of the ongoing actions that are integrated into the plan, such as implementation of forest HCPs, maintenance of county roads, operation of the sockeye hatcheries, or regulation of fisheries, are not voluntary, as they are already subject to an existing permit, contract, or regulation. In that sense, the plan incorporates some required actions because of their potentially significant contribution to achieving recovery, as well as the new, proposed, voluntary actions detailed in this chapter. Table 7.1 lists the actions.

Table 7.1. Summary of proposed recovery program actions.

Plan Section	Actions
7.1 Fisheries Management	1. Maintain all currently closed or restricted sockeye fisheries (Section 7.1). 2. Continue timing, location, and method limits on current ocean fisheries and other salmon-directed fisheries, to ensure that these fisheries do not interfere with Lake Ozette sockeye salmon recovery (Section 7.1.3.2). 3. Continue current commercial and recreational fisheries ban on directed and incidental harvest of Lake Ozette sockeye salmon in Lake Ozette, Ozette River and all Lake Ozette tributaries (Section 7.1.3.1). 4. Depending upon ESA evaluation and determination that recovery would not be compromised, resume limited ceremonial and subsistence fisheries (Section 7.1.3.1). 5. Subject to ESA review and approval, as sockeye populations recover, commercial and recreational fisheries directed at sockeye salmon may be allowed in Ozette watershed (Section 7.1.3.1). 6. Minimize incidental harvest impacts on juvenile and adult sockeye salmon by regulating fisheries on other fish species (Section 7.1.3.1). 7. Study impacts on sockeye of increased cutthroat trout population, and consider changing cutthroat trout non-retention regulation if necessary (Section 7.1.3.1). 8. Continue Lake Ozette watershed recreational fisheries designed to reduce non-native fish species that prey on juvenile sockeye salmon (Section 7.1.3.1). 9. Long-term future sockeye marine fisheries harvest may be resumed after evaluation of proposed harvest plans for tribal commercial, ceremonial and subsistence, and all-citizen recreational fisheries (Section 7.1.4.2).
7.2 Habitat-Related Actions	
7.2.1 Habitat-Related Programmatic Actions	• Implement the Washington Forest Practices Habitat Conservation Plan on private timber lands in the Lake Ozette watershed (Section 7.2.1.1).
	• Implement the Washington Department of Natural Resources Habitat Conservation Plan on state timber lands in the Lake Ozette watershed (Section 7.2.1.2).
	• Implement Clallam County Critical Areas Ordinance and Storm Water Management Plan in the Lake Ozette watershed (Section 7.2.1.3).
	• Implement the Clallam County Road Maintenance Plan in the Lake Ozette watershed (Section 7.2.1.4).

Plan Section	Actions
	• Implement the Olympic National Park General Management Plan in the Lake Ozette watershed (Section 7.2.1.5).
	• Implement the Olympic Coast National Marine Sanctuary Management Plan (Section 7.2.1.6).
	• Implement the Washington State Department of Fish and Wildlife Hydraulic Code (Section 7.2.1.7).
	• Implement the Washington State Department of Ecology's water quality and water resource programs in the Lake Ozette watershed (Section 7.2.1.8).
7.2.2 Habitat Protection, Restoration and Enhancement Projects	• Implement Broad-scale Sediment Reduction Projects (Section 7.2.2.1) that may be carried out as part of the Forest Practices HCP, WDNR HCP, or by other landowners.
	• Implement Hydrologic Restoration Projects by carrying out computer modeling to analyze impacts of past land use and large wood removal actions, and identify potential future actions to improve natural hydrologic functions in the watershed (Section7.2.2.2).
	• Research and identify options for large wood placement projects (Section 7.2.2.3).
	• Implement site-specific large wood placement projects in Umbrella Creek (Section 7.2.2.3.2).
	• Implement broad-scale and site-specific riparian and floodplain restoration projects (Section 7.2.2.4).
	• Seek conservation easements and encourage market-driven transfer of development rights for conservation (Section 7.2.2.6).
Section 7.3 Hatchery Supplementation Actions	• Implement the current hatchery practices as required in the 2000 Lake Ozette Sockeye Salmon Hatchery and Genetic Management Plan (Section 7.3).
	• Continue to use Umbrella Creek sockeye salmon for hatchery broodstock collection actions (Section 7.3.1.1).
	• Continue to use broodstock spawning procedures in accordance with NMFS guidelines under the ESA (Section 7.3.1.2).
	• Continue to use ESA-approved protocols for juvenile sockeye salmon rearing and release actions (Section 7.3.1.3).
	• Implement the ESA-approved hatchery program practices and return adult carcasses to Umbrella Creek (Section 7.3.1.4).
	• Implement beach spawner supplementation research as defined in the ESA-approved hatchery plan (Section 7.3.1.5).
	• Implement potential long-term hatchery enhancement actions (Section 7.3.2.1.1).

Plan Section	Actions
Section 7.4 Predator-Related Recovery Actions	• Create an incentive program, as appropriate within NPS regulations, to encourage or require lethal take of largemouth bass and other non-native fish species, with a goal of reducing or eliminating non-native fish species (Section 7.1.4.1). • Create fishing regulations that will limit take of native species while maximizing the removal of non-native species (Section 7.1.4.1). • Conduct field assessments of northern pikeminnow abundance in the Lake Ozette watershed, spatiotemporal distribution by life state, and the species' diet composition, to evaluate the impact on sockeye salmon survival and productivity. Assessments should take into consideration annual reductions in the number of sockeye fry and smolts potentially caused by northern pikeminnow predation and adult equivalent reduction in sockeye spawner returns to the lake attributable to pikeminnow predation on juvenile fish. Identify management options to reduce northern pikeminnow predation impacts if it is determined to be necessary to meet sockeye population viability criteria. (Section 7.1.4.1). • Work with NMFS, ONP, WDFW, and the Tribes to study impacts of marine mammals and river otters on sockeye salmon, particularly on beach spawning grounds. Based on this information, develop a NMFS-sanctioned plan to address these impacts through a variety of predator control measures being tested in the watershed and used in the NMFS Northwest Region. Any predator control activities proposed within the boundaries of Olympic National Park will require approval by the Park's Superintendent. • Working in coordination with NMFS, ONP, the Tribes, and the State, analyze the impacts of seals and sea lions on sockeye salmon and identify options to minimize these impacts, including reinstating ceremonial and subsistence hunting of seals and sea lions in Tribal Usual and Accustomed hunting and fishing areas. • Modify sockeye adult enumeration techniques at the Ozette River weir to reduce any predation mortality on adult and juvenile sockeye. • Implement research and monitoring actions proposed in Chapter 8 to analyze fishing regulations, predator-prey interactions, and predation at all life stages for beach spawners.
Section 7.5 Research, Mon. & Adapt. Mgmt	• Implement research, monitoring and adaptive management actions (see Chapter 8).

Plan Section	Actions
Section 7.6 Public Education	• Develop an education and outreach program regarding negative impacts of non-native fish and plants. • Produce a 3-5 page summary brochure or handout describing the key parts of the Lake Ozette Sockeye Recovery Plan and highlighting the recovery actions that can be carried out by the public and landowners • Develop a clearinghouse of information about recovery plan implementation to keep partners and the public informed about recovery actions. • Work with landowners in the watershed to provide information and help identify appropriate recovery actions on landowner property. • Produce educational materials that can be used in the local schools, community colleges, and community centers. • Develop cooperative educational and outreach programs with existing organizations and nonprofit groups to include information about sockeye recovery in their materials. • Develop exhibit materials that can be used at fairs, festivals, or other venues. • Work with Olympic National Park staff to develop materials, posters, and display boards to educate the public visiting Lake Ozette about the need to recover sockeye salmon and the recovery actions being carried out within the Park. • Seek funding to carry out the proposed education and outreach actions. Develop a clearinghouse of information on funding sources. Support local entities, landowners, and Tribes to seek funding for recovery actions. • Identify which entities and individuals will carry out the education and outreach actions. • Develop public education information that can be posted on the NMFS, Olympic National Park, Olympic Coast National Marine Sanctuary, and Clallam County's NPCLE web sites. Identify other opportunities for web postings of recovery information. • Carry out briefings and presentations to civic, business, trade, environmental, and conservation organizations. • Lead seasonal tours of the watershed so the public can observe spawning sockeye salmon and visit recovery project restoration sites.
Section 7.7 Action Integration	• Implement priorities for actions based on the recovery strategy hierarchy, subbasin prioritization, and limiting factors presented in the recovery plan.

7.1 FISHERIES MANAGEMENT ACTIONS

This section of the plan addresses recovery-directed actions and regulatory measures that will be applied over the short and long-terms (e.g., 50 years) in the management of fisheries directed at the harvest of Lake Ozette sockeye salmon. This section also addresses short- and long-term actions and measures applied for fisheries that may incidentally affect the population through harvests directed at other fish species.

These harvest actions will apply to all fisheries under the jurisdiction of Federal, Washington State, and tribal resource management agencies and entities that, because of their timing and/or location, have a moderate to high likelihood of harvesting Lake Ozette sockeye salmon. All fisheries that historically occurred in Lake Ozette, Lake Ozette tributaries, and the Ozette River, but that are presently closed or restricted for conservation purposes, are subject to the sockeye salmon preservation and recovery actions described in this plan. Recently extant, but now closed or restricted freshwater area fisheries covered by this plan include any proposed tribal commercial, ceremonial, and subsistence fisheries, and all recreational fisheries jointly managed by the Olympic National Park and WDFW (Olympic National Park consults annually with WDFW on all fishing regulations for the park, including those in the Ozette watershed). Nothing in this plan is intended to address or define the tribal treaty rights to fish in Lake Ozette, Lake Ozette tributaries or the Ozette River, including the equitable allocation of harvestable fish.

Marine area fisheries that will be guided by conservation-directed measures included in this plan are tribal and non-tribal commercial and recreational fisheries in Washington marine waters regulated by the Tribes, WDFW, and NMFS through the Pacific Fisheries Management Council, North of Cape Falcon, and Pacific Salmon Treaty fisheries management forums. Under current management regimes, ocean salmon-directed fisheries in Washington, British Columbia, and Alaska, including those managed under the terms of the Pacific Salmon Treaty, are not likely to substantially affect Lake Ozette sockeye salmon (LFA Section 5.6.1.1) (Haggerty et al. 2009). The expectation is that fishing patterns for these fisheries, and their attendant unsubstantial impacts on Lake Ozette sockeye salmon, are unlikely to change to the detriment of Lake Ozette sockeye salmon over the short or long-term. However, management actions for these potential interceptory fisheries, including their timing and location relative to sockeye migration routes, will be monitored by NMFS. In the event that any interceptions of Lake Ozette sockeye are documented through monitoring of these fisheries, NMFS will notify and work with the managers overseeing the fisheries to implement management measures that will minimize to the extent feasible any mortality resulting from the fisheries as the sockeye population recovers. Measures that may be required by NMFS to minimize ocean area interceptions in the fisheries may include time and area closures and gear restrictions.

7.1.1 Tribal Fishing Rights and Lake Ozette Sockeye Salmon Recovery

As noted in Section 1.6, sockeye salmon population recovery goals are accentuated by the Federal government's trust responsibilities to ensure that tribal treaty fishing rights are preserved. The Treaty of Neah Bay (1855) and the Treaty of Olympia (1856) identify lands ceded to the federal government by the Makah and Quileute Tribes, respectively. The Tribes share a common boundary of their ceded lands, described in both treaties. The treaties reserved to the Tribes the right of fishing "at all usual and accustomed grounds and stations." This right was reaffirmed by the Boldt Decision in 1974 (*U.S. v. Washington*, 384 F. Supp. 312, 362). Under the Federal trust responsibility, Federal agencies, including NMFS, have an obligation to support the Tribes in efforts to preserve and rebuild treaty salmon fisheries in the Tribes' usual and accustomed fishing area. The U.S. Government has an obligation to protect tribal land, assets, and resources, as well as a duty to carry out the mandates of Federal law with respect to Tribes. This unique relationship provides the Constitutional basis for legislation, treaties, and Exectutive Orders that grant unique rights or privileges to Native Americans to protect their property and their way of life.

Implementation of a recovery plan that achieves the basic purposes of the ESA will lead to major improvements in the status of the species (ESU) and its habitat over time, such that the Lake Ozette sockeye salmon ESU reaches the point where it no longer needs protection under the Act. However, stock status improvement resulting from implementation of this plan, and recovery of the ESU to the point of delisting, may not fully meet treaty-reserved tribal fishing rights and expectations. Ensuring availability and sufficient abundance of sockeye salmon to allow for, and sustain, harvest can be important elements in fulfilling treaty fishing rights and the Federal trust responsibilities for them, as well as garnering public support for the recovery plan. It is appropriate for this recovery plan to take the need for a harvestable abundance of sockeye salmon into account and to plan for recovery strategies that include harvest. NMFS' policy is therefore that the process of recovery of the Lake Ozette sockeye salmon population must achieve two goals: (1) recovery and delisting of the listed ESU under the provisions of the ESA, and (2) the restoration of the meaningful exercise of tribal fishing rights. It is NMFS' view that there is no conflict between the statutory goals of the ESA and the Federal trust responsibility to Indian tribes regarding the allowance for, and restoration of, treaty-reserved fisheries.

Treaty fishing rights, although stated as an objective in this Plan, are not currently being achieved. Declines in the abundance and productivity of Lake Ozette sockeye salmon from historical levels led to the complete cessation of tribal fisheries in the Ozette River in 1982 (Jacobs et al. 1996). An important objective of this recovery plan will therefore be rebuilding of the Lake Ozette sockeye salmon population to allow sustainable, directed tribal ceremonial and subsistence and commercial sockeye salmon fisheries in the Lake Ozette region. An important companion goal is restoration of sustainable recreational and subsistence fisheries for sockeye salmon for the benefit of all citizens in the region.

7.1.2 Considerations and Criteria for Re-Establishment of Sockeye Salmon Fisheries

The fisheries restoration goals described above are part of the broad-sense goals in the Steering Committee's vision statement. As this recovery plan is implemented and changes resulting from other recovery-directed measures have an effect, the protective approach currently applied regarding adult sockeye salmon harvest management will be reassessed and revised. Specifically, the harvest approach will be adjusted to allow re-establishment of sockeye salmon-directed and/or incidental harvest fisheries in the Lake Ozette basin and its nearshore marine areas. However, any fisheries must not compromise rebuilding and recovery of the population and the eventual attainment and maintenance of a viable population. Key considerations regarding re-establishment of sockeye-directed fisheries will include:

- The trajectory and status of the sockeye salmon population relative to ESU viability criteria, based on analyses using viability status detection and measurement parameters developed by the co-managers, NMFS, and the PSTRT, respectively, addressing spawner abundance status, fish recruitment, population age structure, and other viability metrics;
- The abundance status of each of the component beach and tributary aggregations relative to population abundance targets set for these spawning areas, and considering their contribution to ESU spatial structure and diversity criteria;
- Improvements in the condition of habitat in beach and tributary spawning areas;
- Effects of the tributary hatchery programs in returning adult fish, and in establishing self-sustaining natural spawning aggregations;
- Determination of a total returning population abundance threshold above which directed harvest could be allowed consistent with ESU rebuilding objectives; and,
- Derivation of a "rebuilding exploitation rate" of harvest that defines a harvest impact level that will not significantly impede the opportunity for the population to consistently achieve, or grow towards, identified recovery targets. The rebuilding rate will incorporate assessment of the habitat and abundance considerations described in the above bullets, providing a structure in which harvest is constrained to appropriate levels as the population rebuilds from current abundance to recovery.

The parties to this recovery plan are working toward restoration of a viable Lake Ozette sockeye salmon population, as defined by criteria developed by the PSTRT. Recovery of the population to a viable level is considered highly unlikely without commensurate improvements in limiting factors identified as of moderate and high risk to the listed population. Sockeye salmon harvest regimes implemented over the long-term would likely be based on a conservative assessment of maximum sustainable harvest, accompanied by monitoring, adjustment for survival and productivity conditions in the Lake Ozette basin, and taking into account uncertainties in data, data analysis, and management implementation. As other recovery strategies take effect, such an approach will allow the majority of the expected, increasingly abundant fish to pass through to the spawning grounds. Objectives for fisheries directly or incidentally affecting Lake Ozette sockeye salmon will address catch accounting, risk management in the conduct of fisheries, and adherence to the principles of overarching salmon management plans, court orders, and agreements as follows (generally from PSTT and WDFW 2004):

- Conserve the abundance, diversity, spatial structure, and productivity of the ESU;
- Manage all fisheries to account for uncertainty and risk in estimating population sizes and the impacts of harvest;
- Meet the section 7 standards of the ESA for any Federal authorizations to ensure that harvest is not likely to jeopardize the continued existence of the ESU;
- Provide opportunity to harvest surplus production from other species/populations originating from the Lake Ozette basin or adjacent watersheds;
- Account for all sources of fishery-related mortality;
- Adhere to the principles of the Puget Sound Management Plan and legal mandates of United States *v*. Washington to ensure equitable sharing of harvest opportunity among Tribes and among treaty and non-treaty anglers; and
- Ensure the exercise of Indian treaty rights in "usual and accustomed" areas.

7.1.3 Short-Term Actions (Initial 1-12 Years)

In both freshwater and marine fisheries, harvest management in the initial 1- to 12-year period of the recovery plan will continue to emphasize sockeye population protection and rebuilding.

7.1.3.1 Freshwater Fisheries (RS#4)

The primary short-term harvest management approach will be to continue to protect Lake Ozette sockeye salmon from directed and incidental commercial and recreational fisheries harvests in Lake Ozette, the Ozette River, and all Lake Ozette tributaries. This action will be accomplished by continued implementation of current ONP, WDFW, and tribal fishing regulations that prohibit the directed harvest and retention of Lake Ozette sockeye salmon in recreational and tribal commercial fisheries.

Makah commercial sockeye harvest was discontinued in 1977, but the Makah Tribe continued a ceremonial and subsistence fishery in the Ozette River until 1982 (MFM 2000). Quileute elders and the Quileute Natural Resources Department state that no Quileaute Tribal sockeye fishery occurred after 1982 (personal communication, Mel Moon, Jr., 2008). No directed *O. nerka* (sockeye salmon and kokanee) harvests have occurred since that time, and harvest prohibitions for the species have applied to all freshwater recreational, commercial, and ceremonial and subsistence fisheries in the watershed. There are no open fisheries within the Ozette River during the juvenile sockeye emigration period and therefore there are no impacts on sockeye salmon from permitted in-river fisheries. For example, the Ozette River is closed to all sport fishing until August 1st. When the river is open, selective fishery rules apply and all sockeye salmon encountered must be released immediately. The current protective fisheries management approach has resulted in categorization of harvests of adult and juvenile sockeye during all life history phases in the watershed as negligible limiting factors to population recovery (Sections 4.2.3.2.1, and 4.2.3.2.2) (see LFA Sections 6.1.2.2 and 6.1.11.2).

The Makah Tribe has requested a resumption, during the initial recovery plan implementation period, of limited ceremonial and subsistence fisheries for sockeye salmon. The Quileute Tribe has not requested participation in a ceremonial and subsistence fishery for Lake Ozette sockeye. Any such ceremonial and subsistence fisheries would be implemented consistent with the need to ensure that rebuilding of the population to a recovered level would not be compromised. ESA evaluation and determination of the effects of such fisheries on population recovery would be made under the ESA 4(d) Rule limit on section 9 prohibitions applicable to listed threatened species for actions under tribal resource management plans (65 FR 42481, July 10, 2000). Initially, ceremonial and subsistence fisheries that are proposed would be limited to the removal of no more than **1 percent** of the estimated total returning sockeye salmon population in a given year. Such fisheries would need to address considerations and objectives described above in Section 7.1.2 of this plan that are pertinent to implementation of a limited ceremonial and subsistence harvest designed to avoid substantial harvest impacts on the beach spawning aggregations. Proposed ceremonial and subsistence fisheries would therefore target, to the extent feasible, marked Lake Ozette tributary-origin sockeye salmon identified through in-season stock assessment data analyses as surplus to natural spawning and hatchery broodstock escapement needs in Umbrella Creek and Big River. Ceremonial and subsistence harvest of beach-origin sockeye salmon would be avoided to the extent feasible through actions such as time and area restrictions and/or exploration of selective fishery techniques.

Federal law (CFR Title 36, Ch. I, Part 7, Sec. 7.28) requires the Olympic National Park to issue its fishing regulations “in conformance” with applicable state regulations and “after consultation with the State and any affected Indian tribe.” The regulations are worked out during the annual Pacific Fishery Management Council (PFMC) sessions. As noted in the LFA document (Section 5.3.4.2.6), changes in lake and fisheries management have the potential to increase the abundance of certain predators known to consume sockeye salmon. ONP’s recent implementation of fishing regulations requiring release of coastal cutthroat trout may have the effect of increasing the abundance of cutthroat trout in Lake Ozette, potentially to a point where juvenile sockeye salmon mortality is substantially increased from current levels. As a short-term harvest management action, this regulation change will be reexamined by ONP to determine whether protecting cutthroat trout is warranted and outweighs hazards the change may pose to the recovery of sockeye. If a determination is made by ONP, after consultation with WDFW and the Tribes, that the increased cutthroat trout population resulting from the non-retention regulation is likely to substantially impact juvenile sockeye salmon abundance levels (for example, through life cycle analysis computations showing that cutthroat predation is a significant factor impeding recovery), ONP will revise or rescind the cutthroat trout non-retention regulation. ONP may make a similar decision to allow cutthroat retention if stock status evaluations in Lake Ozette show that the abundance status of the cutthroat population is not at risk or is trending upward.

As a further measure to reduce piscivorous fish predation risks to juvenile sockeye salmon rearing in Lake Ozette, ONP and WDFW will adjust as necessary current recreational fishery regulations to promote and maximize the removal of non-native fish species. Piscivorous species that will be the focus of regulation changes, including liberalization of open fishing periods or cessation of bag limits (subject to the need to avoid sockeye bycatch), are largemouth bass and yellow perch (addresses RS#3).

7.1.3.2 Marine Area Fisheries (RS#4)

In continuation of the current approach, no directed harvests of sockeye salmon are allowed in the Ozette River estuary, nearshore area, or adjacent U.S. marine waters during the migration period of Lake Ozette sockeye salmon. Reviews of the current fisheries management approach for coastal marine area fisheries in Northeast Pacific waters, harvest data in Washington Catch Reporting Area 4, and estimated Lake Ozette sockeye salmon marine area migration timing and abundance estimates have resulted in categorization of interceptory marine area fishery harvests as a negligible limiting factor to recovery of the Lake Ozette sockeye salmon population (Section 4.2.3.1) (LFA Sections 5.6.1.1 and 6.1.13.1). The timing, location, and methods applied in current coastal fisheries limit the likelihood for substantial harvest impacts to Lake Ozette sockeye salmon. Continuation of current fishing regimes over the short-term is expected to be sufficiently protective of sockeye salmon so as not to interfere with the population's recovery to a viable level.

7.1.4 Long-Term Actions (Subsequent 13-50 Years)

This section concerns long-term fisheries harvest management actions affecting ESU recovery, tribal fishing rights, freshwater fisheries, and marine area fisheries.

7.1.4.1 Freshwater Fisheries (RS#4)

As the Lake Ozette sockeye salmon population recovers, commercial and recreational fisheries directed at sockeye salmon may be allowed in the Lake Ozette watershed, subject to ESA approval of a fishery management plan (e.g., a Fisheries Management and Evaluation Plan [FMEP]). Among other criteria, the fishery plan would address the objectives and key considerations presented in Section 7.1.2, and describe the effects of the proposed plan. Directed commercial and recreational fisheries—for example, fisheries designed to harvest tributary-origin sockeye—may be considered prior to de-listing of the population, if such fisheries will not exert harvest impacts that are likely to impede progress toward ESU recovery when measured against a "0" harvest management approach. The sockeye salmon population abundance level sufficient for allowing limited directed commercial and recreational fishery harvests of adult fish in the watershed, and the maximum allowable harvest impacts from such fisheries, will be determined through application of the considerations and criteria identified in Section 7.1.2. As noted in Section 7.1.3, as the population recovers, limited harvests of adult sockeye salmon would continue to be considered as a means to meet tribal ceremonial and subsistence fishery needs over the long-term. NMFS will work with the Tribes, ONP, and WDFW within the ESA, NEPA, and *U.S. v. Washington* fishery management forums to evaluate specific directed commercial or recreational sockeye salmon fishery harvest plans proposed within the watershed prior to making formal decisions.

Fisheries directed at other fish species in the Lake Ozette basin will be regulated over the long-term to minimize incidental harvest impacts on juvenile and adult sockeye salmon. Key considerations and objectives described above in Section 7.1.2 will be addressed when considering implementation of commercial, recreational, and tribal ceremonial and subsistence fisheries that may have incidental harvest impacts on listed sockeye salmon.

To reduce piscivorous fish predation risks to juvenile sockeye salmon, recreational fisheries designed to remove and eradicate non-native fish species will continue to be promoted (RS#3). No-bag-limit fisheries directed at largemouth bass and yellow perch will be promulgated by ONP and WDFW, where and when appropriate.

7.1.4.2 Marine Area Fisheries (RS#4)

Long-term harvest actions may include resumption of sockeye salmon-directed tribal commercial, ceremonial and subsistence, and all-citizen recreational fisheries in estuarine and nearshore marine areas adjacent to, and seaward of, the mouth of the Ozette River. Although unlikely because of the fishery timing relative to adult migration, incidental catches in ocean fisheries may also increase as abundance increases. All proposed fisheries would be subject to a review of the objectives and key considerations identified above, and ESA approval involving an assessment of the fisheries and their specific effects on listed Lake Ozette sockeye salmon. Before making formal decisions, NMFS will work with the Tribes and WDFW within the ESA, NEPA, PFMC and *U.S. v. Washington* forums to evaluate any specific sockeye salmon-directed harvest plans proposed within marine areas where, based on a review of fisheries location and timing, Lake Ozette sockeye salmon may be present, and will also evaluate any fisheries shown to be incidentally harvesting Lake Ozette sockeye (as identified through DNA analysis or mark recoveries).

Fisheries directed at other sockeye salmon populations and fish species in U.S. marine fishing areas will continue to be regulated over the long-term to minimize the risk of incidental harvest impacts to juvenile and adult sockeye salmon originating from Lake Ozette.

7.2 HABITAT-RELATED ACTIONS

The following habitat-related proposed recovery actions are voluntary and are identified as guidance and for planning purposes only. These actions are proposed for future consideration, and are not required or mandated as a result of being in the draft recovery plan. Proposed recovery actions will need to be refined during development of the Implementation Schedule (see Section 9.1), budgets will need to be developed and funding sought, permits issued from authorizing agencies, potential social and economic effects of actions evaluated, and actions coordinated with the Lake Ozette Steering Committee in order to select and implement any proposed recovery action. There is no requirement to implement these habitat-related actions, with the exception of those ongoing, programmatic actions that have been previously approved, required through other regulatory processes, and now integrated into this plan. The following habitat-related projects are identified because they address habitat factors that are limiting Lake Ozette sockeye salmon and the projects are intended to improve the viability and recovery of this ESU.

Recommended habitat-related actions may be programmatic or project/site-specific.

7.2.1 Habitat-Related Programmatic Actions

“Programmatic” recovery actions are part of a policy, program or process, as opposed to being specific projects or related to specific sites. They are generally part of a regulatory or planning process. For example, programmatic actions could be part of a County’s land use and regulatory program or a watershed planning process. Comprehensive plans, critical area ordinances, shoreline management programs, and zoning could all be considered programmatic actions. Programmatic actions can include projects of a comprehensive or broadly encompassing nature e.g., riparian protection as part of a forest management plan. Watershed management plans often include projects to address specific limiting factors; for the purposes of this recovery plan, the management plans or planning processes will be considered programmatic actions, whereas the projects identified within the management plans will be categorized as projects.

This subsection describes programmatic actions related to the Washington State Forest Practices Habitat Conservation Plan (FPHCP), the WDNR State Land HCP, Clallam County Critical Areas Ordinance, Storm Water Management Plan, and Road Maintenance Plan, the Olympic National Park General Management Plan, the Olympic Coast National Marine Sanctuary Management Plan, and the WDFW Hydraulic Code. No attempt has been made to list *all* of the projects or specific practices that may be part of each policy, program, or process.

7.2.1.1 Forest Practices HCP

The Washington State Forest Practices Habitat Conservation Plan (FPHCP; WDNR 2005) is a programmatic statewide plan covering 60,000 miles of streams in 9.3 million acres of non-Federal and non-tribal forestland. The FPHCP incorporates the Washington State Forest Practice Regulations, adopted by the Washington Forest Practices Board in response to the 1999 Forest Practice Regulations (see Section 2.6.2.2.3). The FPHCP covers 16 listed threatened and endangered species under NMFS' jurisdiction, including Lake Ozette sockeye. Details of the FPHCP are summarized at http://www.nwr.noaa.gov/Salmon-Habitat/Habitat-Conservation-Plans;washington-Forest-Practices/Index.cfm. The FPHCP contains a set of conservation measures and an administrative framework to implement and adaptively manage them. It is expected that as these practices are implemented and monitored, watershed conditions will improve. Approximately 37,000 acres (75 percent of forested watershed) of privately managed timberlands in the Lake Ozette watershed are to be managed according to the FPHCP.

7.2.1.1.1 Protection Measures Contained in the FPHCP

FPHCP protection measures consist of two parts: (1) a riparian conservation strategy and (2) an upland conservation strategy. The conservation objective of the riparian strategy is to protect riparian habitat function on lands covered by the FPHCP and to enable improvement of those levels once they are attained (WAC 222-30-010(2)). Riparian functions include large-wood recruitment, sediment filtration, streambank stability, shade, litterfall and nutrients, in addition to other processes important to riparian and aquatic systems.

The riparian strategy from the FPHCP consists of three separate but related sets of protection measures:

- Riparian and wetland management zones that provide large-wood recruitment, shade, and other ecological functions through tree retention.
- Limitations on equipment use in and around waters and wetlands to minimize erosion and sedimentation and maintain hydrologic flowpaths.
- Streamside land and timber acquisitions for the long-term conservation of aquatic resources.

The goal of the upland strategy is to prevent, avoid, minimize, or mitigate forest practice-related changes in erosion and hydrologic processes and the associated effects on public resources. The upland strategy in the FPHCP consists of protection measures that are implemented in upslope areas outside Riparian Management Zones (RMZs) and wetlands. These measures are intended to limit forest practice-related changes in physical watershed processes, such as erosion and hydrology that may adversely affect the quality and quantity of riparian and aquatic habitat lower in the watershed. The upland strategy includes Washington Forest Practices Rules, guidance from the Forest Practices Board Manual, and guidance issued through the WDNR Forest Practices Division related to unstable slopes and landforms; the location, design, construction, maintenance, and abandonment of forest roads; and harvest-induced changes in rain-on-snow peak flows. Further, the effectiveness and validation monitoring component of the FPHCP (as described in Section 4a-4.2 of the FPHCP) is designed to evaluate the degree to which the Washington Forest Practices Rules and guidance meet performance targets and resource objectives.

The following constitute specific protective actions that are required under the FPHCP, and that will directly benefit Lake Ozette sockeye salmon:

- Road Maintenance and Abandonment Plans

The Road Maintenance and Abandonment Plans (RMAPs) are the part of the Forest Practice regulations that most directly focuses on recovery of salmon. Forest landowners are required to submit their own RMAP to the Department of Natural Resources (WDNR) outlining their plans to properly abandon or stabilize existing forest roads whether they are used or not, and to improve standards on how new roads are to be built. Work must show progress over time and be prioritized by the "worst first" to give the most benefits to public resources early in the period. For example, fish barriers, stream-adjacent parallel roads, and large sediment sources would be addressed sooner than sites with less significant impact. Road maintenance is required to prevent potential or actual damage to public resources, such as disconnecting road drainage that delivers sediment to streams. RMAP strategies should meet the special needs of each watershed; each RMAP strategy is tailored to a particular geography. Adaptive management allows forest landowners to meet the special needs of each watershed while continually improving the standards of road and culvert construction.

One of the outcomes that the Forest Practice regulations seek is to minimize the possibility of forest roads being catastrophically washed downstream as a result of heavy flooding. Therefore, culverts and bridges are being enlarged, new road techniques are being used, and old culverts and stream passages that pose a risk of failure are being re-engineered to a 100-year flood standard.

Most large forest landowners have submitted their plans to the WDNR and have been practicing new methods since 2001. (Merrill & Ring began implementing RMAP's requirements in 2000 because of the pending change in regulations and the listing of Lake Ozette sockeye.) The three large timber land managers (Merrill & Ring, Rayonier, and Green Crow) that make up most of the managed forest land within the Lake Ozette watershed have submitted their RMAPs and have begun implementing them. All forest landowners are required to complete their road and culvert improvements by 2016 and must report annual RMAP accomplishments to WDNR while presenting a more detailed plan for each year's proposed RMAP work.

- Road Best Management Practices

Best management practices (BMPs) are the specific design techniques applied to ensure that sediment from forest roads is minimized. Application of BMPs for roads is a performance-based process; however, WDNR has published a Board Manual (Board Manual Section 3, Guidelines for Forest Roads). This manual outlines BMPs associated with:

- Road Location and Design – Where you place a road is often more important than the design itself. Avoiding constructing roads near watercourses, steep or unstable slopes, wetlands, and other sensitive sites all help minimize the impact of forest roads. Road design techniques such as out-sloping help move water off the road surface and onto the forest floor.
- Road Construction and Maintenance - Proper compaction of fills and placement of vegetative material on freshly constructed road slopes also minimize erosion. Grading, maintaining drainage structures to be sure they are clear of debris, and rock surfacing are all elements of maintaining a well-drained forest road.
- Landings – Construction techniques, location, and drainage of landings is as important as on forest roads, especially the location of landing fills.
- Water Crossings – Designing the approach to watercourse crossings so they are perpendicular, not parallel to the stream minimizes the impact near the stream. Hydrologically disconnecting the road from the crossing so that road sediment is transferred to the forest floor, not the stream, is a critical element of crossing design. Water crossings must be installed at all channels and natural seeps and springs.
- Drainage Structures – These design features all function to remove water from the road surface and disperse it onto the forest floor. Rolling dips are slight changes in road grade that collect water and disperse it without dramatically altering the running surface of the road. Water bars are like “speed bumps” that block surface runoff and disperse it onto the forest floor. Ditch relief pipes are usually 18-inch pipes that break up the water flow in a roadside ditch and disperse it onto the forest floor.
- Road Abandonment – Removal of unnecessary or poorly designed roads is a very effective BMP to address sedimentation from roads. This is an intensive process and requires the road to be in a “maintenance free” state. Crossings and unstable fills are removed and low maintenance drainage structures are installed.

- Riparian Management Zones

Riparian Management Zones (RMZs) are the stream buffers put in place to ensure that upslope harvest activities minimize impacts on salmon. The Forest Practice Regulations established these zones to increase function for salmon over time, in addition to serving as mitigation for current activities.

- Unstable Slopes

As a general rule, it is best to avoid operations on unstable slopes. In order to do that it is important to be able to recognize these features on the landscape. Both the Forest Practice Rules (WAC 222-16-050) and the Board Manual (Section 16, Guidelines for Evaluation of Potentially Unstable Slopes and Landforms) provide this guidance. In the rare situations where this is not possible, the rules require a higher level of review by the state and generally a project proponent invests in hiring a professional geologist to evaluate the proposal and provide recommendations to minimize impacts on the resources.

- Harvest unit size, green up, and reforestation requirements

There are several regulatory elements in place that limit the size and spatial distribution of clear-cut blocks. Additionally there are requirements to ensure prompt reforestation. The specific elements are outlined in WACs 222-30-025 and 222-34-010. Collectively, these regulations ensure limitations in size and timing of less hydrologically mature areas over a watershed. This mitigates potential landscape-level sedimentation and peak flow effects.

- Yarding Methods

Both cable and ground-based yarding limitations reduce the potential for sediment delivery during logging operations. For cable yarding, this includes prohibiting yarding across fish-bearing waters where logs could damage stream beds and banks.

Ground-based yarding has more extensive limitations within the watercourse and RMZs. Additionally, there are prohibitions on operating on unstable and highly erosive soils. Use of ground-based equipment that would result in significant soil compaction or displacement during wet weather is also prohibited. Additional limitations and guidance are specified in WACs 222-30-060 and 222-30-070.

Any time yarding activities work over a fish-bearing stream, an additional Hydraulic Permit and review is required by the Washington Department of Fish and Wildlife. These permits provide detailed, site-specific design and activity criteria to minimize impacts to the streams.

- Road Use During Wet Weather

Road use during wet weather is highly dependent on the location and surface condition of the road. Operations on roads should be stopped when there is a risk of discharge of sediment to a stream. This is generally interpreted by WDNR inspectors as well as landowners as a visual increase in turbidity in the receiving water. However, efforts should be made to arrive at acceptable quantitative methods for assessing sediment inputs to standardize enforcement and to help reduce sediment discharge during rain events.

7.2.1.1.2 Administrative Framework of the FPHCP

The administrative framework of the FPHCP allows for the development, implementation, and refinement of the state's Forest Practices program. This includes creation of new Forest Practices Rules and guidance, administering forest practices permitting, performing compliance monitoring, and taking enforcement action. An additional part of this administrative process is the concept of refining forest practices based on adaptive management.

The two main elements of this administrative framework that are an integral part of any successful recovery strategy are compliance monitoring/reporting on the implementation of the rules and the adaptive management process. These are both outlined in WAC 222-08-160.

- Compliance Monitoring and Reporting

Consistent with the Forest Practice Regulations, a required Compliance Monitoring Program is outlined in WAC 222-08-160. Compliance monitoring ensures that the rules in place are being put into practice on the ground as they were intended. WDNR is required to conduct compliance audits and submit monitoring reports to the [Forest Practices] Board every two years. WDNR is also required to maintain an infrastructure to support adequate compliance, monitoring, enforcement, training, education, and budget. In addition to the mandated compliance monitoring program, WDNR field foresters conduct reviews and inspections before, during, and after Forest Practices activities.

- Adaptive Management

As stated in WAC 222-08-160, "The adaptive management program will be used to determine the effectiveness of forest practices rules in aiding the state's salmon recovery effort and provide recommendations to the board on proposed changes to forest practices rules to meet timber industry viability and salmon recovery."

The science-based adaptive management program complements the forest practices rules outlined in the FFR to protect fish and water quality in two ways: 1) by addressing near-term uncertainties with initial prescriptions and 2) ensuring that forest practices will continue to meet the ESA requirements over the long-term by improving knowledge and incorporating new information. This allows for changes to environmental protections to take place over time as we learn what is effective in promoting salmon recovery. This process is described in statute in WAC 222-12-045.

The Forest Practice regulations specify that changes to forest practices rules may occur through three avenues: 1) recommendations consistent with results from the scientifically based adaptive management process, 2) court mandates, and 3) legislative direction.

7.2.1.1.3 Additional Actions within the Scope of the FPHCP:

The following are additional actions within the scope of the Forest Practice Regulations that when properly evaluated and implemented could accelerate the recovery of salmon.

- Compliance and enforcement of forest practice regulations

Consistent with the Forest Practices Regulations, the state WDNR will maintain sufficient compliance and enforcement staff to enforce forest practice regulations within the Lake Ozette watershed. These activities should be carried out consistent with applicable local, state, and Federal laws and the stated objectives and intents of the FPHCP.

- Annual reports

WDNR will produce annual reports on FPHCP compliance for forest practices in the Lake Ozette watershed, including compliance with forest practices BMPs and forestry impact monitoring results, per HCP requirements. NMFS will work closely with WDNR to review annual reports and address and resolve perceived non-compliance issues. WDNR is encouraged to seek involvement of representatives from the Lake Ozette Steering Committee to investigate and address compliance issues.

- Seek funding for FPHCP monitoring and adaptive management

Coordinate, seek funding for, and implement FPHCP effects monitoring programs within the Lake Ozette watershed, and adaptive management actions based on monitoring results that complement implementation of recovery plan research, monitoring and adaptive management activities. Coordinate these activities closely with FPHCP Cooperative Monitoring, Evaluation and Research Committee (CMER), recovery plan, ONP, tribal, and county research, monitoring and adaptive management actions. Identify and link FPCHP monitoring and adaptive management to this recovery plan's monitoring and adaptive management activities (Chapter 8).

7.2.1.1.4 Proposed Voluntary Actions within the Scope of the FPHCP:

The following are voluntary actions within the scope of the Forest Practice Regulations that when properly evaluated and implemented could accelerate the recovery of salmon.

- Voluntary acceleration of restoration-related practices

Based on availability of funding and other resources and the results of in-watershed and /or CMER forest practice effects monitoring, timber companies may voluntarily accelerate, or, with approval, modify FPHCP practices to restore watershed processes sooner by, for example, leaving larger tributary buffers, upgrading roads, speeding road improvements, increasing rotation lengths, or other forestry management options.

Special emphasis should be given to carrying out these voluntary measures in Umbrella Creek sub-watershed, an important timber production area, and one of the two lake tributaries (including Big River) where a tributary spawning sockeye population is becoming established. Sub-basins that have the greatest potential to contribute sediment to beach spawning should be prioritized above other sub-basins.

- Removal of unneeded roads, consistent with the FPHCP.

7.2.1.2 WDNR State Land HCP

The WDNR manages 11 percent of the land base of the Lake Ozette watershed. In 1997, the WDNR and NMFS signed a habitat conservation plan (HCP) that covers 1.4 million acres of industrial timber lands managed by the state in western Washington. The WDNR HCP is a multi-species ESA section 10 agreement that uses a combination of conservation measures that are expected to minimize and mitigate the impacts of take of listed species covered by the HCP, including Lake Ozette sockeye. The HCP defines management of riparian areas and specifies buffer widths for all fish-bearing streams. Non-fish-bearing streams also have a specific buffer width. No commercial timber harvest is allowed in the first 25 feet of the riparian buffer. Other components of the HCP include protections for inner gorges and mass-wasting areas, watershed analyses, and road management practices. Details of the WDNR HCP are summarized at: http://www.nwr.noaa.gov/Salmon-Habitat/Habitat-Conservation-Plans/WA-Dept-Natural-Resources/index.cfm.

Recovery plan actions within the scope of the WDNR HCP:

- Continue WDNR annual reporting on forest practices covered by the WDNR HCP. Consider including the Ozette watershed in WDNR's statewide HCP effectiveness monitoring.
- Consistent with the WDNR HCP and its incidental take permit, WDNR will maintain sufficient compliance audit and enforcement staff to enforce forest practices regulations within the Lake Ozette watershed. WDNR is encouraged to seek involvement of representatives from the Lake Ozette Sockeye Steering Committee to regularly review implementation of the WDNR State Lands HCP and forest practice compliance with the HCP's regulations.
- WDNR is encouraged to implement lessons learned from effectiveness monitoring in other basins to promptly improve implementation of the WDNR HCP in Ozette.
- Coordinate WDNR HCP monitoring and adaptive management activities with implementation of recovery plan research, monitoring, and adaptive management activities.

7.2.1.2.1 Proposed Voluntary Actions within the Scope of the WDNR HCP:

The following are voluntary actions within the scope of the WDNR HCP that when properly evaluated and implemented could accelerate the recovery of salmon.

- Voluntary acceleration of restoration-related practices

Based on availability of funding and other resources, and the results of WDNR HCP forest practice effects monitoring in Lake Ozette watershed and/or in other basins, WDNR may voluntarily accelerate, or, with approval, modify WDNR HCP practices to restore watershed processes sooner by, for example, leaving larger tributary buffers, upgrading roads, speeding road improvements, increasing rotation lengths, or other forestry management options.

- Voluntary consideration of cumulative effects should address WDNR's ownership of land and the impact of potential harvest on Umbrella, Siwash, and Elk Creek sub-basins.

WDNR should consider evaluating the cumulative effects of other commercial timber harvests in the watershed when they are planning sales on state lands. Special emphasis should be given to carrying out these voluntary measures in Umbrella, Siwash, and Elk Creek sub-basins. These and other sub-basins that have the greatest potential to contribute sediment to beach spawning areas should be prioritized above other sub-basins.

- Removal of unneeded roads, consistent with the WDNR HCP.

7.2.1.3 Clallam County Zoning and Land Use

The Lake Ozette watershed is entirely within Clallam County. Implementing and/or enforcing the county zoning and land use regulations can make an important contribution to protecting water quality and freshwater resources.

- Enforce all County rules pertaining to small landowners along Big River: specifically, zoning laws, critical areas ordinances, and development in the 100-year floodplain and/or CMZ.
- Enforce state laws restricting cattle access to rivers to protect water quality.
- Implement Clallam County critical areas ordinance and storm water management rules.
- Enforce county zoning laws limiting septic tanks that are hydrologically connected to water courses (e.g., where a leach field is draining directly into river).
- Enforce State Water Right Laws that limit the location of water withdrawals (e.g., illegal surface water diversions).

- Accurately delineate floodplain and channel migration zones. Protect floodplains and channel migration zones from development and incompatible land use activities through application of the WDFW hydraulic code and county land use regulations.
- Work with ONP, private timber companies, WDNR, Tribes, and other interested parties to develop conceptual modeling exercises to analyze potential scenarios of conversion of forest land to non-forest uses and the resulting potential impacts on the viability of Lake Ozette sockeye salmon. Based on this analysis, identify land use and management options that Clallam County can implement, while working within existing authorities and not affecting tribal treaty rights, to address future potential land conversion threats to Lake Ozette sockeye. The County will implement a preferred option, based on its resources and authority, to: (1) restore natural sediment production; (2) restore hydrologic processes and natural hydrologic variability; (3) and maintain and protect the lake and tributary riparian forests.

7.2.1.4 Clallam County Road Maintenance Plan

Adhere to Regional Road Maintenance Endangered Species Act Program Guidelines as per ESA 4(d) Rule protections.

7.2.1.5 Olympic National Park General Management Plan

The Olympic National Park (ONP) owns 15 percent of the Lake Ozette watershed, including Lake Ozette, its shoreline, and much of the land along the Ozette River. ONP's General Management Plan establishes a long-term vision for the future of the park, including its management philosophy and the framework used to make park management decisions (http://www.nps.gov/olym/parkmgmt/planning.htm). The General Management Plan describes desired resource conditions and visitor experiences for the park, and provides clear direction for resource preservation, visitor use, and proposed management strategies to achieve its goals. The last park-wide management plan was completed in 1976. In 2001, ONP began a public process to update its General Management Plan, which was completed in 2008.

The General Management Plan is a long-term plan that establishes and provides a vision for the future of Olympic National Park, including the framework to be used for decision making and problem solving. Implementation of the approved plan could take many years and some components would require additional funding. The park would actively seek funding based on planning priorities; however, there is no guarantee that all of the components of the plan would be implemented.

Through the Olympic National Park GMP process, the park established parkwide policies and desired conditions based on laws, regulations, servicewide mandates and policies. The resources described in the GMP related to the Ozette watershed include: wilderness management and protection; ecosystem management; water resources, rivers and floodplain, and wetlands protection; native species management and protection; exotic plant management and eradication.

The following programmatic actions relate to the Ozette watershed:

- Implement ONP's General Management Plan within the ONP boundaries in the Lake Ozette watershed.
- Implement the ONP's General Management Plan preferred alternative to move the campground or sites within the campground to protect shoreline habitat.
- Continue to follow NPS policies and regulations. Implement specific actions and strategies in the Lake Ozette watershed based on the General Management Plan and wilderness management policies. Future development and/or restoration projects will consider the protection of the Ozette watershed and fisheries habitat.
- Protect wetlands and riparian habitat in the Ozette watershed.
- Control exotic and invasive plants using the National Park Service's Exotic Plant Management Team, park staff, volunteers, and other partners within Olympic National Park and throughout the Lake Ozette watershed.
- Identify specific ways to fund and implement sockeye recovery plan actions through research partnerships, management actions, and communication with the public.
- Seek voluntary partnerships with Clallam County, private timber companies, WDNR, Tribes, and other interested parties to develop conceptual modeling exercises to analyze potential scenarios of conversion of forest land to non-forest uses and the resulting potential impacts on the viability of Lake Ozette sockeye salmon. Based on this analysis, identify land use and management options that can be implemented to address future potential land conversion threats to Lake Ozette sockeye, while working within existing authorities and not affecting tribal treaty rights.

7.2.1.6 Olympic Coast National Marine Sanctuary Management Plan

Established in 1994 and administered by NOAA's National Marine Sanctuary Program, the Olympic Coast National Marine Sanctuary's Management Plan describes objectives for resource protection, research, and education programs: http://www.ocnms.nos.noaa.gov/. In 2008, the Sanctuary initiated a process to review and update its management plan. Healthy estuarine and nearshore habitat is an important component of sockeye life history. Therefore, continued implementation of the Olympic Coast National Marine Sanctuary Management Plan is important to protect nearshore habitat for sockeye salmon recovery.

Recovery plan actions within the scope of the Olympic Coast National Marine Sanctuary Management Plan:

- Continue to implement the Olympic Coast National Marine Sanctuary's Management Plan, particularly as it relates to nearshore habitat management and research activities.

- Identify nearshore habitat data and research needs for sockeye recovery that may be addressed in cooperation with the Olympic Coast National Marine Sanctuary research programs.
- Seek funding to carry out cooperative research and management actions identified in Chapter 8, Adaptive Management, Research, Monitoring, and Evaluation, with the Sanctuary, NMFS Northwest Fisheries Science Center, and other interested parties or institutions.
- Share information and data collected by the Sanctuary with parties implementing the Lake Ozette Sockeye Recovery Plan.
- Cooperate and seek funding for public education and outreach materials and activities to promote public awareness about sockeye recovery.
- Implement the Coast Guard's Northwest Area Contingency Plan in response to any oil spill within the Sanctuary.

7.2.1.7 Washington State Department of Fish and Wildlife Hydraulic Code

Washington Department of Fish and Wildlife (WDFW) is responsible for preserving, protecting, and perpetuating all fish and shellfish resources in the state. In 1949 the state Legislature adopted a state law known as the "Hydraulic Code" to help WDFW carry out this mission. The Code requires individuals, organizations, or government agencies that want to carry out construction projects that will use, divert, obstruct, or change the bed or flow of state waters to do so with a permit issued by WDFW (http://apps.leg.wa.gov/RCW/default.aspx?cite=77.55). A sample of activities that may be conducted in the Lake Ozette watershed that need a hydraulic code permit include stream bank construction; construction of piers or docks[3]; culvert installation; gravel removal; and log, log jam, or debris removal.

- Continue to implement and enforce the WDFW hydraulic code, with particular attention to gravel mining, fish passage projects, and culvert replacement projects.
- As per WAC 220-11-010, each application for a Hydraulic Project Approval (HPA) shall be reviewed on an individual basis. Therefore, require a site visit to inspect proposed job site for every HPA application to determine site-specific issues and technical provisions necessary for the protection of fish life and fish habitat.
- Encourage WDFW fisheries enforcement to prioritize habitat issues and strictly enforce WDFW hydraulic code.
- Use the Region 6 HPA Administrative Audit and Hydraulic Permit Compliance, Implementation, and Effectiveness Pilot Study as a template for how to improve the HPA permitting process in the Lake Ozette watershed.

[3] Construction of piers and/or docks within ONP (e.g., Lake Ozette) falls under the exclusive jurisdiction of ONP. Activities within ONP must comply with ONP permitting processes.

7.2.1.8 Washington State Department of Ecology

Washington Department of Ecology (DOE) is responsible for protecting, preserving, and enhancing Washington's environment, as well as promoting wise management of air, land and water resources. DOE's water quality program manages point source and non-point source pollution prevention and cleanup programs, stormwater management, and financial assistance for jurisdictions to improve and protect water quality. The Federal Clean Water Act (CWA) requires DOE to assess statewide water quality and to identify water bodies that fail to meet water quality standards in its Water Quality Assessment Report. Assessment Reports include the CWA 303(d) list of impaired waters of the state and the CWA 305(b) statewide assessment of water quality.

- Advocate further involvement of WDOE in assessing baseline water quality conditions in Lake Ozette watershed.
- Encourage WDOE to prioritize the Lake Ozette watershed for immediate 303(d) assessment and advocate for watershed level studies (e.g., for TMDL).
- Enforce State Water Right Laws that limit exempt wells to less than 5000 gallons per day.

7.2.2 Habitat Protection and Restoration-Enhancement Projects

The habitat protection, restoration, and enhancement projects described below include both broad-scale conceptual projects and site-specific projects. Collectively, the actions described below address a portion of the recovery strategies presented in Chapter 6 (other recovery strategies are addressed in other portions of Chapter 7). Where recovery strategies are directly linked to the actions below, a notation within parentheses is included within text linking the recovery strategy to the action.

7.2.2.1 Broad-Scale Sediment Reduction Projects

The following actions may be carried out as part of the voluntary actions under the FPHCP or WDNR HCP, or by other landowners not covered by these HCPs.

- Quantitatively assess sediment production impacts from logging (gully creation, debris flows, landslides), road building, LWD removal, and other land use activities in Priority Subbasins I, II, and III. Develop program to reduce land use related sediment inputs.
    - Implement rigorous sediment reduction and retention program designed to reduce coarse and fine sediment delivery to the Ozette River (see Sediment Processes).
    - Use the results of subbasin-scale sediment budgets (see broad-scale actions) to define the relative contribution of different sediment sources and target specific sites for restoration activities.

- Where interest, willing landowners, and funding exist, purchase land from willing sellers in Priority Subbasins I, II, and/or III and manage land to recover watershed processes and ecosystem function for sockeye salmon recovery.
- Develop a voluntary comprehensive "green" forestry program at the landscape scale that promotes ecosystem function and watershed process recovery. Research programs and identify potential voluntary forestry program options to achieve sockeye recovery goals.
- Reconnect floodplains in Priority I and II Subbasins by reintroducing LWD to all tributaries to improve floodplain connectivity and sediment deposition/storage.
- Plant or under-plant conifer riparian forests in fields and disturbed hardwood zones to increase bank rooting strength, increase hydrologic roughness, and aid in sediment storage/deposition (see Section 7.2.2.4.2).
- Eradicate non-native plants (e.g., knotweed) in the riparian zone and replace with native species more effective at protecting soil and banks (see Section 7.2.2.4.2).

7.2.2.2 Hydrologic Restoration Projects

- Quantitatively assess hydrologic impacts from land use and large wood removal activities and develop a distributed hydrologic model calibrated for each tributary in conjunction with Ozette River hydraulic model to prioritize actions needed to improve natural hydrologic functions where needed (RS#8).
    - Based on modeling results, remove and/or disconnect hydrologically connected road systems via road decommissioning (full removal), abundant road cross-drain installation, and adequate culvert sizes at tributary crossings to ensure passage of LWD, sediment and water at the 100-year flood.
    - Agree on any proposed large wood placement actions designed to restore natural hydraulic conditions and maintain the natural range of lake level variability (see Sections 7.2.2.3 and 7.2.2.3.1) when producing the Implementation Schedule (see Section 9.1). Decisions regarding large wood placement actions will balance the biological needs of sockeye with considerations of social and economic effects on residents in the Ozette watershed. All actions will be considered in coordination with Olympic National Park, WDNR, WDFW, co-managing Tribes, WRIA 20, land owners, and other relevant entities and agencies.
    - Based on modeling results, restore or improve permanent vegetative hydrologic maturity throughout watershed.

7.2.2.3 Large Woody Debris (LWD) Placement Projects

Large woody debris may be root wads or trees fallen into or across the channel. It is beneficial in the following ways:

- In all forested rivers and streams, LWD plays a key role in shaping the channel.
- It creates pools and hiding places, providing salmon with protection from predators.

- It helps filter sediment to provide clean gravel for spawning.
- It provides organic matter to feed the small invertebrates that salmon feed on.
- Streams with adequate riparian vegetation and LWD on banks and in the channel are more resilient to catastrophic floods and help maintain a stable, healthy channel.

It is understood, however, that LWD projects need to be carefully evaluated and thought through to make sure that benefits accrue and that potential damage or future problems are foreseen, prevented, or mitigated.

The following projects are proposed because they address limiting factors, respond to recommendations in research studies (e.g., Herrera 2005), and provide scientifically based actions to improve sockeye viability. These actions are recommended for consideration when developing the Implementation Schedule (see Chapter 9). Actions should be selected after careful consideration of both the biological needs of sockeye salmon and the social and economic needs of residents in the Ozette watershed, in coordination with Olympic National Park. During the implementation phase of the recovery plan, all actions will be further defined, options analyzed, costs identified or refined, permitting needs identified, and decisions made in coordination with relevant permitting agencies and the public.

7.2.2.3.1 Broad-Scale LWD Placement Projects

Throughout the last century, and particularly in the last 60 or 70 years, LWD was removed from the Ozette River and tributaries in the belief that its removal would help the fish or that it would reduce flooding. However, the research evidence now indicates that LWD removal, in combination with other factors, has affected water quality (Hypothesis 2), Ozette River streamflow (Hypothesis 3), and Ozette River habitat conditions such as pool depth, pool volume, and cover (Hypothesis 4). It has also contributed to lower average lake levels and resulted in increased vegetation along the lake shore (Hypothesis 6). Historically, LWD was also removed from portions of the lake shoreline. This removal affected the shoreline hydraulics, resulting in reduced localized turbulence around wood. Shoreline wood functions to cleanse gravel locally and scour colonizing vegetation through turbulence. Without wood, vegetation can more effectively colonize bare soil and trap fine sediment, reducing substrate size and habitat suitability.

Adding large wood to rivers, streams, or shoreline can help to recover natural processes in the short-term; however, to restore long-term watershed health, these measures should be accompanied by strategies to allow trees to mature in the riparian area and, in the long-term, to fall naturally. With that proviso, the following broad-scale actions are recommended:

- Place LWD structures in selected sections of the lower Ozette River to enhance habitat complexity, help prevent/hinder harbor seal migration into the lake, and provide cover for migrating sockeye salmon to help reduce predation.

- As may be recommended by modeling results (Section 7.2.2.2), add large wood to some parts of the upper 1.3 miles of Ozette River to restore natural hydrologic conditions and maintain natural range of variability of lake levels in order to improve beach spawning habitat.
- Reconnect floodplains by reintroducing large wood in all tributaries to improve floodplain connectivity, water retention, and peak flow attenuation.
- Add LWD accumulations in the mainstem of Umbrella Creek to re-activate its floodplain where disconnected and store suitably sized spawning gravels where absent (see Section 7.2.2.3.2).

1. Lower Ozette River

Placement of LWD in the Lower Ozette River relates to Hypothesis 1: Predation by marine mammals in the Lower Ozette River is a limiting factor for Lake Ozette sockeye.

- Placing LWD structures in the lower Ozette River would help prevent or hinder harbor seal migration into the lake.
- LWD would also provide cover for migrating salmon and help to reduce predation.

2. Upper 1.3 miles of Ozette River

Adding LWD in the upper 1.3 miles of Ozette River would help to restore natural flow patterns and maintain a natural range of lake levels in order to improve beach spawning habitat (indicated according to preliminary studies by PWA 2002; Herrera 2005; 2006; and Brummer et al. 2006). This should be considered only after implementing the following recommended additional studies (#3 below).

3. Additional studies

Before starting any large wood placement project in the Ozette River directed at restoration of hydrologic conditions, implement the following actions[4]:

- **Identify current flood hazards and potential flood risks around the lake.** Determine risk for flooding and options to address landowner concerns about lake levels and their property. Many of these concerns were discussed during the November 2007 NOAA/landowner meeting at Clallam Bay. A summary of this meeting is included in Appendix C. Use this information to evaluate proposed recovery actions when developing the Implementation Schedule (Section 9.1).
- **Refine hydrologic model.** Improve the hydraulic model for design of instream structures and evaluating potential flood hazards around the lake. Better floodplain definition may be needed, especially in cross-sections in the upper reach. Although the model calibration was deemed suitable for purposes of this

[4] Note: the following bulleted actions apply only to large wood placement in the upper 1.3 miles of the Ozette River, where it would affect lake levels. LWD placement in the lower Ozette River would not affect lake levels.

phase II study (Herrera 2005), it should be refined for the final design and for detailed flood prediction purposes.

- **Determine the effect of increased lake levels on property and infrastructure.** Perform a topographic survey of flood-prone areas around Lake Ozette and the Ozette River, such as the ONP ranger station facilities and individual residences along the lake. Reprocessing the LiDAR data should greatly assist in this analysis. Additional surveys should be tied into the control established by CTS Engineers in October 2003. The results of the topographic survey will be compared with simulated lake elevations and durations to estimate the degree of potential flood risks at flood-prone locations.
- **Identify a range of options for large wood placement** based on the refined hydrologic model and flood hazard analysis, together with the costs and benefits associated with each option, and ways to minimize unintended impacts of large wood placement.
- **Identify potential projects** to be evaluated for the Implementation Schedule based on balancing the biological needs of sockeye with the social and economic effects on local residents. Potential projects should consider implementing these recommendations when developing projects:
    - **Establish reference spawning areas.** Survey actual spawning locations and elevation zones; beach slope; substrate types; vegetation types, elevation zones, and conditions; and ordinary high water mark. This information will be used to further analyze the existing results from the hydraulic modeling to make more detailed site-specific estimates of impacts on the existing spawning habitat that are associated with changes in lake levels and to determine design criteria and goals for future enhancement and restoration efforts.
    - **Evaluate and select restoration sites.** Evaluate the existing, historically active, and potential spawning area locations to develop a prioritized list of spawning areas (existing and potential) to be targeted during restoration. This assessment will also define the favorable hydraulic regime in these target locations. Survey potential spawning area locations and elevation zones; beach slope; substrate types; groundwater/hyporheic conditions; vegetation types, elevation zones, and conditions; and ordinary high water mark.
    - **Develop shoreline vegetation plan.** Assess passive versus proactive plan for removal of shoreline vegetation that encroaches on lake shore, focusing on substrate cohesion and impacts on spawning. Experiments in vegetation removal would be done to better understand the difference between sediment mobility with and without vegetation. A timeline for beach recovery would be developed for either scenario. Development of any such plan must consider state-listed threatened and sensitive aquatic plants species that are found in Lake Ozette.
    - **Analyze the social and economic effects** of each potential project and refine these options during development of the Implementation Schedule (Section 9.1).

4. Umbrella Creek

Fish habitat and LWD conditions in Umbrella Creek were intensively monitored and measured in 1999 and 2000. Researchers found that there are areas where there is not very much LWD, the stream channel is unstable, and there is little suitable spawning gravel. The plan recommends considering reintroducing LWD to several channel segments with the intent to stabilize the channel and restore spawning gravels. The following section details these recommendations.

7.2.2.3.2 Site-Specific LWD Placement Projects

Habitat and LWD conditions were intensively monitored and measured; the results are presented in detail in Haggerty and Ritchie 2004. Figure 7.1 depicts LWD conditions at the watershed scale. Within Umbrella Creek, several channel segments have been identified where LWD conditions are poor and suitable spawning substrate sizes are absent due to degraded channel conditions. Within these wood-starved reaches, LWD should be reintroduced with the intent to stabilize the channel and store suitably sized spawning gravels. Sites where this should be attempted or considered are included as thick red line segments in Figure 7.2.

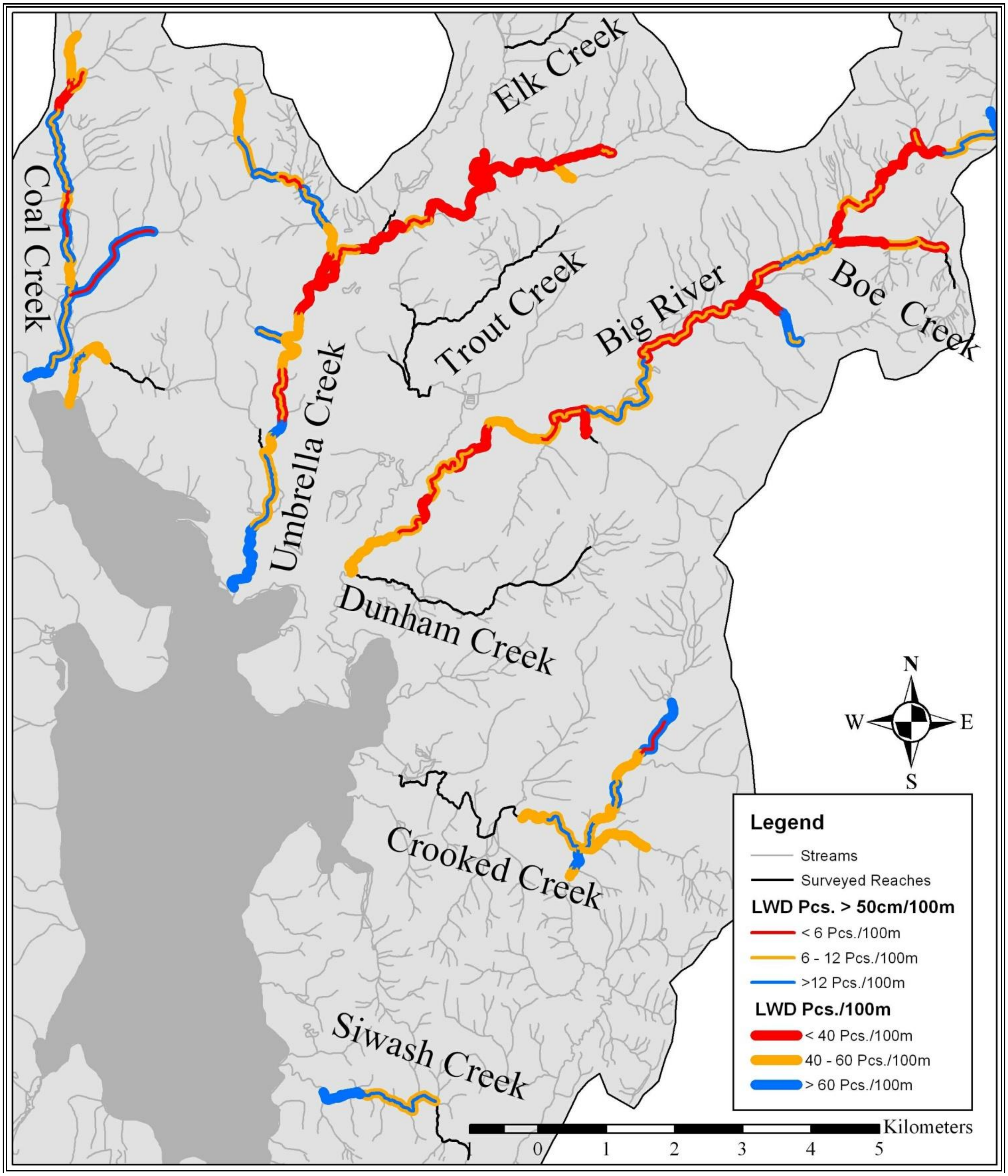

Figure 7.1. Overview of LWD conditions measured in 1999 and 2000 in major tributaries to Lake Ozette (source: Haggerty and Ritchie 2004).

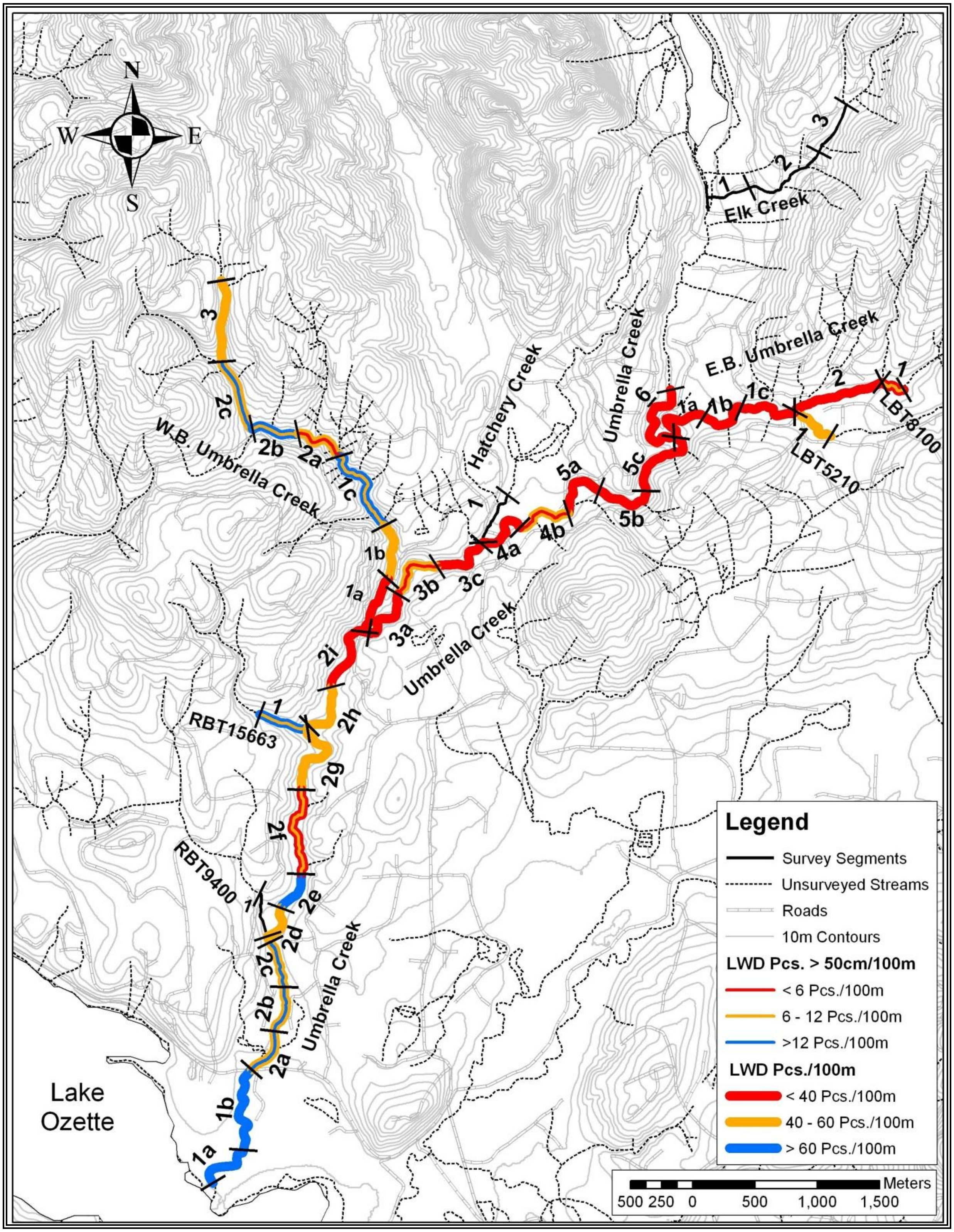

Figure 7.2. LWD conditions measured in 1999 and 2000 in Umbrella Creek, thick red lines depict sites where LWD reintroduction should be considered (source: Haggerty and Ritchie 2004).

7.2.2.4 Riparian and Floodplain Restoration Projects

The approach used in this plan for riparian and floodplain processes and condition recovery is to implement the recovery strategies presented in Sections 6.2.6 (RS #15), 6.33 (RS#21), and 6.4.4 (RS #29, 30, 31, and 32) by taking the actions described below. Note: Any plantings within Olympic National Park must be done according to NPS Management Policies, i.e. using native genetic stock.

7.2.2.4.1 Broad-Scale Riparian and Floodplain Restoration Actions

- Conduct a high resolution, detailed survey of the lake shoreline and riparian zone documenting non-native plant species. Develop program to eliminate non-native, invasive plant species (RS#21). These activities should be conducted in cooperation with ONP.
- Plant or under-plant conifer riparian forests in fields and disturbed hardwood zones (RS#15, 29).
- Within Lake Ozette tributaries, eradicate non-native vegetation (RS#21, RS#30).
- Reconnect floodplains by reintroducing LWD to all tributaries where LWD is deficient and floodplain connectivity is impaired in order to improve floodplain connectivity, sediment storage, water retention, and peak flow attenuation (RS#32).
- Relocate the county road where the road affects floodplain connectivity or reduces functionality of riparian processes (RS#31).

7.2.2.4.2 Site-Specific Riparian and Floodplain Restoration Actions

Site-Specific Riparian-Floodplain Action #1 (RS#15)

Plant native conifer tree species along the right bank of the Ozette River as depicted in Figure 7.3. Where feasible, establish a minimum 200-foot-wide riparian forest managed to mature sufficiently to provide longterm LWD recruitment. Maintain planting until trees are free to grow. Remove or relocate infrastructure within 200 feet of river’s bankfull edge, where feasible (addresses RS#15). Total length of the treatment reach is approximately 2,800 ft. Total area of the location proposed for treatment is approximately 11.1 acres.

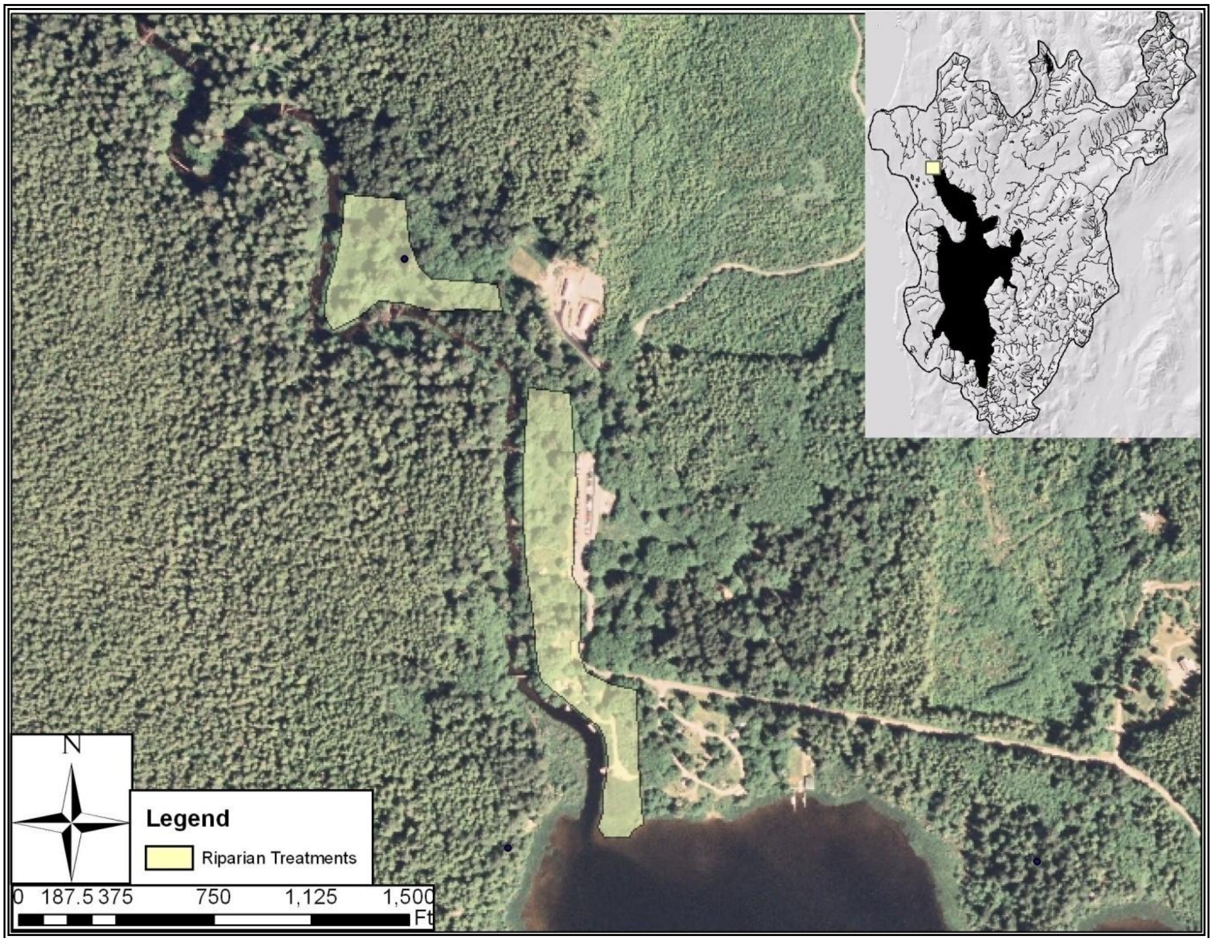

Figure 7.3. Riparian treatment areas adjacent to upper Ozette River.

Site-Specific Riparian-Floodplain Action #2 (RS#31)

The LFA identifies numerous riparian and floodplain impacts within the Big River watershed (e.g., riparian road density >17mi/mi^2 in channel segment 1). Riparian-Floodplain Action #2 addresses riparian-floodplain infrastructure in segment 1 and sub-segments 2a-2h (2.8 river miles total). Within 200 feet of the bankfull edge of Big River from segment 1 to 2h (as classified in the LFA and Haggerty and Ritchie 2004), there are approximately 9,800 feet of riparian-floodplain road and 900 feet of riprap. Riparian forest conditions are variable and include mature conifer and alder, as well as young alder. However, most of the riparian forest is dominated by either young red alder or strips of mature red alder.

- Identify riparian-floodplain infrastructure impairing the riparian floodplain function in this reach of Big River (Figure 7-4).
- Relocate a portion of Hoko-Ozette Road affecting floodplain. The road is elevated above the floodplain and bisects the flood path of both Big River and Trout Creek, limiting floodplain function. Figure 7.4 depicts a conceptual route for realignment of the Hoko-Ozette Road out of the immediate riparian-floodplain of

the Big River. In addition to relocation, the road should be constructed so that it does not hinder flood water movement between Big River and Trout Creek.

- Other road segments colored purple in Figure 7-4 should be considered for removal and replanted with the appropriate mix of conifer and alder trees. The Swan Bay Road and bridge also function to disconnect flood waters from the floodplain; this issue may be resolved by reconstructing the road in a manner that allows for free passage of flood waters across the floodplain.
- The Hoko-Ozette Road segment located just upstream of the map shown in Figure 7.4, at the confluence with Solberg Creek, should also be considered for a realignment outside of the Big River riparian area.

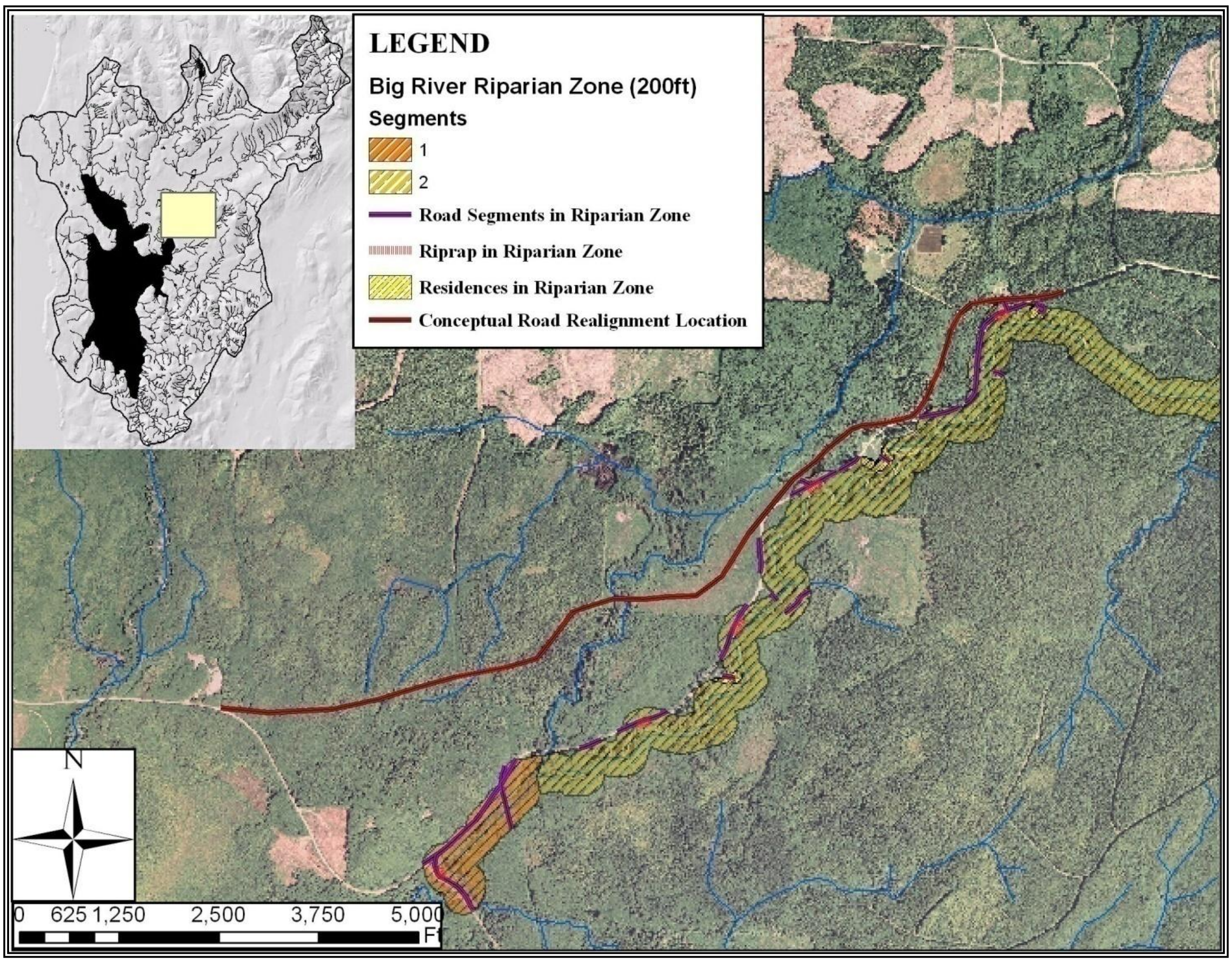

Figure 7.4. Map depicting Big River channel segments, roads, riprap, and residences within 200 feet of bankfull edge and the conceptual location of Hoko-Ozette Road realignment.

Site-Specific Riparian-Floodplain Action #3 (RS#31)

Plant the appropriate mix of native conifer and deciduous tree species in the pastures depicted in Figure 7.5. Establish a 200-foot-wide riparian forest where feasible; this may require property acquisition or a conservation easement to compensate the landowner. Maintain plantings until trees are free to grow (RS#29). If cattle are going to graze in the remaining pasture, then a fence should be installed to prevent their access to the river. Remove or relocate unneeded infrastructure within 200 feet of river's bankfull edge (addresses RS#31). Total length of riparian planting treatment is approximately 1,800 feet (right bank) (RB) and 2,600 feet (left bank) (LB). Total area of treatment is approximately 9.1 acres. If downstream infrastructure is relocated and floodplain processes restored, then this stream reach should receive an LWD treatment aimed at reconnecting the channel and floodplain. LWD piece counts in habitat segment 3f were among the lowest measured in Big River.

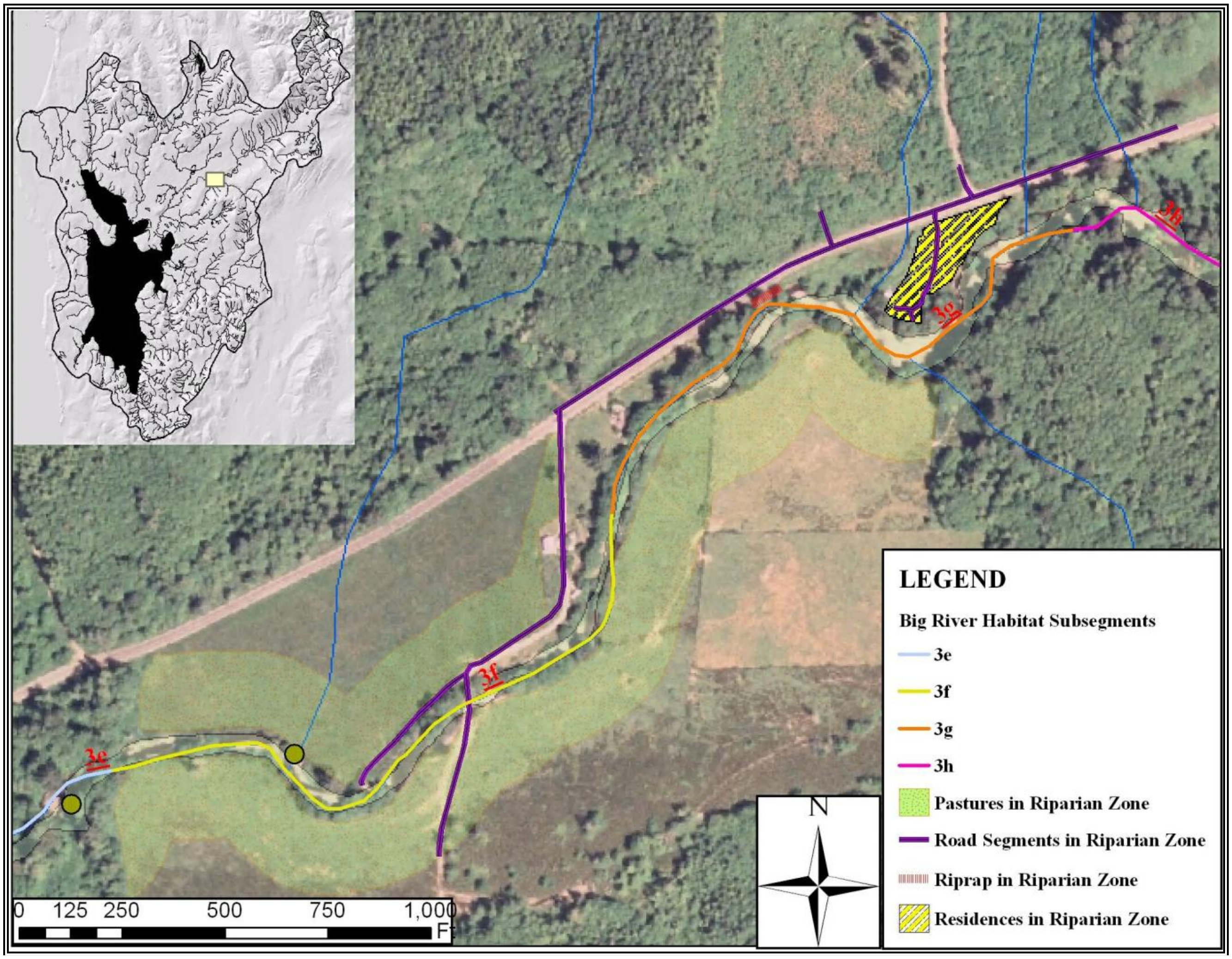

Figure 7.5. Map depicting Big River habitat segments 3f and 3g with pastures, roads, riprap, and residences within 200 feet of the bankfull edge.

Site-Specific Riparian-Floodplain Action #4 (RS#31)

Plant the appropriate mix of native conifer and deciduous tree species in the pastures depicted in Figure 7.6. Establish a 200-foot-wide riparian forest where feasible; this may require property acquisition and/or conservation easements to compensate the landowners. Maintain plantings until trees are free to grow (RS#29). If cattle are going to graze in the remaining pastures, then a fence should be installed to prevent their access to the river. Remove or relocate unneeded infrastructure within 200 feet of river's bankfull edge (addresses RS#31). Total length of riparian planting treatment is approximately 3,500 ft (RB) and 2,500 ft (LB). Total area of treatment is approximately 21.7 acres. If downstream infrastructure is relocated and floodplain processes restored, then this stream reach should receive a LWD treatment aimed at protecting banks from excessive erosion. Several homes are located along this stream reach; therefore, restoring floodplain connectivity using LWD introductions is not likely feasible. LWD piece counts in habitat segment 3i were among the lowest measured in Big River.

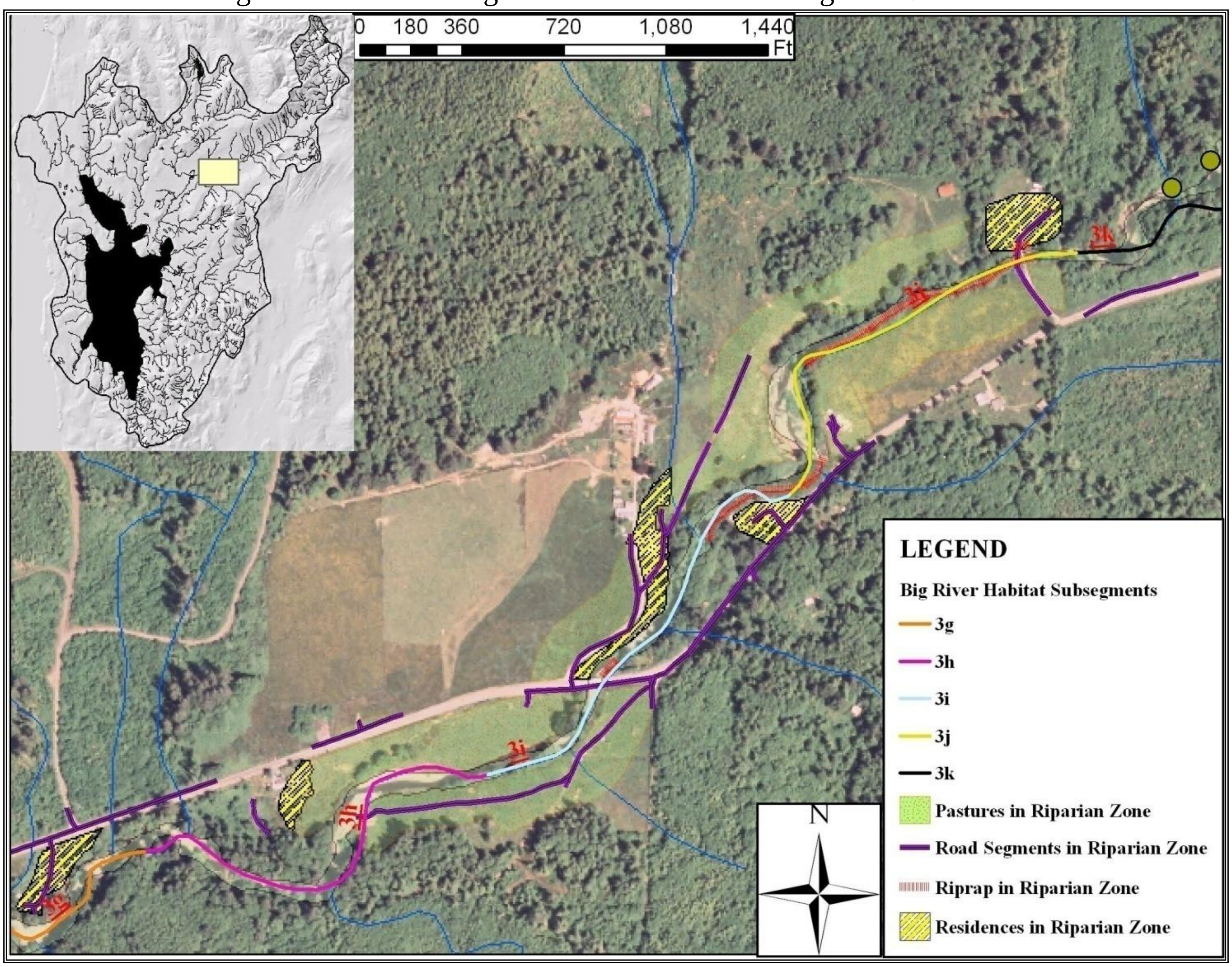

Figure 7.6. Map depicting Big River habitat segments 3h through 3j with pastures, roads, riprap, and residences within 200 feet of the bankfull edge.

Site-Specific Riparian-Floodplain Action #5 (RS#31)

Plant the appropriate mix of native conifer and deciduous tree species in the pasture depicted in Figure 7.7. Establish a 200-foot-wide riparian forest where feasible; this may require property acquisition and/or conservation easements to compensate the landowners. Maintain plantings until trees are free to grow (RS#29), and manage for long-term natural LWD recruitment. If cattle are going to graze in the remaining pasture, then a fence should be installed to prevent their access to the river. Remove or relocate unneeded infrastructure within 200 feet of rivers bankfull edge (addresses RS#31). Total length of riparian planting treatment is approximately 1,850 ft (LB). Total area of treatment is approximately 7.1 acres. If downstream infrastructure is relocated and floodplain processes restored, then this stream reach should receive a LWD treatment aimed at protecting banks from excessive erosion. A few homes are located along this stream reach (habitat segment 4a,); therefore, restoring floodplain connectivity using LWD introductions is not likely feasible. LWD piece counts in habitat segment 4a were the lowest measured in Big River.

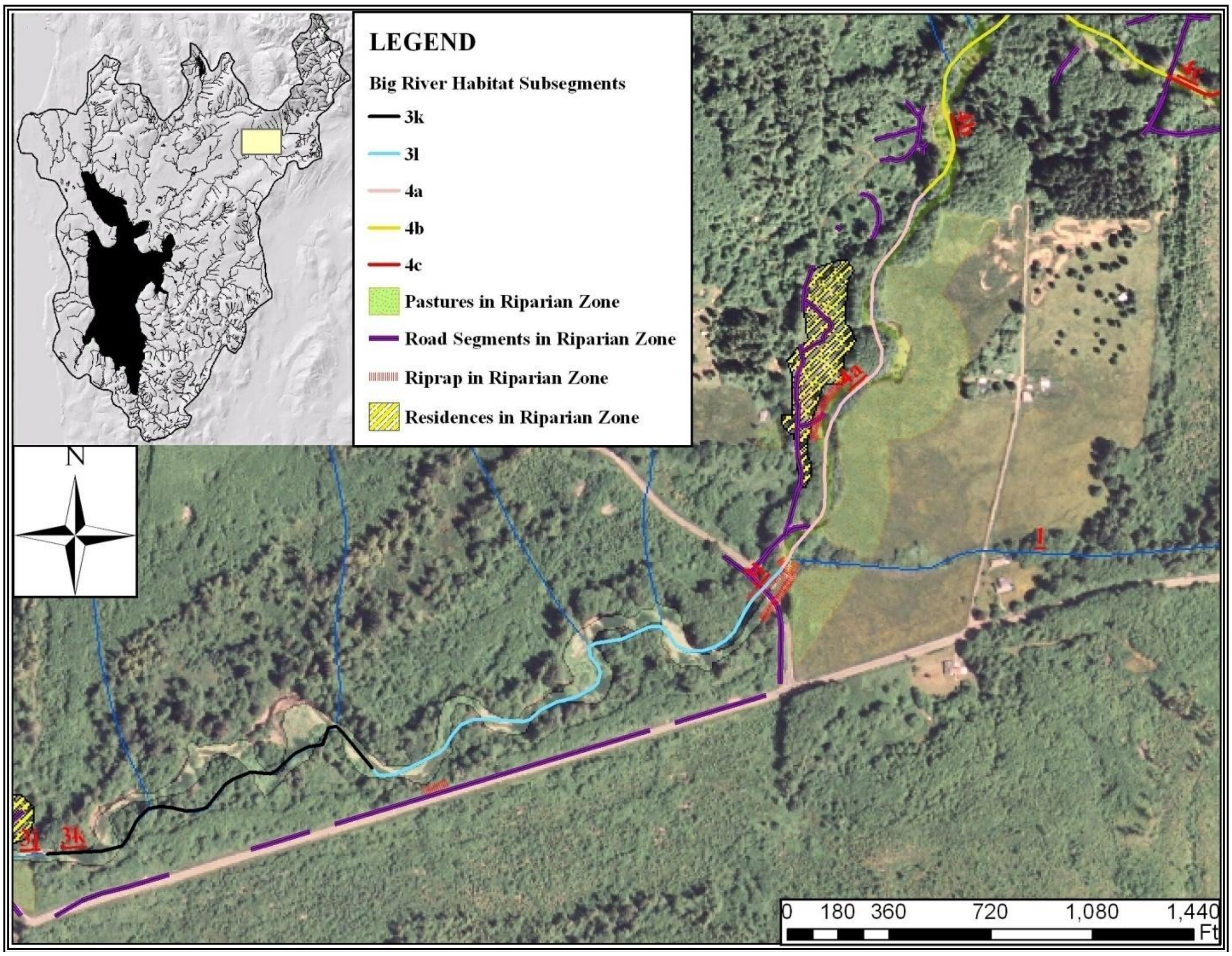

Figure 7.7. Map depicting Big River habitat segments 3k, 3l, 4a, 4b, and 4c with pastures, roads, riprap, and residences within 200 feet of the bankfull edge.

Site-Specific Riparian-Floodplain Action #6 (RS#30): Invasive Plant Species Eradication

In 2004, Clallam County began to control knotweed on the WDNR and Barber properties on the Big River (around segment 2h in Figure 7.8). This was followed by a cooperative knotweed control project in partnership with the Makah Tribe in 2005 and 2006. During these two years, two treatments of knotweed control were conducted on the entire stretch on the Hoko-Ozette Road, Big River, and Boe Creek. It is estimated that it will take at least 3-4 more years to completely eradicate knotweed from the Big River system. Figure 7.8 depicts known knotweed sites along the Big River from surveys conducted in 2006. There are several other species of noxious weeds present in this watershed (Himalayan blackberry, tansy ragwort, reed canary grass, morning glory) and these weeds should be opportunistically controlled when encountered. Continued efforts by the Makah Tribal, Clallam County, Quileute Tribal, and ONP noxious weed control programs should focus on eradicating noxious weeds and reestablishing native riparian forests with the help of private landowners and others.

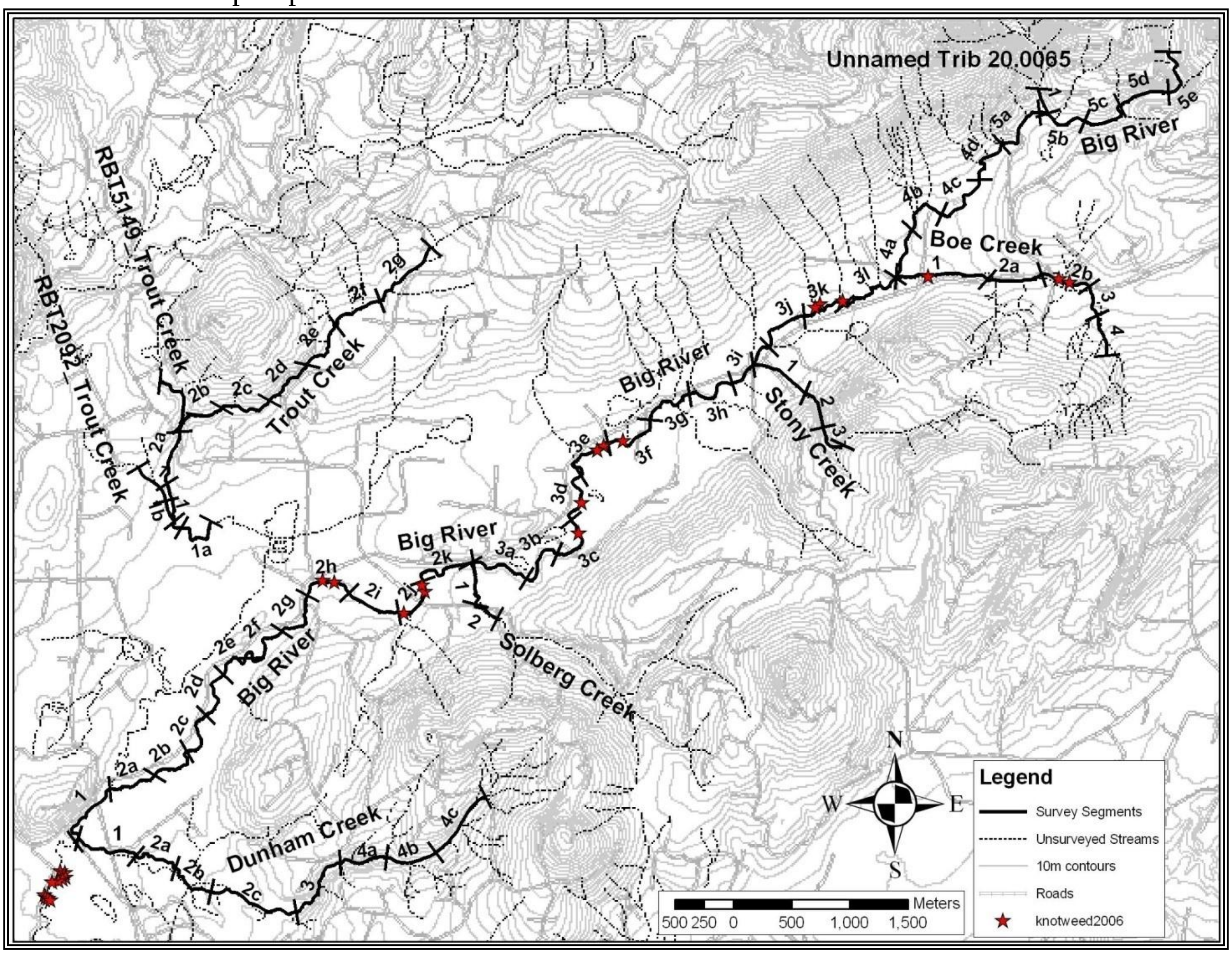

Figure 7.8. Big River habitat segments and 2006 mapped knotweed locations (knotweed source data provided by Makah Forestry).

7.2.2.5 Spawning Habitat Restoration and Enhancement Projects

The following proposed projects are conceptual in nature and will need to be refined during development of the Implementation Plan. Any recovery action will need to be developed and implemented in cooperation with appropriate landowner(s). All activities on private property will require the prior written permission of the landowner(s).

- Develop comprehensive program to restore beach spawning habitat at Umbrella Beach (in addition to Umbrella Creek recovery efforts). After improving habitat conditions on the beach, implement an experimental sockeye re-introduction program (see Section 7.3.1.5).
- Identify other potential sockeye beach spawning habitats and attempt re-introducing sockeye salmon in conjunction with habitat and watershed process rehabilitation efforts as described in Sections 7.3.1.5 and 7.3.2.1.4. Habitat enhancement projects may include the placement of downed trees on spawning beaches to promote gravel storage and sorting, mobilization and transport of fine sediment, and increased hyporheic flow, as well as mechanical improvements of beach spawning areas (see Section 7.3.2.1.3).
- Within sockeye spawning tributaries such as Umbrella Creek, implement LWD placement concepts described in Section 7.2.2.3.
- Develop a shoreline habitat restoration plan, including vegetation removal, gravel cleaning, and beach restoration actions at selected shoreline project sites. The plan should include flood protection measures for areas that were identified as flood-prone. Involve volunteers to carry out actions as part of the public education and outreach actions (see Section 7.6).

7.2.2.6 Conservation Easements and Land Acquisition

Land acquisition from willing sellers and establishment of conservation easements are two useful conservation and habitat management tools that could be applied to improve sockeye salmon habitat. Community land trusts or other private or local governmental organizations could acquire land from willing sellers within the most important subbasins within the watershed and manage these systems to protect and/or restore ecosystem functions.

- Where interest, funding, and willing sellers exist, purchase land within Ozette watershed and restore and actively manage for old-growth unroaded conditions. The priority for such subbasin conservation is as follows.
    - Umbrella Creek
    - Big River
    - Tier II subbasins
    - Tier III subbasins
- If acquisition does not occur, develop conservation easements with willing landowners to promote ecosystem function and watershed process recovery with management objectives focused on aquatic ecosystem restoration.

7.3 HATCHERY SUPPLEMENTATION ACTIONS

The following actions need to be coordinated with NMFS, ONP, state and tribal co-managers, and/or other relevant entities to receive necessary permits and meet applicable standards.

7.3.1 Short-Term Actions

The short-term approach applied in this plan regarding the use of artificial propagation (i.e., hatcheries) for recovery purposes incorporates all actions and requirements specified in the Makah Tribe's 2000 Lake Ozette Sockeye Salmon Hatchery and Genetic Management Plan (HGMP) (MFM 2000), and in the NMFS 2003 ESA 4(d) Limit 6 approval for the hatchery plan (NMFS 2003). The HGMP, as approved by NMFS, applies supplementation methods based on the best available science to establish natural, self-sustaining sockeye salmon aggregations in two major Lake Ozette tributaries (Umbrella Creek and Big River), using the indigenous Lake Ozette stock as broodstock. These supplementation and sockeye salmon aggregation establishment actions are summarized in Section 2.5 of this plan. The approved HGMP also includes extensive research, monitoring, and evaluation actions designed to track the effects of the plan on Lake Ozette sockeye salmon and to identify stock status, life history, and behavioral information critical for use in recovery planning. Research, monitoring, and evaluation actions conducted under the HGMP and proposed for application over the short-term in this plan, are summarized as management actions in Chapter 8. The results from these research, monitoring, and evaluation actions will be applied to adjust the HGMP. The adaptive nature of the HGMP (as specified in the ESA approved plan [NMFS 2003]) will be applied to ensure that the hatchery and research approaches are consistent with recovery needs and criteria identified in this plan.

In the short-term, implementation of the hatchery actions specified in the HGMP should assist in meeting ESU recovery goals identified in this plan. HGMP goals of establishing self-sustaining tributary spawning aggregations and avoiding hatchery intervention for the beach spawning aggregations are likely to benefit population abundance, spatial distribution, and diversity parameters for Lake Ozette sockeye salmon (NMFS 2003; NMFS 2004), and should assist in meeting VSP criteria developed by the PSTRT (Rawson et al. 2008) to define a viable sockeye ESU.

In its 2003 ESA 4(d) Rule Limit 6 determination for the HGMP, NMFS found that the sockeye salmon supplementation strategy focusing on establishment of self-sustaining tributary spawning aggregations and risk reduction measures applied through the program were adequately protective of the listed sockeye salmon ESU, that they were likely to benefit prospects for recovery of the ESU, and that they would not appreciably reduce the likelihood of its survival and recovery (NMFS 2003). In a subsequent evaluation of the effects of the HGMP on listed sockeye population viability, NMFS concluded that the plan benefited three of four VSP attributes (McElhany et al. 2003) for the listed ESU (NMFS 2004). NMFS found that the abundance of naturally spawning sockeye salmon in the ESU was increased by the tributary hatchery program, as evidenced by the establishment of adult returns in Umbrella Creek. The HGMP actions were determined unlikely to contribute to the abundance of natural-origin fish produced in beach-spawning areas, but naturally spawning hatchery-origin sockeye were leading to the production of natural-origin adult fish in Umbrella Creek. The hatchery plan was also unlikely to benefit or affect natural beach-spawning sockeye salmon productivity, but naturally spawning hatchery fish in Umbrella Creek appeared to be enhancing overall productivity in the ESU boundaries. Fry releases through the program in Umbrella Creek had returned adult spawners above replacement levels, as evidenced by establishment of adult returns in Umbrella Creek that are sufficient in most recent years to meet broodstock collection needs and seed natural habitat.

ESU spatial structure has been enhanced through reintroduction of spawners in tributaries that have been vacant for decades (NMFS 2003). NMFS concluded that genetic diversity of the beach-spawning population was being safeguarded from hatchery effects coincident with operation of the hatchery programs through application of appropriate hatchery protocols. NMFS judged that ESU diversity had benefited from the creation by the hatchery program of genetic reserves through establishment of tributary spawning aggregations originally derived from the beach-spawning population. However, given the intent to terminate the tributary hatchery programs after 12 years (see Section 2.5), NMFS determined that the viability of natural populations and extinction risk to the ESU will soon depend entirely on performance of natural-origin populations in their available habitat. Based on this evaluation of population viability effects, and considering application of criteria specified in NMFS' Hatchery Listing Policy (70 FR 37204, June 28, 2005), the hatchery-origin sockeye salmon produced through the HGMP were included as part of the Lake Ozette sockeye salmon ESU, and listed, with the natural beach spawning population, as "threatened" under the Federal ESA through NMFS' updated species status review in 2005 (70 FR 37160, June 28, 2005).

For these reasons, the ESA-approved actions specified in the HGMP, including all risk-reduction measures, are adopted in this plan as the appropriate short-term artificial propagation measures for application in the recovery of the Lake Ozette sockeye salmon ESU. Implementation of the approved HGMP through this recovery plan, in concert with actions addressing the major limiting factors to recovery, is expected to benefit achievement of the recovery goals identified in this plan for the listed ESU.

The focus of short-term recovery actions involving hatcheries will be on the continuation of on-going programs in the Umbrella Creek (Umbrella Creek Hatchery) and Big River (Big River Remote Streamside Incubators) (RSIs) watersheds, with the goal of establishing naturally spawning, self-sustaining tributary aggregations. Therefore, through 2012, the recovery-directed hatchery program will include the following actions, summarized here and fully described in the Lake Ozette sockeye salmon HGMP (MFM 2000). The NMFS ESA authorization document for the supplementation plan also describes the hatchery programs, highlighting operational measures that will be applied to reduce hatchery-related hazards to listed sockeye salmon population viability (NMFS 2003).

7.3.1.1 Sockeye Salmon Broodstock Selection and Collection Actions

Adult sockeye salmon returning to Umbrella Creek will continue to be the brood source for the tributary hatchery programs. Prior to 2004, sockeye salmon were collected from Lake Ozette spawning beaches for artificial propagation. Progeny of these fish were planted in Lake Ozette and in several tributaries, and were the source broodstock for present tributary returns. Under the approved HGMP, the tributary hatchery program relies only on adult sockeye salmon returns to Umbrella Creek to sustain the program. The lake spawning sockeye salmon population will not be used under the short-term recovery approach as broodstock for supplementation and reintroduction. However, a small number of adult sockeye salmon may be collected from Lake Ozette each year for research purposes only.

Sockeye salmon used as broodstock for the tributary hatchery program will continue to be trapped in Umbrella Creek as returning adults originating from past hatchery releases or from naturally spawning hatchery-origin returns. Up to 200 adult sockeye salmon adults (plus 10 percent or 20 fish if needed to account for inadvertent pre-spawning mortality) may be trapped and retained in lower Umbrella Creek each year using a weir. Weir collections may be augmented by seining of gravid fish upstream of the weir if necessary to meet annual broodstock requirements. Broodstock will be collected in Umbrella Creek from October through December, encompassing the spawner entry period. Sockeye salmon broodstock will be collected as the fish arrive at the trap location, proportional to the timing, weekly abundance, and duration of the total return to the creek. Collection protocols allow for the random selection of broodstock that is representative of the total tributary return, without bias towards origin (first generation hatchery or natural origin adults), return timing, fish size, or fish age. Fish will be transferred for holding through spawning at Umbrella Creek Hatchery in circular tanks. Alternatively, sockeye adults may be spawned on-site at the point of capture, with gametes transported for incubation at iso-incubation facilities, as specified in the HGMP.

7.3.1.2 Sockeye Salmon Broodstock Spawning Actions

Broodstock spawning procedures will continue to be conducted in accordance with NMFS guidelines for artificial propagation under the ESA (Hard et al. 1992), and with co-manager fish health guidelines designed to reduce disease transfer and amplification risks (NWIFC and WDFW 1998. A partial factorial mating procedure using a four female by four male spawning matrix is applied through the program. Adult sockeye salmon spawned in each factorial mating are randomly selected from the pool of eligible ripe adults on each spawning date. This mating design was chosen to minimize the effects of inadvertent or advertent selection on the genetic diversity of the population. Specifically, this mating design lowers the risk of effective population size reduction, increases the probability of unique genetic combinations in the brood return spawned, and provides for back-up fertilization in the event of infertility of males spawned. Spawning will be accomplished at Umbrella Creek Hatchery, or potentially in Umbrella Creek, adjacent to the Umbrella Creek weir or seining locations. Gametes will be collected and stored in oxygenated plastic bags for transport to iso-incubation facilities at Makah NFH.

Approximately 305,000 unfertilized eggs will be collected from tributary-origin sockeye each year for incubation and the production of eyed eggs or fry for out-planting the following spring or summer into Umbrella Creek or Big River.

7.3.1.3 Juvenile Sockeye Salmon Rearing and Release Actions

HGMP protocols for incubation call for the use of iso-incubation quarantine units at Makah NFH or Educket Creek Hatchery. By iso-incubating all sockeye eggs at these locations (using individual incubators for each egg group), the eggs are provided enhanced protection from catastrophic loss and fish disease. Backup water supply systems, alarm systems, and on-site staffing at the hatcheries decrease the likelihood for egg mortality from power loss, flow loss, or flooding. Isolated incubation practices will continue to be applied (low egg incubation densities, sequestered and disinfected water supplies and discharges) to reduce the risk of fish pathogen amplification in the propagated sockeye salmon population (particularly IHN virus, which is endemic to Lake Ozette sockeye salmon). Eggs at both sites are incubated on pathogen-free water in bucket-style incubators through the eyed stage. All eggs are otolith marked using standard thermal marking procedures during incubation. Differentiating otolith marks are applied to various release groups (different release locations, rearing and release strategies, or life stages at release) to allow for assessment of origin and survival rates during smolt emigration and upon adult return. When reaching the eyed life stage, eggs destined for the production of unfed fry and fingerling sockeye salmon releases will be transported to the Umbrella Creek Hatchery, Umbrella Creek RSI, and Big River RSI for the short period from eyed egg incubation until hatching. Eggs and fry will be propagated at low densities using gravity-fed water from tributaries to Umbrella Creek and Big River. Upon swim-up (mid-April to late May), the fry will be ponded into rearing troughs and reared on an artificial diet, potentially supplemented with live feed as a natural rearing strategy. At the RSI sites, fry will be reared in 3-foot-deep troughs.

At Umbrella Creek Hatchery, fry will be retained in the troughs until successfully started on feed. The fry will then be transferred into 10-foot-diameter circular fiberglass tanks for approximately 60 days of rearing. Fed fry from all rearing locations will be reared to a final target average individual fish size of one gram. A proportion of the mass otolith-marked fry produced at Umbrella Creek Hatchery will also be marked with an adipose fin clip to allow for visual identification of the fish during smolt emigration and upon adult return. The proportion of sockeye salmon receiving an adipose fin clip each year will be sufficient to allow for statistically significant evaluations of adult fish straying to beach spawning locations.

Up to 80,000 fed fry will be released each year into Umbrella Creek (at the hatchery site and/or at the RSI site located upstream of the hatchery) between late-March and late-June at dusk. Sockeye salmon eggs from Makah NFH or Educket Hatchery will also be transferred to RSIs in the Umbrella Creek and Big River watersheds.

Up to 140,000 otolith-marked eyed eggs will be transferred for incubation and fry release each year into Big River, assuming average survival rates for adult tributary-origin sockeye spawned for the Big River program. Resultant fry will be allowed to volitionally emigrate from the RSIs into plastic raceways from mid-March to late April. Half of the annual Big River RSI sockeye fry production will be released from the raceways into the Big River as otolith-marked, unfed fry (average individual size of approximately 0.15 gram, or 3,000 fish per pound [fpp]) or "early" fed fry (average size of approximately 0.5 gram, or 900 fpp). These fry would not be additionally marked with an adipose fin clip, because their small size will preclude application of such a mark. Unfed and early fed fry are produced through the program for comparison of unfed fry, early fed fry, and later fed fry (one gram fingerling, or 453 fpp) survival rates to adult return. The remaining half of the annual hatchery production will be reared for 45 to 60 days on an artificial diet, partially supplemented with natural food, for release in the early summer as fingerlings (average individual size of one gram). A proportion of the fingerlings produced at the Big River site will receive an adipose fin clip mark to augment the otolith mark. The proportion marked with a fin clip will be sufficient to allow for evaluation of adult contribution and stray rates to beach spawning areas. The production of fingerlings at the Big River site will follow protocols applied for fed fry at Umbrella Creek Hatchery. A representative sample of adult sockeye salmon returning to the Big River will be examined for otoliths and fin clips to compare hatchery-origin unfed fry, early fed fry, and fingerling survival rates and to identify contribution rates for natural-origin sockeye salmon.

7.3.1.4 Hatchery-Origin Adult Sockeye Salmon Disposition Actions

The short-term hatchery approach under this plan will carry forth plans for the disposition of adult sockeye salmon specified in the Lake Ozette sockeye salmon HGMP. The effective number of sockeye salmon broodstock collected from Umbrella Creek each year will continue to be limited to 200 adults (plus 10 percent or 20 fish if needed to account for pre-spawning mortality). Up to 10 additional adult sockeye salmon may also be collected from the lake spawning areas for use in research. The potential for possession of surplus adults and eggs or juvenile fish through the program will be low. Remaining adult hatchery-origin sockeye salmon will be allowed to spawn naturally in the Lake Ozette tributaries. Carcasses of spawners collected from Umbrella Creek and the lake will be returned to the stream or lake, respectively, after spawning. Return of carcasses to the tributary and lake will provide ecosystem-wide benefits through nutrient enrichment. The caudal fin will be removed from carcasses returned to the natural environment to distinguish fish used for broodstock from carcasses of naturally spawned fish during spawner abundance surveys. No adult sockeye will be retained through other monitoring and evaluation and research activities planned in the HGMP. Adult sockeye trapped in the Ozette River for sockeye salmon migration and spawning behavior evaluation purposes will be released after biological sampling and tagging are completed. The majority of these fish will spawn naturally in the Lake Ozette Basin.

7.3.1.5 Beach Spawning Aggregation Supplementation Research

Under the approved HGMP carried forth in this recovery plan, artificial propagation of sockeye salmon is confined to two Lake Ozette tributaries, and supplementation of beach areas is avoided. The approach in the short-term is to allow the beach spawning populations to recover without hatchery intervention. This approach assumes that other recovery actions in the watershed will result in improved beach incubation conditions, and acknowledges the need to obtain better information regarding beach spawning population abundance levels and spawning locations. NMFS approved research to determine egg survival rates on Lake Ozette sockeye salmon spawning beaches (NMFS 2003) as a means to identify the degree to which incubation survival conditions were a limiting factor for ESU recovery. NMFS also authorized the annual removal of up to 10 adult fish from beach spawning areas for use as broodstock supplying eggs used in beach survival research. No actions, however, will be implemented on private property without the prior written permission of the landowner(s).

As identified in Sections 4.2.1 and 5.4.2 in the LFA document, spawning and incubation conditions in known, extant beach spawning areas are impaired. Although recovery actions now underway and planned in the watershed are expected to substantially improve processes affecting beach conditions for sockeye salmon, it is uncertain whether the beach spawning aggregation survival and productivity will improve naturally and without human intervention. In particular, deleterious water quality and fine sediment levels in known spawning areas may continue to limit survival of beach spawning sockeye salmon. For example, high fine sediment levels accumulated on the beaches over time may not be alleviated because of the low numbers of sockeye spawners available for cleaning gravels through the act of spawning each year. Several potential alternative methods for improving sockeye beach spawning habitat conditions, survival, and productivity through artificial means are described below in the long-term action section (Section 7.3.2).

To prepare for the implementation of potential long-term actions to bolster survival and productivity of beach spawning fish, investigations of beach spawning sockeye supplementation will be implemented as short-term actions. The primary objective of this research will be to expand the number of effective tools available for recovering viable beach spawning sockeye aggregations on known spawning beaches by perfecting beach supplementation techniques. Completion of this research will allow for the potential use of beach supplementation as a future action on a larger scale and perhaps at known beach spawning sockeye locations, if beach spawner survival and productivity cannot be improved naturally. Specific, initial actions would involve collection of the following kinds of improved data:

- beach spawning aggregation abundances at known and newly discovered sites
- precise beach locations where sockeye salmon spawn in Lake Ozette
- beach conditions available to sockeye in identified spawning locations
- egg and fry survival rates in beach redds
- factors affecting sockeye egg and fry survival at the specific locations

- identification of suitable new locations in Lake Ozette, where habitat conditions for spawning and incubation may support introduced beach spawning aggregations

An additional short-term research action will be identification of a suitable pilot location where beach supplementation could be tested. The basic concept would be to seed artificial redds with eyed sockeye salmon eggs on a suitable, unoccupied beach removed from known, extant beach spawning aggregations. Habitat conditions at the beach would be fully documented prior to planting, with substrate conditions, beach gradient, and beach upwelling features noted. Mass, differentially otolith-marked eggs from Umbrella Creek Hatchery tributary-origin sockeye adults would be used as the brood source to avoid mining the extant beach spawning aggregations. Egg survival and fry emergence from the seeded beach would be monitored to estimate fry survival and abundance. Resultant adult sockeye returns to the beach would be enumerated and sampled for marks post-spawning. Changes in beach condition from pre-spawning conditions, including the degree of coarsening of spawning substrate where redds were constructed, would be documented.

A potential location for a pilot beach supplementation project is Umbrella Beach, near the mouth of Umbrella Creek. This site was historically used by beach spawning Lake Ozette sockeye, but it is not used at present. Watershed processes and habitat conditions in the Umbrella Creek watershed are being restored and enhanced to properly functioning conditions through the FPHCP (Section 7.2.1.1), the WDNR state lands HCP (Section 7.2.1.2), and other recovery plan actions (see Sections 7.2.2.1 through 7.2.2.6), so beach supplementation at the site would be integrated with planned habitat recovery strategies and actions. Umbrella Beach is at a distance from the two known beach spawning areas on the southern end of Lake Ozette, and the risk of research program adult fish straying would be further reduced by the location of the beach at the mouth of Umbrella Creek. If they were to stray, adult fish would more likely home to and enter Umbrella Creek, where they originated, and adjacent to where they were released as eyed-eggs.

7.3.2 Long-Term Actions

As described in Section 2.9, the proposed tributary hatchery program is expected to last 12 years, or three sockeye salmon generations, per release site. This limit in duration is intended to address the concern that repeated enhancement of the same population segment would result in a decrease in effective population size of the target population (WDFW and PNPTT 2000; Kapuscinski and Miller 1993). It also limits the exposure of natural-origin sockeye salmon to potentially deleterious selective effects of hatchery conditions to a few generations, minimizing the likelihood for divergence between hatchery and natural-origin fish within the supplemented stock. The completion of the initial 12-year period may be used to define the end of the short-term phase of the use of hatchery methods in Lake Ozette sockeye salmon recovery.

Longer term hatchery approaches may include several actions that are more fully described below. Options include termination or continuation of sockeye salmon tributary program production after the 12-year operational period, depending on the status of the programs in meeting criteria summarized in Section 2.9 for escapement and establishment of spawning aggregations. The successful establishment of self-sustaining natural spawning aggregations in Umbrella Creek and Big River may decrease the need for further artificial propagation in the watershed. It would also be important to consider whether or not commensurate improvements in the status of the core naturally spawning beach populations had occurred. If there are no improvements in the viability status of the beach spawning sockeye aggregations, the long-term approach may include implementation of enhancement approaches specifically designed to preserve and bolster beach spawner abundance and productivity. Potential methods include: mechanical improvement of spawning gravels in known beach spawning areas, creation of new beach-spawning sites with suitable spawning and incubation conditions, and (following on research described above in Section 7.3.1.5) the use of hatchery supplementation methods to increase the survival and production of eggs and fry at spawning beaches.

A decision on the appropriate long-term use of artificial propagation for the recovery of Lake Ozette sockeye salmon will need to consider many factors, including the following:

- Changes in the viability status of beach and tributary spawning aggregations in response to the implementation of short-term recovery actions, as measured by comparison of ESU abundance, diversity, spatial structure, and productivity with population viability parameters developed by the PSTRT and the co-managers, and adopted by NMFS as ESU delisting criteria;
- Observed or likely changes in the status of habitat-sustaining natural spawning aggregations in response to habitat-related protection and restoration actions applied over the short-term through this recovery plan; and
- Results of research, monitoring, and evaluation designed to identify the effects of short-term artificial propagation, habitat improvement, and other resource management actions implemented through the recovery plan.

The following section describes potential long-term options for the use of hatchery supplementation and other associated enhancement methods to recover the Lake Ozette sockeye salmon ESU to a viable level. Implementation of these and other enhancement-related actions within the boundaries of Olympic National Park will require review and approval of the action by Olympic National Park, and by NMFS if the action has the potential to affect listed sockeye salmon or the species' habitat.

7.3.2.1 Potential Long-Term Enhancement Actions

7.3.2.1.1 Termination or Continuation of Tributary Supplementation Programs

After 12 years of operation of the currently approved tributary hatchery programs (post 2012 for Umbrella Creek and post 2014 for Big River), and depending on co-manager agreement through the *U.S. v. Washington* Future Brood Document process, and the results of evaluations of the status of tributary sockeye salmon escapement, tributary population sustainability, and habitat in the tributaries, a decision would be made to either terminate or continue the supplementation programs on Umbrella Creek and Big River. Termination of the programs would lead to full reliance on natural production for the recovery of viable sockeye salmon aggregations in the tributaries. The benefits of program termination could include a reduced risk of hatchery-related hazards, such as genetic diversity reduction, for the tributary spawning aggregations. The risks of the approach include the potential loss of the aggregations, in the event that habitat conditions in the tributaries have not been improved to levels that will support self-sustaining sockeye salmon production. A decision to continue specific components of the HGMP beyond 12 years would be based on a review of the program to determine whether its goals and performance standards had been met, or were expected to be achieved if not yet fully accomplished.

Similarly, if aspects of the program were not meeting goals or standards, but alternative measures were identified that, if implemented, would be likely to achieve goals and standards providing a net benefit to the ESU, program elements would be changed and continued upon evaluation and reassessment before or after the 12-year evaluation. The overall goals and objectives for the supplementation programs will be reevaluated over the short-term duration of the programs to incorporate new findings. Tributary escapement goals and population abundance thresholds developed by the PSTRT and the co-managers, and applied as NMFS' recovery criteria in this plan, will be used as standards for determining whether program continuation is appropriate. The ability to meet minimum escapement and spawner distribution goals for the tributaries for each brood year will be considered in determining program continuance or termination.

7.3.2.1.2 Natural Colonization of Beaches

The long-term approach could include the decision to continue to forego use of enhancement, in particular, supplementation, as a means to recover healthy Lake Ozette sockeye salmon aggregations on the spawning beaches. Such a decision would be a continuation of the short-term approach, which is to confine the use of enhancement activities to the two major northern tributaries, where natural spawning aggregations are being established. The benefits of foregoing enhancement of the beach spawning aggregations include a reduced risk of hatchery-related hazards to the core spawning aggregations, including effects of broodstock removal on the remaining naturally spawning aggregations, and the potential for a reduction in their genetic diversity and natural spawning fitness as a consequence of taking the fish into hatchery propagation. Risks of foregoing supplementation include the continuation of spawner returns based on natural production that are low and/or downward trending in abundance, if the beach spawning populations do not respond to other recovery actions taken in the watershed. Decisions regarding whether to maintain the beach spawning aggregations without hatchery intervention over the long-term will be based on an assessment of the status of the aggregations, ensuring that they are maintaining above the critical abundance level and showing improvement in return levels year-to-year.

7.3.2.1.3 Mechanical Improvement of Beach Spawning Areas

One primary limiting factor affecting sockeye salmon egg incubation on the beaches is the reduction of spawning habitat quality and quantity from historical levels (Limiting Factors Analysis, Section 6.1.5.1) (Haggerty et al. 2009). As noted in Section 5.4.2.1.1.2 of the LFA, the small beach spawning aggregations that have persisted during the last 30 years may have been reduced to levels incapable of sufficiently cleaning spawning gravels of fine sediment and maintaining vegetation-free spawning gravels. In the absence of sufficient numbers of mass spawning sockeye, it might be effective to clean spawning gravels manually to increase the quantity and quality of beach spawning habitat. The objective would be to mimic the effects of mass spawning sockeye by manually or mechanically coarsening beach spawning substrate, reducing the percentage of fine materials (e.g., silt and sand). The percentage of “fines” (sediment particles less than 0.85 mm in diameter) in beach spawning area samples has been shown to be at levels that are detrimental to egg survival. The gravel could be cleaned during the summer months, when sockeye salmon are not using the beaches for staging, spawning, or incubation. A reduction in fines may be effective in improving spawning success and incubation survival rates, relative to current natural conditions. This type of enhancement is relatively unobtrusive ecologically, with very low risks of ecological, genetic, or demographic hazards to the beach sockeye salmon aggregations.

7.3.2.1.4 Creation of New Beach Spawning Locations and Stock Introduction

A potential long-term enhancement action would be to create new beach spawning locations in Lake Ozette, followed by natural colonization by sockeye or seeding of the new locations using hatchery methods. This action would respond to reduced spawning habitat quality and quantity as a primary limiting factor affecting sockeye salmon egg incubation on the beaches (LFA Section 6.1.5.1). Beach spawning by sockeye salmon is currently limited to two known beaches along the lake where habitat conditions are apparently suitable for spawning and incubation. Other beach areas are known to have been used historically by sockeye (e.g., Umbrella Creek beach). Beaches historically used by sockeye could be mechanically rehabilitated, if likely past causes of their degradation as spawning habitat were under control. New locations in Lake Ozette, where habitat conditions for spawning and incubation are identified as suitable, could be seeded with sockeye salmon eggs procured from Olsen’s Beach or Allen’s Bay spawners to initiate adult returns in subsequent years.

7.3.2.1.5 Supplementation of Beach Spawning Aggregations

As described in the Lake Ozette sockeye salmon HGMP (MFM 2000), a potential application of artificial propagation in the future could include supplementation of beach spawning sockeye salmon aggregations. Specifically, the HGMP states that the tributary-directed hatchery program and associated research actions are also designed to provide information on whether supplementation can potentially be used in the future to rebuild beach spawning aggregations, and to expand spawning in Lake Ozette to currently unused beaches. This potential use of hatchery methods is consistent with the long-term goal of the HGMP, which is to increase sockeye abundance to levels that will "meet future estimated escapement goals and culminate in sustainable fisheries." However, under the approach approved by NMFS, the method applied in the HGMP to pursue these goals over the short-term is the establishment of tributary-spawning sockeye salmon aggregations.

NMFS approved the HGMP under the ESA based on isolating the tributary supplementation program from the core beach spawning aggregations (NMFS 2003). A precautionary approach to supplementation that reduced the likelihood for unintended adverse genetic and ecological effects on the beach spawning aggregations was proposed, improved based on agency review, and implemented. The approved hatchery program relies on broodstock removed from Lake Ozette tributary sockeye salmon returns. The listed beach spawning population is not used as broodstock. Sufficient sockeye adults, both first-generation hatchery sockeye and natural-origin sockeye, return to Umbrella Creek to sustain the tributary hatchery programs. Adult sockeye salmon returns to the tributaries result directly from hatchery juvenile sockeye salmon releases, or from natural spawning by hatchery-origin adult sockeye salmon. Broodstock from the core, listed beach-spawning population is proposed to be collected only in low numbers and only for research purposes.

Under the HGMP, future determinations regarding whether sockeye broodstock are collected from Lake Ozette beaches to supplement or reintroduce lake aggregations would be made pending results of limiting factors evaluations and research. Only when it has been determined that hatchery supplementation is likely to aid recovery of the beach spawning sockeye aggregations, and that a successful method of supplementation is available, will the lake aggregations be considered for use in beach aggregation supplementation and/or reintroduction measures.

Although NMFS does not believe that supplementation of the extant beach spawning sockeye aggregations is warranted in the short-term, hatchery intervention may be considered if those aggregations do not respond to other recovery actions, remaining at critically low abundance levels, and/or continuing to trend downward in population size year to year. Potential supplementation methods could include collection of broodstock staging on the beaches for holding, spawning, and artificial propagation of progeny at facilities used for the tributary supplementation program. Eyed eggs or fry could be returned to the beaches (e.g., for incubation in Jordan-style incubators anchored to spawning gravels) to complete development, egress, and imprint. This approach would circumvent potential limiting factors affecting beach spawner success and egg and fry incubation and survival in the natural environment (LFA Section 6.1.5.1). The approach may increase the abundance of fry emigrating from the beaches into pelagic zones in Lake Ozette, thereby increasing the likelihood that more beach-origin smolts will survive to emigrate and return as adults. If a determination is made that supplementation of the beach spawning aggregations is warranted, specifics regarding the approach, including annual broodstock removal and fry production objectives, would need to be provided in an HGMP. Broodstock removal and fry production objectives would be limited by spawning habitat capacity and the need to maintain a proportion of the donor/recipient spawning aggregation in a natural condition. These limitations would be of lesser concern if the aggregations were at imminent threat of extirpation because of small population size.

7.4 PREDATION-RELATED RECOVERY ACTIONS

In addition to the piscivorous fish predation actions identified in Section 7.1.4.1, Freshwater Fisheries (RS #4), the following recovery actions are proposed to address predation-related impacts. Any predation control measures, however, will consider the impacts of each action on native species. (Note that any predator control activities that are proposed within ONP's boundaries will require approval of the ONP superintendent.)

- Create an incentive program, as appropriate within NPS regulations, to encourage or require lethal take of largemouth bass and other non-native fish species, with a goal of reducing or eliminating non-native fish species.
- Create fishing regulations that will limit take of native species while maximizing the removal of non-native species.
- Working in coordination with the National Park Service and NMFS, WDFW, and the Tribes, collect data regarding juvenile sockeye salmon and northern pikeminnow abundance in Lake Ozette (including the upper Ozette River), the species' spatiotemporal distribution by lake life stage, and northern pikeminnow diet composition. Use these data to help determine whether northern pikeminnow predation is significantly influencing sockeye production, considering annual reductions in the number of sockeye fry and smolts potentially caused by northern pikeminnow predation and the adult equivalent reduction in sockeye spawner returns to the lake attributable to pikeminnow predation on juvenile fish.
- Identify management options to reduce northern pikeminnow predation impacts if the sockeye predation levels or rates are determined to be substantial considering currently depressed total juvenile and adult sockeye abundance (e.g., if pikeminnow predation is estimated to reduce annual juvenile sockeye population abundance by 10-20 percent). Potential management responses, if deemed necessary based on prior impact evaluations, may include allowances by the National Park Service and the co-managers for culling of the northern pikeminnow population using traps, existing weirs, or hook and line methods in lake and river areas where sockeye juveniles may be most vulnerable to predation (e.g., the lake outlet during the sockeye smolt emigration period). The standing of the northern pikeminnow population as a native species in the Lake Ozette watershed, and the need to maintain the viability of this native fish population, must be factored into any plan calling for the species' removal as a sockeye predator control action.
- Work with NMFS, ONP, WDFW, and the Tribes to study impacts of marine mammals and river otters on sockeye salmon, particularly on beach spawning grounds. Based on this information, develop a NMFS-sanctioned plan to address

these impacts through a variety of predator control measures being tested in the watershed and used in the NMFS Northwest Region. Any predator control activities proposed within the boundaries of Olympic National Park will require approval by the Park's Superintendent.

- Working in coordination with NMFS, ONP, WDFW, and the Tribes, analyze the impacts of seals and sea lions on sockeye salmon and identify options to minimize these impacts, including reinstating ceremonial and subsistence hunting of seals and sea lions in Tribal Usual and Accustomed hunting and fishing areas.
- An option that will be investigated as a potential means to reduce harbor seal (and potentially sea lion) predation on sockeye salmon in the Lake Ozette watershed is placement and maintenance of a grated barrier within the lowest portion of the Ozette River, near where the river enters marine waters. The barrier will be designed to exclude pinnipeds from entering and transiting the river, while allowing for the unobstructed upstream passage of sockeye salmon. This recovery action will initially include completion of a feasibility study to identify permitting requirements, potential designs, site location options, logistical requirements (including operation timing and duration), and risks and benefits of barrier placement and operation to listed sockeye salmon recovery. Potential follow-up actions to develop, place and operate the barrier will be based on results of the feasibility study, and decisions made during the recovery plan implementation planning phase.
- Modify sockeye adult enumeration techniques at the Ozette River weir to reduce any predation mortality on adult and juvenile sockeye.
- Implement research and monitoring actions proposed in Chapter 8 to analyze fishing regulations, predator-prey interactions, and predation at all life stages for beach spawners.

7.5 RESEARCH, MONITORING AND ADAPTIVE MANAGEMENT ACTIONS

A plan for research, monitoring, and adaptive management will be developed in 2009 after NMFS adopts the Lake Ozette Sockeye Recovery Plan (See Chapter 8).

7.6 PUBLIC EDUCATION AND OUTREACH ACTIONS

Recovery of Lake Ozette sockeye depends on the collective actions of citizens in the region. Recovery actions will need to be implemented by diverse organizations, Tribes, Olympic National Park, individuals, private companies, and governmental entities, all striving for the common goal of sockeye recovery. Implementation will also, of course, depend on the availability of funds and staff time.

The goal of public education and outreach is to engage the public as an active partner in implementing and sustaining recovery efforts. This goal will be achieved by building public awareness, understanding, and support, and by providing opportunities for participation in all aspects of recovery implementation. This effort will also involve sharing information between scientists and the public as recovery projects and monitoring actions are carried out. An excellent example of educational materials developed for a similar sockeye population in Cultus Lake in British Columbia, Canada, can be found at: http://www.cultuslake.bc.ca/documents/Caring_for_Cultus_Lake.pdf

- Develop and implement an education and outreach program directed at anglers and the general public regarding the negative impacts of non-native fish and plants on native species, habitat, and the Lake Ozette ecosystem.
- In cooperation with co-sponsors, produce a 3-5 page summary brochure or handout describing the key parts of the Lake Ozette Sockeye Recovery Plan and highlighting the recovery actions that can be carried out by the public and landowners. Distribute the brochure to the public in cooperation with Olympic National Park, soil and water conservation districts, Clallam County, public libraries, schools, local businesses and Chambers of Commerce, and other organizations.
- Develop a clearinghouse of information about recovery plan implementation to keep partners and the public informed about recovery actions. The clearinghouse should include all relevant data and reports produced by implementing parties. This may be web based, in coordination with an annual "Sockeye Summit" to brief the public on status, progress, and achievements of recovery plan implementation.
- In cooperation with Clallam County, local Soil Water and Conservation Districts, and the Natural Resource Conservation Service, work with landowners in the watershed to provide information regarding the need to implement recovery actions and help identify appropriate recovery actions on landowner property.
- Produce educational materials that can be used in the local schools, community colleges, and community centers to educate children about needed recovery actions.
- Develop cooperative educational and outreach programs with existing organizations and nonprofit groups to include information about sockeye recovery in their materials.
- Develop exhibit materials that can be used at fairs, festivals, or other venues to communicate the recovery actions needed to protect and restore sockeye salmon.
- Work with Olympic National Park staff to develop materials, posters, and display boards to educate the public visiting Lake Ozette about the need to recover sockeye salmon and the recovery actions being carried out within the Park.
- Seek funding to carry out the proposed education and outreach actions. Develop a clearinghouse of information on funding sources. Support local entities, landowners, and Tribes to seek funding for recovery actions.
- Identify which entities and individuals will carry out the education and outreach actions.
- Develop public education information that can be posted on the NMFS, Olympic National Park, Olympic Coast National Marine Sanctuary, and Clallam County's

NPCLE web sites. Identify other opportunities for web postings of recovery information.

- Carry out briefings and presentations to civic, business, trade, environmental, and conservation organizations.
- Lead seasonal tours of the watershed so the public can observe spawning sockeye salmon and visit recovery project restoration sites.

7.7 RECOVERY STRATEGY AND ACTION INTEGRATION

The PSTRT's 2003 guidance for recovery planning emphasizes the importance of an integrated strategy that describes the types of habitat, harvest, and hatcheries measures that will lead to recovery. Such a strategy provides a set of specific, integrated actions for habitat, harvest, and hatcheries that are hypothesized to result in achieving the salmon population targets. The Lake Ozette Sockeye Salmon Recovery Plan is based on that concept, recognizing that habitat conditions and aquatic ecosystem function are a result of the interaction between watershed controls, watershed processes, land use, and human management regimes. Because this recovery plan is organized around population segments, clearly stated hypotheses, and biological processes associated with the entire ecosystem, including habitat, hatcheries, and harvest, it is inherently an integrated plan.

Recovery goals, strategies, and actions are linked to specific hypotheses about the factors limiting the Lake Ozette sockeye ESU. Flow charts were developed that depict the hierarchical strategy for prioritizing protection, restoration, and enhancement activities to address factors affecting each population segment (i.e., all population segments, beach spawners, and tributary spawners). Factors typically affecting salmonid VSP parameters, such as habitat, hatchery, and harvest management (the "H" factors), are addressed and evaluated within the context of the biological processes that create the survival conditions (the habitat) for the fish.

Appendix D integrates programmatic and site-specific actions with the applicable recovery strategies articulated in Chapter 6. The appendix presents the relative priority of actions across all H factors, based upon the recovery strategy hierarchy (Figure 6.4), subbasin prioritization, and limiting factors.

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8 ADAPTIVE MANAGEMENT & RESEARCH, MONITORING, AND EVALUATION

As recovery plans for the Puget Sound recovery domain were completed and the PSTRT products finalized, NMFS restructured the PSTRT into the Recovery Implementation Technical Team (RITT). The focus of the newly formed RITT is to provide technical guidance, analysis and products related to implementation of recovery plans in the Puget Sound recovery domain. In 2009, after NMFS adopts the Lake Ozette Sockeye Recovery Plan, NMFS will develop a detailed adaptive management and monitoring plan, together with an implementation plan, in coordination with the RITT, Lake Ozette Steering Committee, and co-managers.

8.1 ADAPTIVE MANAGEMENT

Because of the length and complexity of the salmonid life cycle, there are many uncertainties involved in improving salmonid survival. Simply identifying cause-and-effect relationships between any given management action and characteristics of salmon populations can be a scientific challenge. It is essential to design a monitoring and evaluation program that will answer these basic questions: How will we know we are making progress? How will we get the information we need? And how will we use the information in decision making?

As part of implementing the Lake Ozette sockeye salmon recovery plan, a detailed monitoring and evaluation program will be designed and incorporated into an adaptive management framework based on the principles and concepts laid out in the NMFS guidance document, *Adaptive Management for Salmon Recovery: Evaluation Framework and Monitoring Guidance* (available at http://www.nwr.noaa.gov/Salmon-Recovery-Planning/ESA-Recovery-Plans/Other-Documents.cfm).

Adaptive management is the process of adjusting management actions and/or directions based on new information. To do this, it is essential to incorporate a plan for monitoring, evaluation, and feedback into an overall implementation plan for recovery. The plan should link results (intermediate or final) to feedback on design and implementation of actions. Adaptive management works by coupling the decision-making process with collection of performance data and its evaluation. Most importantly, it works by offering an explicit process through which alternative strategies to achieve the same ends are proposed, prioritized, and implemented when necessary.

As outlined in the NMFS *Adaptive Management* guidance document, several types of monitoring are needed: (1) implementation and compliance monitoring, which is used to evaluate whether the recovery plan is being implemented; (2) status and trend monitoring, which assesses changes in the status of an ESU and its component populations, as well as changes in status or significance of the threats to the ESU; and (3) effectiveness monitoring, which tests hypotheses and determines (via research) whether an action is effective and should be continued. In addition, it is important to build in some research to illuminate the many unknowns in salmon recovery—the "critical uncertainties" that make management decisions all the harder. Critical uncertainty research may seem expensive or unnecessary in light of basic information needs; however, in the long run, it may reduce monitoring and implementation costs.

Implementation and compliance monitoring simply check on whether activities were carried out as planned, and whether specified criteria are being met as a direct result of an implemented action. For example, if a fence is planned for 2 miles of stream corridor to keep livestock off the stream banks so that riparian vegetation will rebound, implementation monitoring would verify the presence of the fence. Compliance monitoring would take note of the presence or absence of livestock in the fenced-off area.

Status and trend monitoring is a simple compilation of data-based descriptions of existing conditions. To be useful in decision making, the raw data, or metrics, must be reduced to a more directly applicable form or indicator. For example, if the question is "What is the annual population size of sockeye spawning in the Big River?" the indicator would be total spawning numbers of sockeye over one season for the entire subbasin; however, the metric, or directly measured thing, would be something quite different, perhaps live sockeye sighted on weekly passes within the indexed spawning grounds. Thus, the metric must be processed to translate it from the metric data type (e.g., observed sockeye) into the indicator data type (e.g., total spawners), and then reduced to generate the indicator required (e.g., "reduce" list of weekly counts on spawning grounds to annual total for watershed).

Effectiveness monitoring specifically addresses cause-and-effect questions. Demonstrating the direct and indirect impact of management actions requires supporting all steps in the logical chain that connects the action to its expected impact. This chain is rarely short and usually contains several hypotheses. For this reason, it is better to build the effectiveness monitoring into the recovery action strategies, with, for example, pilot-scale tests or other methods carefully thought out beforehand. Monitoring and evaluation will only provide the answers to the questions they were designed to address; they do not provide the framework for revising these questions if they are ill-posed, evaluating the assumptions upon which the strategy was built, or incorporating learning into future decisions on actions and strategies—this is the role of adaptive management.

NMFS' guidance document presents a decision framework that can guide the design of a research, monitoring, and evaluation plan. The framework (Figure 8.1) contains two basic sorts of questions: (1) questions regarding ESU status (biological viability criteria) and (2) questions regarding statutory listing factors and factors limiting recovery (limiting factor and threats criteria). Evaluating a species for potential delisting requires an explicit analysis of both types of criteria.

The guidance document contains a more detailed discussion of the framework and identifies the specific questions that must be answered to evaluate ESU status. These specific questions take the form of a series of decision-question sets that address the status and change in status of a salmonid ESU and the risks posed by threats to the ESU. The decision-question sets are designed to elicit the information NMFS needs to make delisting decisions. For recovery planners, the framework can guide future decisions about strategies and actions aimed at achieving recovery goals.

Designing an effective monitoring program for salmon recovery involves the following initial steps:

1. Clarify the questions that need to be answered for policy and management decision making. Include the full ESU and the full salmonid life cycle.
2. Identify entity or entities responsible for coordinating development of this program.
3. Identify:
    - Which populations and associated limiting factors to monitor
    - Metrics and indicators
    - Frequency, distribution, and intensity of monitoring
    - Tradeoffs and consequences of these choices
4. Assess the degree to which existing monitoring programs are consistent with NMFS guidance.
5. Identify needed adjustments in existing programs, additional monitoring needs, and strategy for filling those needs.
6. Develop a data management plan (See Appendix B of the NMFS guidance document).
7. Prioritize research needs for critical uncertainties, testing assumptions, etc.
8. Identify entities responsible for implementation.

The Lake Ozette sockeye salmon monitoring and evaluation program will build on existing programs designed for monitoring tributary and lake habitat, hatchery programs, and actions outside of the Lake Ozette watershed (e.g., ocean harvest). The Ozette sockeye monitoring and evaluation program will provide (1) a clear statement of the metrics and indicators by which progress toward achieving goals can be assessed, (2) a plan for tracking such metrics and indicators, and (3) a decision framework through which new information from monitoring and evaluation can be used to adjust strategies or actions aimed at achieving the plan's goals.

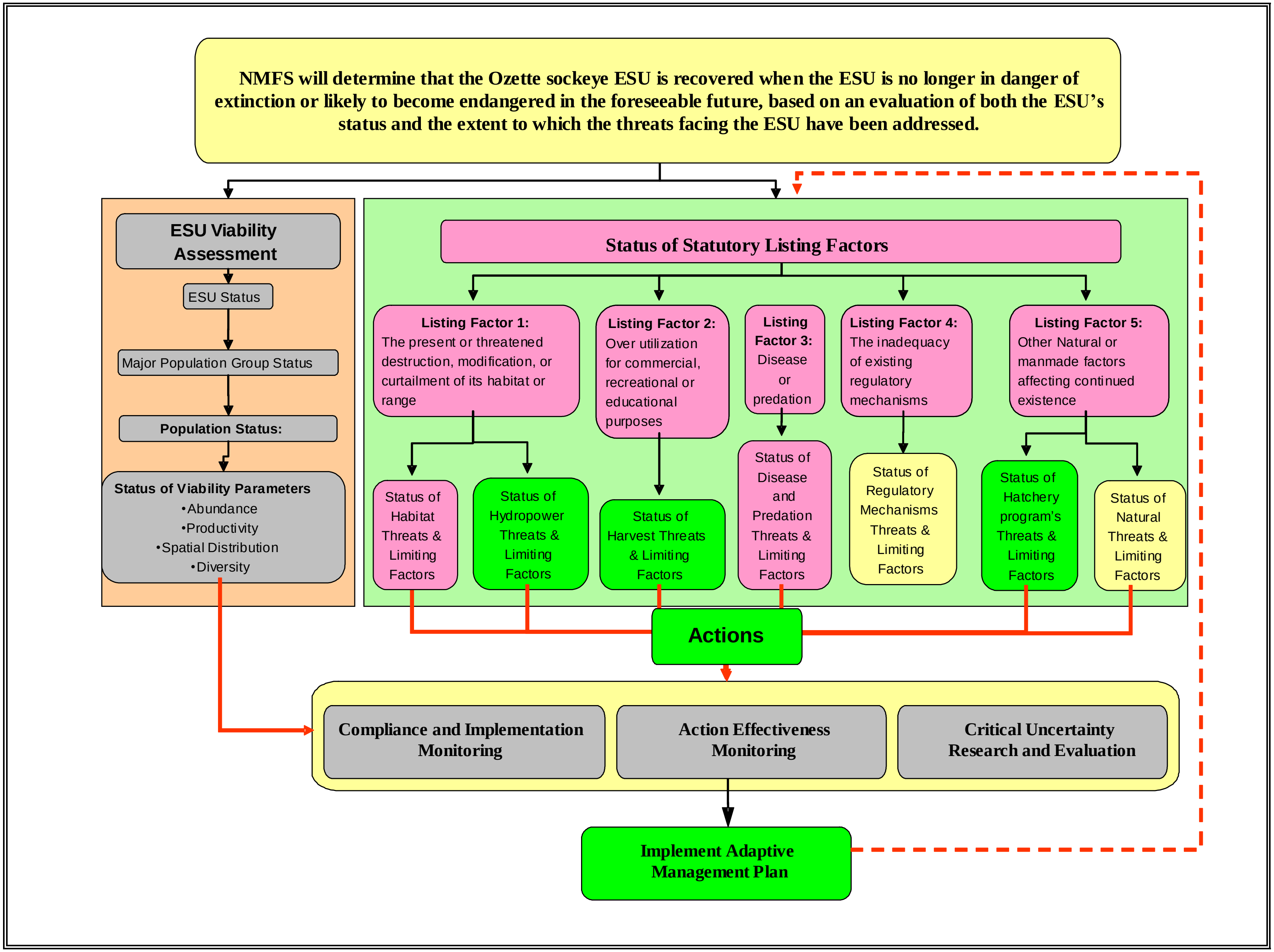

Figure 8.1. NMFS listing status decision framework.

8.2 RESEARCH AND MONITORING

The following table lists research, monitoring, and evaluation needed for long-term, effective decision making regarding Lake Ozette sockeye recovery. (Note that some of the recommended research and monitoring is already ongoing as part of the HGMP.)

Table 8.1. Research, monitoring, and evaluation needs for long-term decisionmaking (not prioritized)

RM&E ID	Affected Population Segment	Process or Condition to Investigate	Geographic Location	Description
RME#1	All Population Segments	Streamflow	Ozette River	Continue to monitor Ozette River streamflow. Investigate effects of reduced streamflow on run timing and sockeye fitness.
RME#2	All Population Segments	Sediment	Ozette River and Coal Creek	Continue to collect turbidity and SSC data in Coal Creek.
RME#3	All Population Segments	Thermal	Ozette River	Continue and expand Ozette River stream temperature monitoring program.
RME#4	All Population Segments	Biological	Lake Ozette and Ozette River	Continue and expand on all sockeye population monitoring (run size and timing, smolt production, spawning escapement, etc.). Conduct biological monitoring included in the LOS HGMP.
RME#5	All Population Segments	Biological	Lake Ozette and Ozette River	Develop and implement program to monitor and evaluate predator-prey interactions in Lake Ozette and the Ozette River.
RME#6	All Population Segments	Biological	Lake Ozette and Ozette River	Re-evaluate the impacts of Lake Ozette fishing regulations (e.g., non-retention of cutthroat trout)
RME#7	All Population Segments	Biological	Lake Ozette	Examine lake holding mortality factors and rates from predation, disease, and other factors.

RM&E ID	Affected Population Segment	Process or Condition to Investigate	Geographic Location	Description
RME#8	All Population Segments	Biological Limnological Conditions	Lake Ozette	Routinely collect standard limnological data. Include limnological monitoring focused on temperature, water quality, photosynthetic rates, and zooplankton communities and sockeye salmon.
RME#9	All Population Segments	Biological	Lake Ozette	Temporal and spatial distribution of sockeye fry remains unknown. It is generally assumed that Ozette sockeye fry quickly migrate to the pelagic zone upon emergence. Studies to determine nearshore habitat utilization after emergence could aid in understanding predator prey relationships, as well as food type and availability during the fry stage.
RME#10	All Population Segments	Habitat Condition #1	Ozette River	Do large logjams that form deep pools in the Ozette river provide important refugia habitat for adult sockeye salmon? Do deep pools provide thermal refugia habitat for adult sockeye? How do habitat complexity and/or simplification affect predation of adult sockeye?
RME#11	All Population Segments	Habitat Condition #2	Ozette River	Are there unique tidal prism influences that enhance or are detrimental to the sockeye life cycle? Quantify the changes in estuary volumes and habitat availability over time in response to altered spit morphology at the ocean mouth. Analyze sequential historic photos, in conjunction with field surveys. How has nutrient and salinity exchange changed in the estuary and how has this

RM&E ID	Affected Population Segment	Process or Condition to Investigate	Geographic Location	Description
				affected sockeye rearing and migration habitat?
RME#12	Beach Spawners	Sediment	Lake Ozette	Key questions include: Is there evidence of anthropogenic impacts on water quality in the lake? If so, to what extent have any changes affected beach spawning sockeye? Quantify seasonal Lake Ozette current and flow patterns, and their likely role in intra-gravel flow and sediment transport at known spawning beaches. Given this information, what are the seasonal patterns and concentrations of turbidity/SSC across the lake and along different beach habitats, especially during various storm events? What beaches/locations are more susceptible to habitat degradation caused by fine sediment deposition? Is water quality changing over time?
RME#13	Beach Spawners	Biological	Lake Ozette	What percent of beach spawners are consumed prior to spawning? Which predators consume more sockeye salmon? Do river otters forage on sockeye carcasses left by harbor seals?
RME#14	Beach Spawners	Biological	Lake Ozette	Investigate predation of emergent fry during their off-shore emigration from spawning beaches to the limnetic zone of Lake Ozette (e.g., coho salmon or pikeminnow predation)

RM&E ID	Affected Population Segment	Process or Condition to Investigate	Geographic Location	Description
RME#15	Beach Spawners	Biological	Lake Ozette	Continue and expand upon adult sockeye predation studies on spawning beaches. Key questions include: How many sockeye spawn each year on each beach? Are other beach spawning areas also utilized? Are secondary areas such as north Olsen's and Cemetery Point used each year and to what degree?
RME#16	Beach Spawners	Biological	Lake Ozette	How many kokanee or kokanee size *O. nerka* spawn annually with sockeye salmon on the beaches? What effect does this level of hybridization have on the population? Are there increasing numbers of kokanee spawning with sockeye on the beaches?
RME#17	Beach Spawners	Habitat Condition #3	Lake Ozette	Investigate several different methods of beach spawning habitat rehabilitation including: vegetation removal, gravel cleaning, LWD introduction, etc…Include sockeye egg survival studies with habitat manipulations.
RME#18	Beach Spawners	Habitat Condition #3	Lake Ozette	Develop a comprehensive understanding of the conditions, factors, and processes controlling egg-to-fry survival on sockeye spawning beaches. Increase the quantity and quality of beach spawning habitat.
RME#19	Tributary Spawners	Riparian	All tributaries	Conduct additional series spruce-alder mixture trials to compare density/proportion/ overstory thinning treatments on primary growth and resilience against pests.

RM&E ID	Affected Population Segment	Process or Condition to Investigate	Geographic Location	Description
RME#20	Tributary Spawners	Hydrology	All tributaries	Long-term streamflow data would allow for a better understanding of the impacts streamflow has on adult sockeye spawning locations in tributaries. Tradeoffs exist between spawning low in a cross-section and avoiding dewatering, compared to spawning higher in the cross-section and avoiding bedload transport and scour. High streamflow variability during the sockeye spawning and incubation period can result in reduced probabilities of successful egg-to-fry survival. Quantification of natural and human-included streamflow impacts on egg-to-fry survival in Ozette tributaries remains a major data gap.
RME#21	Tributary Spawners	Sediment	All tributaries	Collection of continuous turbidity and SSC measurements in all Ozette sockeye tributaries needs to be expanded upon over the long-term, with the goals of understanding the magnitude and duration impacts of high sediment loads on adult sockeye spawning in tributaries and detecting long-term (5-10+ year) trends in turbidity and suspended sediment concentration.
RME#22	All	All	All Tributaries	Develop and implement several projects that examine the effectiveness of HCP prescriptions and “rules” at restoring watershed processes and habitat conditions within the Ozette watershed.
RME#23	Tributary Spawners	Habitat Quantity	All tributaries	In many Ozette tributaries, the quantity of suitable spawning habitat area has been reduced as

RM&E ID	Affected Population Segment	Process or Condition to Investigate	Geographic Location	Description
				a result of the effects of LWD removal, reduced LWD recruitment, increased fine sediment inputs and abundance, channelization and bank armoring, gravel mining, and colonization of bar deposits by non-native vegetation. In some reaches of Big River and Umbrella Creek, spawning gravel beds have been completely converted to sand bed or cobble bed, respectively. No attempts have been made to quantify loss of available spawning habitat over time, which remains a data gap.
RME#24	NA	NA	All tributaries	Clallam County: monitor and report on regulated activities in Ozette watershed (e.g., track land use changes).
RME#25	NA	NA	All	Develop Internet-based database containing all datasets specific to Ozette sockeye and sockeye recovery efforts (e.g., streamflow, sockeye counts, water temperature).

RM&E ID	Affected Population Segment	Process or Condition to Investigate	Geographic Location	Description
RME#26	All Population Segments	Biological / Water Quality	Lake Ozette	Continue and expand upon investigative studies of mercury and other environmental toxins entering the Lake Ozette food web. Determine and monitor the levels of mercury and other environment toxins within Lake Ozette sockeye at all freshwater life history stages.
RME#27	All Population Segments	Biological	All	Further investigate the potential to use δ15N (heavy nitrogen/marine derived nitrogen) from lake sediment cores to estimate the size and variability in the historical sockeye salmon population.
RME#28	All Population Segments	Biological	All	Collect lake hydroacoustic data to help enumerate juvenile sockeye during their lake residence.

RM&E ID	Affected Population Segment	Process or Condition to Investigate	Geographic Location	Description
RME#29	All Population Segments	Biological	Nearshore Marine	Study the survival of juvenile and adult Lake Ozette sockeye salmon in the nearshore marine area adjacent to the mouth of the Ozette River.
RME#30	All Population Segments	Biological	All	Develop an interim ten-year sockeye salmon population goal which will allow NMFS, co-managers, and the public to evaluate the progress in meeting the Plan's overall viability criteria recovery goals.

9 IMPLEMENTATION SCHEDULE, RESPONSIBILITIES, AND TIME AND COST ESTIMATES

Successful implementation of the Lake Ozette Sockeye Salmon Recovery Plan's extensive list of recommended recovery actions and research and monitoring projects will require significant funds and cooperative, coordinated work on the part of Clallam County, the Tribes, Olympic National Park, WDFW, WDNR, private forest land managers, NMFS, local residents, citizen groups, numerous other agencies, and individuals.

Unlike other ESA-listed ESUs in the State of Washington, the Lake Ozette sockeye ESU has not had a state-designated recovery board (such as the Hood Canal Coordinating Council for the Hood Canal summer chum ESU) that could take responsibility for developing a recovery plan. For that reason, NMFS has led the development of the plan; however, leadership for implementing the plan is yet to be determined.

NMFS is working with the Governor's Salmon Recovery Office, the Lake Ozette Steering Committee, and other entities, including the newly formed North Pacific Coast Lead Entity (NPCLE) and the Washington Coast Sustainable Salmon Partnership (WCSSP), to identify responsibilities for coordinating and guiding implementation of the recovery plan.

NMFS' recovery plans usually include an implementation schedule that lists the proposed recovery actions, the appropriate entities to carry out the actions, and the estimated time and cost required for recovery. None of the many organizations that could play a role in implementation are obliged to participate. Listing a party in the implementation schedule does not require the identified party to implement the action(s) or to secure funding for implementing the action(s). It is anticipated that these organizations likely will choose to participate to advance their missions, as part of funding and contractual agreements, and/or in response to public education and outreach.

In many cases, the plan simply acknowledges and recommends coordinating the pre-existing, ongoing recovery efforts and pre-existing laws or regulations that are expected to benefit the species and its environment. Some of the ongoing actions that are integrated into the plan are required under other, separate resource management regulatory processes, such as implementation of forest practices habitat conservation plans, Clallam County road maintenance, operation of the sockeye hatcheries, and regulation of fisheries that may affect sockeye.

9.1 IMPLEMENTATION SCHEDULE AND RESPONSIBILITIES

NMFS and the Steering Committee have discussed the need for an implementation schedule. NMFS intends to work with whatever local group takes the lead in recovery plan implementation to develop the schedule, after the recovery plan has been finalized and accepted. For implementation, the risks and benefits of each proposed project need to be evaluated, balancing social and economic effects with the biological needs of the Lake Ozette sockeye. Some of the proposed projects, if they are not essential to preventing further decline or extinction of Lake Ozette sockeye, may not be included because of social and economic issues.

During the fall of 2007, NMFS worked with the Washington Governor’s Salmon Recovery Office and the Lake Ozette Steering Committee to identify options regarding how the plan can be implemented and what entity will coordinate plan implementation. The following options were discussed:

- NMFS would continue its leadership role to implement the plan, working in coordination with the Steering Committee or other local group;
- NMFS would continue its leadership role to implement the plan, working in coordination with the Steering Committee or other local group, with the addition of incorporating funding support and roles for NPCLE and WCSSP;
- The NPCLE and/or the WCSSP, in concert with any local Lake Ozette group that is formed, would accept responsibility and be funded to coordinate recovery plan implementation;
- An informal group of recovery project implementers would meet periodically to share information on recovery projects and monitoring data;
- A local agency would assume implementation leadership without being identified as a state-sanctioned salmon recovery board, or
- A new group/entity would be formed to implement the recovery plan.

The Lake Ozette Steering Committee continued to discuss recovery plan implementation options at its December 14, 2007 meeting in Port Angeles. Committee members listed the various agencies and entities that have a potential role for implementing recovery actions. The results of this discussion are summarized in Figure 9.1, which identifies the potential linkage, roles, and relationships between these entities. Committee members discussed the roles of the state and federal agencies, as well as the newly formed North Pacific Coast Lead Entity and Washington Coast Sustainable Salmon Partnership. Key roles include technical assistance, funding, grant writing, regulatory implementation, enforcement, monitoring and adapting recovery actions based on monitoring results.

Steering Committee members acknowledged, however, that even with these entities, there is still a need for a local group to share information, coordinate recovery actions, and guide and track recovery plan implementation. They concluded that such a local coordination group should include landowners, Olympic National Park, the Tribes, state agencies, NMFS, Clallam County, and the interested public.

The Steering Committee also discussed potential criteria for selecting and prioritizing future sockeye recovery actions for an implementation schedule, as follows:
The action or project:

- Is in a priority sub-basin identified in the recovery strategy.
- Is consistent with the recovery strategy and action hierarchy identified in the recovery plan.

- Has willing participants and landowners.
- Has a reasonable cost.
- Is cost effective.
- Is part of a sequence of projects.
- Has a high likelihood of success and has been tried elsewhere.
- Benefits fish.
- Is complementary to other projects.
- Has ability to move forward in a timely way.
- Has community support and no active opposition.
- Is consistent with entities' legal obligations.
- Has a low risk potential. Potential unintended consequences should be examined.
- Has the ability to be completed in a timely manner.
- Has a sound financing strategy.
- Does not preclude options for further recovery implementation.

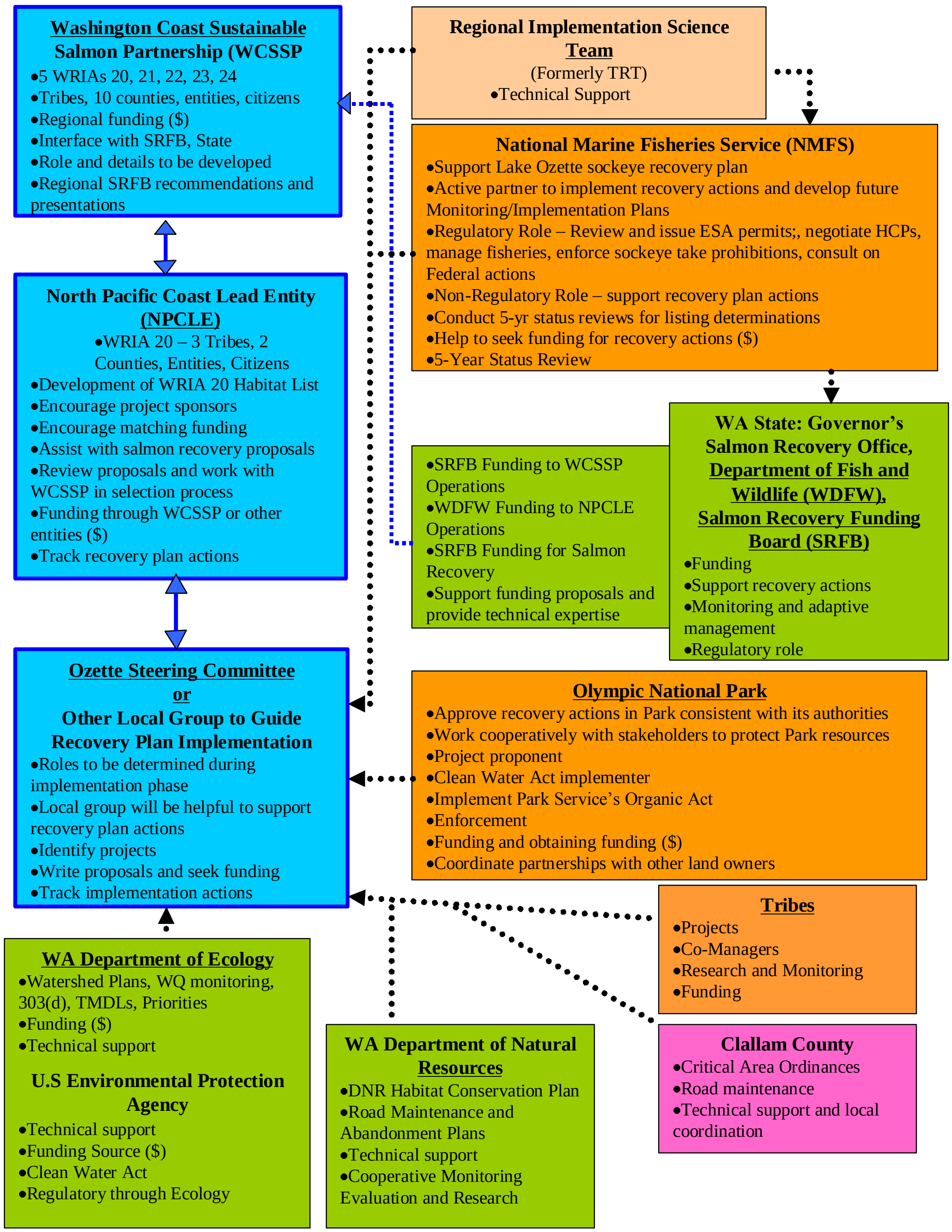

Figure 9.1. Relationship of potential implementing entities and functions from December 14, 2007 steering committee meeting.

9.2 TIME AND COST ESTIMATES

The ESA section 4(f)(1) requires that the recovery plan include, to the extent practicable, “estimates of the time required and the cost to carry out those measures needed to achieve the plan’s goal and to achieve intermediate steps toward that goal” (16 U.S.C. 1531-1544, as amended). This section is intended to meet this ESA requirement.

Time Estimate

NMFS estimates that recovery of the Lake Ozette Sockeye ESU, like recovery for most of the ESA-listed Pacific Northwest salmon, could take 50 to 100 years. While the recovery plan contains an extensive list of actions that need to be undertaken to recover Lake Ozette Sockeye salmon, there are many uncertainties involved in predicting the course of recovery and in estimating total costs. Such uncertainties include biological and ecosystem responses to recovery actions as well as long-term and future funding. While continued programmatic actions in the management of habitat, hatcheries, and harvest will warrant additional expenditures beyond the first 10 years, NMFS believes it is impracticable to estimate all projected actions and costs over 50 to 100 years, given the large number of economic, biological, and social variables involved. NMFS, therefore, supports the policy determination to focus on the first 10 years of implementation, provided that before the end of this first implementation period, specific actions and costs will be estimated for subsequent years, to achieve long-term goals and to proceed until a determination is made that listing is no longer necessary.

Cost Estimates

NMFS and the Lake Ozette Steering Committee have developed an extensive list of projects intended to address the recovery of ESA-listed Lake Ozette sockeye salmon. This project list was developed using the most up-to-date assessment of Lake Ozette sockeye recovery needs, without consideration of cost or potential funding. This section provides a summary of estimated costs, based on specific project cost estimates, where information was sufficient to provide them. These estimates include expenditures by local, tribal, state, and Federal governments, private business, and individuals in implementing both capital projects and non-capital work.

The draft cost estimates were prepared by a NMFS economist at the Northwest Fisheries Science Center in Seattle using a regional recovery database, together with input and review from the Lake Ozette Steering Committee and regional experts in 2007. The approach taken to estimate the total cost of each project was to use the scale described for each action, where available, together with unit costs for each project type. For example, scale was measured either in stream miles of treatment or number of structures as described in Chapter 7. For some actions, no scale estimate is available at this time, in which case no cost estimate is provided in the following section. The unit cost of a project type was estimated using cost data from existing habitat restoration projects and professional judgment. These costs reflected the materials and labor needed to implement a project.

The estimated costs shown below correspond to proposed recovery actions in Chapter 7. The actions range widely from relatively less expensive floodplain restoration, fencing, and tree planting to more expensive projects such as land acquisition and road realignment. Actions also vary considerably in length of time over which they will take place. In some cases a length of time has yet to be determined.

Several cautions must be highlighted regarding these costs. Many of these estimates may be incomplete until actions are better defined. For example, costs for potentially expensive projects such as land acquisition or conservation easements have not been estimated because no lands have been proposed for acquisition or easements. In other cases, unit cost estimates may not yet be available or project scale may still need to be determined.

The following section summarizes the available cost estimates for the 121 projects (programmatic and site specific) proposed in the Lake Ozette Sockeye Recovery Plan, covering all projects judged to be feasible and projected to occur over the initial 10-12 year period of implementing the recovery plan. The overall total cost estimated for all actions during this time period, where costs are available, is about $46,000,000. Many of these are one-time costs. Approximately $100,000 represents ongoing, annual administrative or infrastructure costs that will likely continue for the duration of implementation of the recovery plan. Thus, it can be inferred that if recovery takes 50 years, another $4,000,000 may be incurred over the long-term to continue and maintain proposed habitat improvements.

Recovery Actions and Corresponding Cost Estimates

The following table lists cost estimates (rounded to the nearest $500) and schedules (where known) for actions identified in the recovery plan. The action categories are the following:

- Baseline: These are actions categorized as part of ongoing, existing programs that will be carried out regardless of this recovery plan. No cost estimate is provided for these actions because they do not represent new costs specific to sockeye recovery (Placing a project in this category does not imply that the action's current scale or extent of implementation is sufficient to achieve the desired effect).

- Cost Estimate Exists: These are actions for which an estimate and scale are available.

- To Be Determined: These are actions that have a fairly specific description and so might be sufficiently detailed to support a cost estimate, but insufficient data, such as scale and unit cost, are currently available.

In the implementation phase, NMFS will work with regional experts to identify costs, scale, or unit costs for actions that require more information. A cost estimate is not provided in the following categories, "Baseline Action" or "To Be Determined." In the "To Be Determined" category, there is insufficient data currently to estimate the costs for one or more of the following reasons:

(1) Information on the scale of this action is needed before a total cost can be

estimated
(2) Information on the scale and unit cost of this action is needed before a total cost can be estimated
(3) Some or all of the costs of this action are included in the cost estimate of other actions in the table
(4) The cost of this recovery action cannot be estimated without more detailed information on the action itself.
(5) Actions in this category may also be assigned eveuntually to the Baseline category, in which case no cost estimate would be prepared.

NOTE: The following table, Table 9.1, is presented in two parts: Part I is a summary of proposed recovery action cost estimates, and Part II is a more detailed list of proposed recovery actions and estimated costs.

Table 9.1. Recovery Action Cost Estimates.

PART I: SUMMARY of Proposed Recovery Action Cost Estimates		
Recovery Plan Section	**Proposed Recovery Action**	**Recovery Action Cost Estimates**
7.1 Fisheries Management		
7.1.3 Short-Term Actions	All actions in this section are baseline actions.	Baseline Action
7.1.4 Long-Term Actions	All actions in this section are baseline actions.	Baseline Action
7.2 Habitat-related Actions		
7.2.1 Programmatic Actions		
Forest Practice Regulations	Actions in this section are mostly baseline actions. One action could have a cost estimate but is listed as To Be Determined (see detailed list of actions in Part II below).	Baseline Action
WDNR State Land HCP	All actions in this section are baseline actions.	Baseline Action
Clallam County Critical Areas Ordinance and Storm Water Management Plan	Most of the actions in this section are baseline actions.	Baseline Action
Clallam County Road Maintenance Plan	All actions in this section are baseline actions.	Baseline Action

PART I: SUMMARY of Proposed Recovery Action Cost Estimates		
Recovery Plan Section	**Proposed Recovery Action**	**Recovery Action Cost Estimates**
Clallam County Shoreline Management Plan (SMP)	All actions in this section are baseline actions.	Baseline Action
Olympic National Park General Management Plan	Most of the actions in this section are baseline actions.	Baseline Action
Olympic Coast National Marine Sanctuary Management Plan	Some of the actions in this section are baseline actions. One action could have a cost estimate but is listed as To Be Determined (see detailed list of actions in Part II below).	Baseline Action + $50,000
Washington State Department of Fish and Wildlife Hydraulic Code	All actions in this section are baseline actions.	Baseline Action
Washington State Department of Ecology	All actions in this section are baseline actions.	Baseline Action
7.2.2 Habitat Protection and Restoration-Enhancement Projects		
7.2.2.1 Sediment Reduction Projects		
7.2.2.1 Sediment Reduction Projects	This section has four recovery actions with cost estimates. One other action could have cost estimate but is listed as To Be Determined (see detailed list of actions in Part II below).	$13,750,000 + To Be Determined

PART I: SUMMARY of Proposed Recovery Action Cost Estimates		
Recovery Plan Section	**Proposed Recovery Action**	**Recovery Action Cost Estimates**
7.2.2.2 Hydrologic Restoration Projects		
7.2.2.2 Hydrologic Restoration Projects	This section has two recovery actions with cost estimates. One other action could have a cost estimate but is listed as To Be Determined (see detailed list of actions in Part II below).	$1,450,000 + To Be Determined
7.2.2.3 Large Woody Debris (LWD) Placement Projects		
7.2.2.3.1 Broad-Scale LWD Placement Projects	This section has one recovery action with cost estimate. Two other actions could have cost estimates but are listed as To Be Determined.	$1,200,000 + To Be Determined
7.2.2.3.2 Site-Specific LWD Placement Projects	This section has one recovery action that could have a cost estimate but is listed as To Be Determined.	$4,000,000
7.2.2.4 Riparian and Floodplain Restoration Projects		
7.2.2.4.1 Broad-Scale Riparian and Floodplain Restoration Actions	This section has five recovery actions that could have a cost estimate but are listed as To Be Determined (see detailed list of actions).	See specific costs in Section 7.2.2.4.2.
7.2.2.4.2 Site-Specific Riparian and Floodplain Restoration Actions		
Site-Specific Riparian/Floodplain Action #1 (RS#15)	This section has one recovery action with a cost estimate. One other action could have a cost estimate but is listed as To Be Determined (see detailed list of actions in Part II below).	$28,000 + To Be Determined

PART I: SUMMARY of Proposed Recovery Action Cost Estimates		
Recovery Plan Section	**Proposed Recovery Action**	**Recovery Action Cost Estimates**
Site-Specific Riparian/Floodplain Action #2 (RS#31)	This section has two recovery actions with a cost estimate. One other action could have a cost estimate but is listed as To Be Determined (see detailed list of actions in Part II below).	$179,000 + To Be Determined
Site-Specific Riparian/Floodplain Action #3 (RS#31)	This section has three recovery actions with a cost estimate. One other action could have a cost estimate but is listed as To Be Determined (see detailed list of actions in Part II below).	$56,500 + To Be Determined
Site-Specific Riparian/Floodplain Action #4 (RS#31)	This section has three recovery actions with a cost estimate. One other action could have a cost estimate but is listed as To Be Determined (see detailed list of actions in Part II below).	$97,000 + To Be Determined
Site-Specific Riparian/Floodplain Action #5 (RS#31)	This section has two recovery actions with a cost estimate. One other action could have a cost estimate but is listed as To Be Determined (see detailed list of actions in Part II below).	$23,500 + To Be Determined
Site-Specific Riparian/Floodplain Action #6 (RS#30)	This section has one recovery action (see detailed list of actions in Part II below).	$50,000
7.2.2.5 Spawning Habitat Restoration and Enhancement Projects		
Spawning Habitat Restoration and Enhancement Projects	This section has three recovery actions that could have a cost estimate but is listed as To Be Determined (see detailed list of actions in Part II below).	To Be Determined

PART I: SUMMARY of Proposed Recovery Action Cost Estimates		
Recovery Plan Section	**Proposed Recovery Action**	**Recovery Action Cost Estimates**
7.2.2.6 Conservation Easements and Land Acquisition		
Conservation Easements and Land Acquisition	This section has one recovery action with a cost estimate. One other action could have a cost estimate but is listed as To Be Determined (see detailed list of actions in Part II below).	$25,000,000 + To Be Determined
7.3 Hatchery Supplementation Actions		
7.3.1 Short-term Hatchery Supplementation Actions (Umbrella Creek and Big River Supplementation Programs)	This section has seven recovery actions with a cost estimate. One other action is a Baseline Action and another action could have a cost estimate but is listed as To Be Determined (see detailed list of actions). (Note: Makah RMP Research, Monitoring and Evaluation Actions have been included in this section.)	Baseline Action $2,916,500 over 12 years + To Be Determined
7.3.2 Long-Term Hatchery Supplementation Actions		
7.3.2.1 Potential Long-Term Enhancement Actions	This section has five recovery actions that could have a cost estimate but are listed as To Be Determined (see detailed list of actions in Part II below).	To Be Determined
7.4 Predation-Related Recovery Actions	This section has seven recovery actions that could have a cost. Six are listed as To Be Determined (see detailed list of actions in Part II below).	$50,000 + To Be Determined

PART I: SUMMARY of Proposed Recovery Action Cost Estimates		
Recovery Plan Section	**Proposed Recovery Action**	**Recovery Action Cost Estimates**
7.5 Research, Monitoring, and Adaptive Management Actions	This section has seven recovery actions that could have a cost but are listed as To Be Determined (see detailed list of actions in Part II below).	To Be Determined
7.6 Public Education Actions	This section has seven recovery actions (see detailed list of actions in Part II below).	$170,000

PART II: DETAILED LIST of Recovery Action Cost Estimates		
Recovery Plan Section	**Recovery Action**	**Recovery Action Cost Estimates**
7.1 Fisheries Management Actions		
7.1.1 Short-Term Actions		
7.1.3.1 Freshwater Fisheries	All parties will continue implementation of current ONP, WDFW, and tribal fishing regulations that prohibit the harvest and retention of Lake Ozette sockeye salmon.	Baseline Action
7.1.3.2 Marine Area Fisheries	All parties will continue current marine fishing regimes that limit the likelihood for substantial harvest impacts to Ozette Lake sockeye salmon.	Baseline Action
7.1.4 Long-Term Actions		
7.1.4.1 Freshwater Fisheries	NMFS will work with the Tribes and WDFW within the ESA, NEPA, *U.S. v. Washington* forums, and with the public to evaluate any specific harvest plans proposed within the watershed prior to making formal decisions.[i]	Baseline action
7.1.4.2 Marine Area Fisheries	Fisheries directed at other sockeye salmon populations and fish species in U.S. marine fishing areas will continue to be regulated over the long-term to reduce incidental harvest impacts to juvenile and adult sockeye salmon originating from Lake Ozette.	Baseline action
7.2 Habitat-related Actions		
7.2.1 Programmatic Actions		

PART II: DETAILED LIST of Recovery Action Cost Estimates		
Recovery Plan Section	**Recovery Action**	**Recovery Action Cost Estimates**
Forest Practice Regulations	Consistent with the FPHCP and its incidental take permit, the Washington State Department of Natural Resources (WDNR) will maintain sufficient compliance and enforcement staff to enforce forest practice regulations within the Lake Ozette watershed.[ii]	Baseline Action
	WDNR will produce annual reports on FPHCP compliance, per HCP requirements. NMFS will work closely with WDNR to address and resolve perceived non-compliance issues.[iii]	Baseline Action
	WDNR will coordinate and seek funding for FPHCP monitoring and adaptive management activities that complement implementation of recovery plan research, monitoring and adaptive management activities.[iv]	Baseline Action
Forest Practice Regulations, cont.	Based on availability of funding and other resources, WDNR will provide incentives for timber companies to accelerate, or, with approval, modify FPHCP practices to improve the certainty of restoring watershed processes sooner by, for example, leaving larger tributary buffers, upgrading roads, speeding road improvements, removing unneeded roads consistent with the FPHCP, increasing rotation lengths, or other forestry management options. Special emphasis should be given to carrying out these measures in Umbrella Creek sub-watershed.	To Be Determined
WDNR State Land HCP	WDNR will continue annual reporting on forest practices covered by the WDNR HCP and consider including the Ozette watershed in WDNR's statewide HCP effectiveness monitoring.	Baseline Action

PART II: DETAILED LIST of Recovery Action Cost Estimates		
Recovery Plan Section	**Recovery Action**	**Recovery Action Cost Estimates**
	Consistent with the WDNR HCP and its incidental take permit, WDNR will maintain sufficient compliance and enforcement staff to enforce forest practices regulations within the Lake Ozette watershed.	Baseline Action
	WDNR is encouraged to implement lessons learned from effectiveness monitoring in other basins to promptly improve implementation of the WDNR HCP in Ozette.	Baseline Action
	WDNR will coordinate HCP monitoring and adaptive management activities with implementation of recovery plan research, monitoring and adaptive management activities.	Baseline Action
Clallam County Critical Areas Ordinance and Storm Water Management Plan	Clallam County will enforce all County rules pertaining to small landowners along Big River. Specifically, zoning laws, critical areas ordinances, development in the 100-year floodplain and/or CMZ.	Baseline Action
	Clallam County will enforce state laws restricting cattle assess to rivers to protect water quality.	Baseline Action
	Clallam County will implement county critical areas ordinance and storm water management rules.	Baseline Action
	Clallam County will enforce county zoning laws limiting septic tanks that are hydrologically connected to water courses (e.g., leach field draining directly into river).	Baseline Action

PART II: DETAILED LIST of Recovery Action Cost Estimates		
Recovery Plan Section	**Recovery Action**	**Recovery Action Cost Estimates**
	Clallam County will enforce Washington State Water Right Laws that limit exempt wells to less than 5000gpd.	Baseline Action
Clallam County Critical Areas Ordinance and Storm Water Management Plan, cont.	Clallam County will enforce Washington State Water Right Laws that limit the location of water withdrawals (e.g., illegal surface water diversions). Accurately delineate floodplain and channel migration zones.	Baseline Action
	Clallam County will protect floodplains and channel migration zones from development and incompatible land use activities through application of the WDFW hydraulic code and county land use regulations.	Baseline Action
	NMFS will work with Clallam County, ONP, private timber companies, WDNR, Tribes, and other interested parties to investigate various potential land conversion development scenarios and the resulting potential impact on the viability of Lake Ozette sockeye salmon. Based on this analysis, these parties will identify land use and management options that Clallam County can implement to address future potential land conversion threats to Lake Ozette sockeye.	Baseline Action

PART II: DETAILED LIST of Recovery Action Cost Estimates		
Recovery Plan Section	**Recovery Action**	**Recovery Action Cost Estimates**
	Clallam County will carry out an analysis of forest land conversion in the watershed. Based on this analysis, the County will identify land use and management options that could be implemented by the County to protect watershed processes and functions from potential threats of future forest land conversion. The County will implement a preferred option, based on its resources and authority, to: (1) restore natural sediment production; (2) restore hydrologic processes and natural hydrologic variability; (3) and maintain and protect the lake and tributary riparian forests.	Baseline Action
Clallam County Road Maintenance Plan	Clallam County will adhere to Regional Road Maintenance Endangered Species Act Program Guidelines as per 4(d) Rule protections.	Baseline Action
Clallam County Shoreline Management Plan (SMP)	Clallam County will review and revise permit administrative procedures to integrate SMP administration with other regulatory processes and improve efficiency and complete a thorough inventory of the shorelines within county jurisdiction to characterize shoreline ecological processes and functions.	Baseline Action[v]
Olympic National Park General Management Plan	Olympic National Park (ONP) will implement its General Management Plan within the ONP boundaries in the Lake Ozette watershed.	Baseline Action
	ONP will continue to implement its policies, regulations, site plans, and specific actions in the Lake Ozette watershed based on the General Management Plan.	Baseline Action
	ONP will control exotic and invasive plants using the National Park Service's Exotic Plant Management Team within the ONP's boundary in the Lake Ozette watershed.	Baseline Action

PART II: DETAILED LIST of Recovery Action Cost Estimates		
Recovery Plan Section	**Recovery Action**	**Recovery Action Cost Estimates**
	ONP will continue to implement its Wilderness Management policies, protections, and regulations, particularly to maintain and protect riparian habitat.	Baseline Action
	ONP will continue to implement its Front Country Area policies and protections within the Lake Ozette watershed.	Baseline Action
	ONP will continue to implement its Scenic Easement policy within the Lake Ozette watershed.	Baseline Action
	NMFS will identify specific ways to cooperate with ONP to fund and implement sockeye recovery plan actions through research partnerships, management actions, and communication with the public.	Baseline Action
	NMFS will work with ONP, Clallam County, private timber companies, WDNR, Tribes and other interested parties to analyze different potential forest land conversion development scenarios and the potential impact on the viability of Lake Ozette sockeye salmon. Based on this analysis, the parties will identify land use and management options to protect watershed processes and functions to prevent potential future land use conversion threats.	Baseline Action
Olympic Coast National Marine Sanctuary Management Plan	The Olympic Coast National Marine Sanctuary (OCNMS) will continue to implement its Management Plan, particularly as it relates to nearshore habitat management and research activities.	Baseline Action
	The OCNMS will identify nearshore habitat data and research needs for sockeye recovery that may be addressed in cooperation with the OCNMS research programs.	Baseline Action

PART II: DETAILED LIST of Recovery Action Cost Estimates		
Recovery Plan Section	**Recovery Action**	**Recovery Action Cost Estimates**
	The OCNMS will seek funding to carry out cooperative research and management actions identified in Chapter 8: Adaptive Management, Research, Monitoring, and Evaluation, with the Sanctuary, NMFS' Northwest Fisheries Science Center and other interested parties or institutions.	Baseline Action
	Share information and data OCNMS collects with parties implementing the Lake Ozette Sockeye Recovery Plan.	Baseline Action
	The OCNMS will cooperate and seek funding for public education and outreach materials and activities to promote public awareness about sockeye recovery.	$50,000 (total, years 1-10)
Washington State Department of Fish and Wildlife Hydraulic Code	The Washington State Department of Fish and Wildlife (WDFW) will continue to implement and enforce the WDFW hydraulic code, with particular attention to gravel mining, fish passage projects, and culvert replacement projects.	Baseline Action
	As per WAC 220-11-010, the WDFW will review each application for a Hydraulic Project Approval (HPA) on an individual basis and therefore require a site visit to inspect proposed job site for every HPA application to determine site-specific issues and technical provisions necessary for the protection of fish life and fish habitat.	Baseline Action
	The WDFW will encourage its fisheries enforcement to prioritize habitat issues and strictly enforce WDFW hydraulic code.	Baseline Action
Washington State Department of Ecology	The WDOE will assess statewide water quality and identify water bodies that fail to meet water quality standards.	Baseline Action

PART II: DETAILED LIST of Recovery Action Cost Estimates		
Recovery Plan Section	**Recovery Action**	**Recovery Action Cost Estimates**
7.2.2 Habitat Protection and Restoration-Enhancement Projects		
7.2.2.1 Sediment Reduction Projects		
7.2.2.1Sediment Reduction Projects	Quantitatively assess sediment production impacts from logging (gully creation, debris flows, landslides), road building, large woody debris (LWD) removal, and other land use activities in Priority Subbasins I, II, and III; develop program to reduce land use related sediment inputs.	$1,350,000 (Total, years 1-4) + $5,500,000 ($500K annually, years 5-15)[vi]
	Implement rigorous sediment reduction and retention program designed to reduce coarse and fine sediment delivery to the Ozette River (see Sediment Processes).	
	Use the results of subbasin-scale sediment budgets to define the relative contribution of different sediment sources and target specific sites for restoration activities.	
	Develop voluntary comprehensive "green" forestry program at the landscape scale that promotes ecosystem function and watershed process recovery (*e.g*. Forest Stewardship Council Certification); research programs and identify potential voluntary forestry program options to achieve sockeye recovery goals.	$100,000
	Reconnect floodplains in Priority I and II Subbasins by reintroducing LWD to all tributaries to improve floodplain connectivity and sediment deposition/storage.	$6,750,000, time scale unknown[vii]

PART II: DETAILED LIST of Recovery Action Cost Estimates		
Recovery Plan Section	**Recovery Action**	**Recovery Action Cost Estimates**
	Plant or under-plant conifer riparian forests in fields and disturbed hardwood zones to increase bank rooting strength, increase hydrologic roughness, and aid in sediment storage / deposition	To Be Determined
	Eradicate non-native plants (e.g., knotweed) in the riparian zone and replace with native species more effective at protecting soil and banks	$50,000
7.2.2.2 Hydrologic Restoration Projects		
7.2.2.2 Hydrologic Restoration Projects	Quantitatively assess hydrologic impacts from land use and LWD removal activities and develop a distributed hydrologic model calibrated for each tributary in conjunction with Ozette River hydraulic model to prioritize actions needed to improve natural hydrologic functions where needed.	$500,000, time scale unknown[viii]
	Remove and/or disconnect hydrologically connected road systems via road decommissioning (full removal), abundant road cross-drain installation, and adequate culvert sizes at tributary crossings to ensure passage of LWD, sediment and water at the 100 yr RI flood.	To Be Determined
	As recommended by modeling results, add LWD to the Ozette River to restore natural hydraulic backwater condition and maintain the natural range of variability of lake levels.	$950,000, time scale unknown[ix]
7.2.2.3 Large Woody Debris (LWD) Placement Projects		
7.2.2.3.1 Broad-Scale	Reconnect floodplains by reintroducing LWD to all tributaries to improve floodplain connectivity, water retention, and peak flow attenuation.	To Be Determined

PART II: DETAILED LIST of Recovery Action Cost Estimates		
Recovery Plan Section	**Recovery Action**	**Recovery Action Cost Estimates**
LWD Placement Projects	Conduct modeling studies regarding how to restore natural hydraulic backwater condition and maintain the natural range of variability of lake levels.	To Be Determined
	Reintroduce LWD into the lower Ozette River so as to prevent/block seal migrations into Lake Ozette and provide cover for migrating Ozette sockeye to avoid predation.	$1,200,000, time scale unknown[x]
	Add LWD accumulations in the mainstem of Umbrella Creek to re-activate floodplain where disconnected and store suitably sized spawning gravels where absent (see below).	See site-specific actions below in 7.2.2.3.2.
7.2.2.3.2 Site-Specific LWD Placement Projects	Within Umbrella Creek, several channel segments have been identified where LWD conditions are poor and suitable spawning substrate sizes are absent due to degraded channel conditions. Within these wood-starved reaches, LWD should be reintroduced with the intent to stabilize the channel and store suitably sized spawning gravels. (Cost based on installing five log jams.)	$4,000,000
7.2.2.4 Riparian and Floodplain Restoration Projects		
7.2.2.4.1 Broad-Scale Riparian and Floodplain Restoration Actions	Conduct a high resolution, detailed survey of the lake shoreline and riparian zone documenting non-native plant species. In cooperation with ONP, develop program to eradicate non-native, invasive plant species.	To Be Determined
	Plant or under-plant conifer riparian forests in fields and disturbed hardwood zones	See specific costs in 7.2.2.4.2 below.

PART II: DETAILED LIST of Recovery Action Cost Estimates		
Recovery Plan Section	**Recovery Action**	**Recovery Action Cost Estimates**
	Within Lake Ozette tributaries, eradicate non-native vegetation.	See specific costs in 7.2.2.4.2 below.
	Reconnect floodplains by reintroducing LWD to all tributaries where LWD is deficient and floodplain connectivity is impaired in order to improve floodplain connectivity, sediment storage, water retention, and peak flow attenuation	To Be Determined
	Relocate county road where road affects floodplain connectivity or reduces functionality of riparian processes	See specific costs in 7.2.2.4.2 below.
7.2.2.4.2 Site-Specific Riparian and Floodplain Restoration Actions		
Site-Specific Riparian/Floodplain Action #1 (RS#15)	Plant native conifer tree species along the right bank of the Ozette River. Establish a 200 ft wide riparian forest where feasible. Maintain planting until trees are free to grow.	$28,000, time scale unknown[xi]
	Remove or relocate unneeded infrastructure within a 200 foot distance of river's bankfull edge	To Be Determined
Site-Specific Riparian/Floodplain Action #2 (RS#31)	Relocate Hoko-Ozette Road out of the immediate riparian-floodplain of the Big River. In addition to relocation, the road should be constructed so that it doesn't hinder flood water movement between Big River and Trout Creek.	$150,000, time scale unknown[xii]
	Remove or relocate unneeded infrastructure within a 200 foot distance of river's bankfull edge	To Be Determined

PART II: DETAILED LIST of Recovery Action Cost Estimates		
Recovery Plan Section	**Recovery Action**	**Recovery Action Cost Estimates**
	In addition to relocating the Hoko-Ozette Road, other road segments should be considered for removal and reconstruction: Swan Bay Road (273 meters of road) reengineered and the road elevated on a permeable road prism; Old railroad grade/unused road (176m), removal; Two old logging spurs (88 and 46 meters), removal.	$29,000, time scale unknown[xiii]
Site-Specific Riparian/Floodplain Action #3 (RS#31)	Plant the appropriate mix of native conifer and deciduous tree species in pastures; establish a 200 ft wide riparian forest where feasible; this may require property acquisition or a conservation easement to compensate the landowner; maintain plantings until trees are free to grow (RS#29).	$23,000, time scale unknown[xiv]
	If cattle are going to graze in the remaining pasture, then a fence should be installed to prevent their access to the river.	$10,500, time scale unknown[xv]
	Remove or relocate unneeded infrastructure within a 200 foot distance of river's bankfull edge: 1,600 feet of road to be removed and 685 feet of road relocation.	$23,000, time scale unknown[xvi]
	If downstream infrastructure is relocated and floodplain processes restored, then this stream reach should receive a LWD treatment aimed at reconnecting the channel and floodplain.	To Be Determined
Site-Specific Riparian/Floodplain Action #4 (RS#31)	Plant the appropriate mix of native conifer and deciduous tree species in pastures; establish a 200 ft wide riparian forest where feasible (this may require property acquisition and/or conservation easements to compensate the landowners – see Land Acquisition and Conservation Easements section); maintain plantings until trees are free to grow	$55,000, time scale unknown[xvii]

PART II: DETAILED LIST of Recovery Action Cost Estimates		
Recovery Plan Section	**Recovery Action**	**Recovery Action Cost Estimates**
	If cattle are going to graze in the remaining pastures, then a fence should be installed to prevent their access to the river.	$9,000, time scale unknown[xviii]
	Remove or relocate unneeded infrastructure within a 200 foot distance of river's bankfull edge: 2,900 feet of road that could be removed and 760 feet of road relocation.	$33,000, time scale unknown[xix]
	If downstream infrastructure is relocated and floodplain processes restored, then this stream reach should receive a LWD treatment aimed at protecting banks from excessive erosion; however, several homes are located along this stream reach, and floodplain connectivity using LWD introductions is not likely feasible.	To Be Determined
Site-Specific Riparian/Floodplain Action #5 (RS#31)	Plant the appropriate mix of native conifer and deciduous tree species; establish a 200 ft wide riparian forest where feasible (this may require property acquisition and/or conservation easements to compensate the landowners – see Land Acquisition and Conservation Easements section); maintain plantings until trees are free to grow	$18,000, time scale unknown[xx]
	If cattle are going to graze in the remaining pasture, then a fence should be installed to prevent their access to the river.	$5,500, time scale unknown[xxi]
	Remove or relocate unneeded infrastructure within a 200 foot distance of rivers bankfull edge	To Be Determined
	If downstream infrastructure is relocated and floodplain processes restored, then this stream reach should receive a LWD treatment aimed at protecting banks from excessive erosion.	To Be Determined

PART II: DETAILED LIST of Recovery Action Cost Estimates		
Recovery Plan Section	**Recovery Action**	**Recovery Action Cost Estimates**
Site-Specific Riparian/Floodplain Action #6 (RS#30)	Continue efforts by the Makah Tribal, Clallam County, and ONP noxious weed programs, focusing on eradicating noxious weeds and reestablishing native riparian forests with the help of private landowners and others.	$50,000
7.2.2.5 Spawning Habitat Restoration and Enhancement Projects		
Spawning Habitat Restoration and Enhancement Projects	Develop comprehensive program to restore beach spawning habitat at Umbrella Beach (in addition to Umbrella Creek recovery efforts); upon habitat recovery implement an experimental sockeye re-introduction program.	To Be Determined
	Identify other potential sockeye beach spawning habitats and attempt re-introducing sockeye salmon in conjunction with habitat and watershed process rehabilitation efforts.	To Be Determined
	Within sockeye spawning tributaries such as Umbrella Creek, implement LWD placement concepts described in Section 7.2.2.3.	See Section 7.2.2.3.2.
	Develop a shoreline habitat restoration plan, including vegetation removal, gravel cleaning, and beach restoration actions at selected shoreline project sites.	To Be Determined
7.2.2.6 Conservation Easements and Land Acquisition		
Conservation Easements and Land Acquisition	Where interest, funding, and willing sellers exist, purchase land within Ozette watershed and restore and actively manage for old-growth unroaded conditions. The priority for such subbasin conservation is as follows: Umbrella Creek; Big River; Tier II subbasins; Tier III subbasins	$25,000,000, time scale unknown[xxii]

PART II: DETAILED LIST of Recovery Action Cost Estimates		
Recovery Plan Section	**Recovery Action**	**Recovery Action Cost Estimates**
	Develop conservation easements with willing landowners to promote ecosystem function and watershed process recovery with management objectives focused on aquatic ecosystem restoration.	To Be Determined[xxiii]
7.3 Hatchery Supplementation Actions		
7.3.1 Short-term Hatchery Supplementation Actions (Umbrella Creek and Big River Supplementation Programs)		
7.3.1.1 Sockeye Salmon Broodstock Selection and Collection Actions	Adult sockeye salmon used as broodstock for the tributary hatchery programs will be trapped in Umbrella Creek. Up to 200 adult sockeye salmon will be trapped and retained each year using a weir in lower creek. Broodstock will be collected from October through December, encompassing the spawner entry period. Sockeye salmon broodstock will be collected proportional to the timing, weekly abundance, and duration of the total return to the creek. Fish will be transferred to Umbrella Creek Hatchery for spawning, or spawned at the point of capture.	$885,000 over 12 years + $87,000 one-time cost[xxiv]
7.3.1.2 Sockeye Salmon Broodstock Spawning Actions	Gametes will be collected from brood fish for transport to iso-incubation locations at Makah NFH or Educket Hatchery. Approximately 305,000 unfertilized eggs will be collected each year for incubation.	$17,000 over 12 years[xxv]

PART II: DETAILED LIST of Recovery Action Cost Estimates		
Recovery Plan Section	**Recovery Action**	**Recovery Action Cost Estimates**
7.3.1.3 Juvenile Sockeye Salmon Rearing and Release Actions	Eggs to be incubated at the Umbrella Creek and Big River sites are otolith marked using standard thermal marking procedures. Upon swim-up (mid-April to late May), fry will be reared on an artificial or live feed diet. A proportion of the mass otolith-marked fry produced at Umbrella Creek Hatchery will also marked with an adipose fin clip. Up to 80,000 fingerlings will be released each year into Umbrella Creek between late-May and early July. Up to 140,000 otolith-marked eyed eggs will be transferred for incubation early February with fry released each year into Big River from late April to late May. Half of the annual Big River RSI sockeye fry production will be released as otolith-marked, unfed fry or as "early" fed fry. The remaining half of the annual hatchery production will be reared for release in the early summer as fingerlings. A proportion the fingerlings produced at the Big River site will receive an adipose fin clip mark to augment the otolith mark.	$724,500 over 12 years + $41,500 one-time costs[xxvi]
Administrative Costs for 7.3.1.1, 7.3.1.2, and 7.3.1.3 tasks	Administrative Costs for 7.3.1.1, 7.3.1.2, and 7.3.1.3 tasks	$409,000 over 12 years[xxvii]
7.3.1.4 Hatchery-Origin Adult Sockeye Salmon Disposition Actions	The short-term hatchery approach under this plan will carry forth plans for the disposition of adult sockeye salmon specified in the Lake Ozette sockeye salmon HGMP.	Baseline Action
Makah RMP Research, Monitoring and	Ozette River Adult Counting Weir Operation – (Quote description included in recovery plan)	$27,000 annually + $9,500 one-time costs[xxviii]

PART II: DETAILED LIST of Recovery Action Cost Estimates		
Recovery Plan Section	**Recovery Action**	**Recovery Action Cost Estimates**
Evaluation Actions	Ozette River Juvenile Out-migrant Trap Operation – (Quote description included in recovery plan)	$17,000 annually + $28,500 initial costs[xxix]
	Spawning Ground Escapement Surveys – (Quote description included in recovery plan). (and also include:) A representative sample of adult sockeye salmon returning to the all spawning areas will be sampled for otoliths and fin clips to compare hatchery-origin unfed fry, early fed fry, and fingerling survival rates and to identify stray and contribution rates for hatchery and natural-origin sockeye salmon.	$15,500 annually + $500 one-time costs[xxx]
Administrative Costs for RMP RM&E tasks	Administrative Costs for RMP RM&E tasks	To Be Determined
7.3.2 Long-term Hatchery Supplementation Actions		
7.3.2.1 Potential Long-Term Enhancement Actions		
7.3.2.1.1 Termination or Continuation of Tributary Supplementation Programs	Terminate or continue the supplementation programs on Umbrella Creek and Big River.	To Be Determined
7.3.2.1.2 Natural Colonization of Beaches	Forgo use of enhancement, in particular, artificial propagation, as a means to recover healthy Ozette Lake sockeye salmon aggregations on the spawning beaches; a continuation of the short-term approach.	To Be Determined

PART II: DETAILED LIST of Recovery Action Cost Estimates		
Recovery Plan Section	**Recovery Action**	**Recovery Action Cost Estimates**
7.3.2.1.3 Mechanical Improvement of Beach Spawning Areas	Mimic the effects of mass spawning sockeye by manually or mechanically coarsening beach spawning substrate, reducing the percentage of fine materials (e.g., silt and sand).	To Be Determined
7.3.2.1.4 Creation of New Beach Spawning Locations and Stock Introduction	Create new beach spawning locations in Ozette Lake, followed by natural colonization, or seeding of the new locations using hatchery methods.	To Be Determined
7.3.2.1.5 Supplementation of Beach Spawning Aggregations	Use artificial propagation methods to supplement of beach spawning sockeye salmon aggregations.	To Be Determined
7.4 Predation-Related Recovery Actions	Create an incentive program, as appropriate within NPS regulations, to encourage or require lethal take of largemouth bass and other non-native fish species.	To Be Determined
	Create fishing regulations that will limit take of native species while maximizing the removal of non-native species.	To Be Determined
	Develop a management plan for northern pikeminnow, based on field assessments of the species' impact on sockeye salmon survival and productivity.	To Be Determined

PART II: DETAILED LIST of Recovery Action Cost Estimates		
Recovery Plan Section	**Recovery Action**	**Recovery Action Cost Estimates**
	Work with NMFS and other appropriate agencies to study impacts of marine mammals and river otters on sockeye salmon, particularly on beach spawning grounds. Based on this information, develop a NMFS-sanctioned plan to address these impacts through a variety of predator control measures being tested and used in the NMFS Northwest Region.	$50,000
	Working in coordination with NMFS, ONP, WDFW, and the Tribes, analyze the impacts of seals and sea lions on sockeye salmon and identify options to minimize these impacts, including reinstating ceremonial and subsistence hunting of seals and sea lions in Tribal Usual and Accustomed hunting and fishing areas.	To Be Determined
	Modify sockeye adult enumeration techniques at the Ozette River weir to reduce any predation mortality on adult and juvenile sockeye.	To Be Determined
	Implement research and monitoring actions proposed in Chapter 8 to analyze fishing regulations, predator-prey interactions, and predation at all life stages for beach spawners.	To Be Determined
7.5 Research, Monitoring and Evaluation	Research, monitoring, and adaptive management actions will be carried out based on the research, monitoring, and adaptive management plan that will be developed in 2009 after the Lake Ozette Sockeye Recovery Plan is adopted by NMFS. (See Chapter 8)	To Be Determined

PART II: DETAILED LIST of Recovery Action Cost Estimates		
Recovery Plan Section	**Recovery Action**	**Recovery Action Cost Estimates**
7.6 Public Education and Outreach	Develop and implement an education and outreach program directed at anglers and the general public regarding the negative impacts of non-native fish and plants on native species, habitat, and the Lake Ozette ecosystem.	$50,000
	In cooperation with co-sponsors, produce a 3-5 page summary brochure or handout describing the key parts of the Lake Ozette Sockeye Recovery Plan and highlighting the recovery actions that can be carried out by the public and landowners. Distribute the brochure to the public.	$10,000
	Develop a clearinghouse of information about recovery plan implementation.	Baseline Action
	In cooperation with Clallam County, local Soil Water and Conservation Districts, and the Natural Resource Conservation Service, work with landowners in the watershed to provide information and help identify appropriate recovery actions on landowner property.	$10,000
	Produce educational materials that can be used in the local schools, community colleges, and community centers to educate children about needed recovery actions.	$25,000
	Develop cooperative educational and outreach programs with existing organizations and nonprofit groups to include information about sockeye recovery in their materials.	$25,000

PART II: DETAILED LIST of Recovery Action Cost Estimates		
Recovery Plan Section	**Recovery Action**	**Recovery Action Cost Estimates**
	Develop exhibit materials that can be used at fairs, festivals, or other venues to communicate the recovery actions needed to protect and restore sockeye salmon.	$5,000
	Work with Olympic National Park staff to develop materials, posters, and display boards to educate the public visiting Lake Ozette about the need to recover sockeye salmon and the recovery actions being carried out within the Park.	$25,000
	Seek funding to carry out the proposed education and outreach actions. Develop a clearinghouse of information on funding sources. Support local entities, landowners, and Tribes to seek funding for recovery actions.	Baseline
	Develop public education information that can be posted on the NMFS, Olympic National Park, Olympic Coast National Marine Sanctuary, and Clallam County's NPCLE web sites.	Baseline
	Carry out briefings and presentations to civic, business, trade, environmental, and conservation organizations.	Baseline + $10,000
	Lead seasonal tours of the watershed so the public can observe spawning sockeye salmon and visit recovery project restoration sites.	$10,000

Table Endnotes

i. Text in the recovery plan is the following:

> NMFS will work with the Tribes and WDFW within the ESA, NEPA, U.S. v. Washington forums, and with the public to evaluate any specific harvest plans proposed within the watershed prior to making formal decisions. Fisheries directed at other fish species in the Lake Ozette basin will continue to be regulated over the long-term to reduce incidental harvest impacts to juvenile and adult sockeye salmon. To reduce piscivorous fish predation risks to juvenile sockeye salmon, recreational fisheries designed to remove and eradicate non-native fish species will continue to be promoted (RS#3). No-bag-limit fisheries directed at largemouth bass and yellow perch will be promulgated by ONP and WDFW, where and when appropriate.

ii. Text in the recovery plan is the following:

> Consistent with the FPHCP and its incidental take permit, the state Department of Natural Resources will maintain sufficient compliance and enforcement staff to enforce forest practice regulations within the Lake Ozette watershed. These activities should be carried out consistent with applicable local, state, and Federal laws and the stated objectives and intents of the FPHCP.

iii. Text in the recovery plan is the following:

> WDNR will produce annual reports on FPHCP compliance, per HCP requirements. NMFS will work closely with WDNR to address and resolve perceived non-compliance issues. WDNR is encouraged to seek involvement of representatives from the Lake Ozette Steering Committee to investigate and address compliance issues.

iv. Text in the recovery plan is the following:

> WDNR will coordinate and seek funding for FPHCP monitoring and adaptive management activities that complement implementation of recovery plan research, monitoring and adaptive management activities. Coordinate these activities closely with FPHCP Cooperative Monitoring, Evaluation and Research (CMER), recovery plan, ONP, tribal, and county research, monitoring and adaptive management actions.

v. Text in the recovery plan is the following:

> Clallam County will review and revise permit administrative procedures to integrate SMP administration with other regulatory processes and improve efficiency. Complete a thorough inventory of the shorelines within county jurisdiction to characterize shoreline ecological processes and functions. The inventory supports the development of SMP policies and regulations designed to achieve no net loss of ecological functions, and serve as the basis of a shoreline restoration plan for the county. Inventory also creates an overlay of shoreline structures and modifications with biological features to identify impairments to

ecological functions. WAC 173-20-130 identifies Ozette Lake as a lake of statewide significance.

Costs for SMP update may be funded by special appropriation by Washington State Legislature and/or grants administered by the Wa. Dept. of Ecology SEA program

vi. Source: Memorandum from Mike Haggerty, *Lake Ozette Sockeye Action Table April 12 2007*, May 15, 2007.

vii. Source: Memorandum from Mike Haggerty, *Lake Ozette Sockeye Action Table April 12 2007*, May 15, 2007. This estimate covers Priority I and II tributary sub-basins and does not include the Ozette River, which is covered below.

viii. Source: Memorandum from Mike Haggerty, *Lake Ozette Sockeye Action Table April 12 2007*, May 15, 2007. This estimate assumes the work will be done in conjunction with sediment assessment described in section 7.2.2.1 of the recovery plan.

ix. Source: Memorandum from Mike Haggerty, *Lake Ozette Sockeye Action Table April 12 2007*, May 15, 2007. This figure is based on a rough estimate of the scale and scope of the proposed action.

x. Source: Memorandum from Mike Haggerty, *Lake Ozette Sockeye Action Table April 12 2007*, May 15, 2007. This figure is based on a rough estimate of the scale and scope of the proposed action.

xi. Estimate: 11.1 acres @ $2,500/acre. Source: NWFSC, Memorandum on Habitat Restoration Action Cost Estimates, June 2007.

xii. Estimate: 9800 ft of road @ $80,000/mile. Source: NWFSC, Memorandum on Habitat Restoration Action Cost Estimates, June 2007.

xiii. Estimate: 1913 ft of road @ $80,000/mile - unit cost estimated from OWEB data. Source: NWFSC, Memorandum on Habitat Restoration Action Cost Estimates, June 2007.

xiv. Estimate: 9.1 acres @ $2,500/acre. Source: NWFSC, Memorandum on Habitat Restoration Action Cost Estimates, June 2007.

xv. Estimate: 4250 ft of exclusion fencing @ $13,000/mile. Source: NWFSC, Memorandum on Habitat Restoration Action Cost Estimates, June 2007.

xvi. Estimate: 1600 ft of road decommissioning @ $40K/mile + 685 ft of road relocation @ $80K/mile. Source: NWFSC, Memorandum on Habitat Restoration Action Cost Estimates, June 2007.

xvii. Estimate: 21.7 acres @ $2,500/acre. Source: NWFSC, Memorandum on Habitat

Restoration Action Cost Estimates, June 2007.

xviii. Estimate: 3680 ft of exclusion fencing @ $13,000/mile. Source: NWFSC, Memorandum on Habitat Restoration Action Cost Estimates, June 2007.

xix. Estimate: 1600 ft of road decommissioning @ $40K/mile + 685 ft of road relocation @ $80K/mile. Source: NWFSC, Memorandum on Habitat Restoration Action Cost Estimates, June 2007.

xx. Estimate: 7.1 acres @ $2,500/acre. Source: NWFSC, Memorandum on Habitat Restoration Action Cost Estimates, June 2007.

xxi. Estimate: 2250 ft of exclusion fencing @ $13,000/mile. Source: NWFSC, Memorandum on Habitat Restoration Action Cost Estimates, June 2007.

xxii. Estimate: 10,000 acres (time scale unknown) @ $2,500/acre. Source: Memorandum from Mike Haggerty, *Lake Ozette Sockeye Action Table April 12 2007*, May 15, 2007.

xxiii. Conservation easements typically cost 30-70% of acquisition price. Using a price of $2,500/acre (source: Memorandum from Mike Haggerty, *Lake Ozette Sockeye Action Table April 12 2007*, May 15, 2007), this would put easement costs at ~$1,250/acre.

xxiv. Estimate: Weir placement and removal: $142,560 (3 FTE @ $198/day*20 days *12 years); Weir operation: $742,560 (4 FTE @ $170/day *90days *12 years); Materials: 1) Initial purchase & installation: $76,800; 2) Repair materials, Petersen tags, equipment & consumables, otolith analysis contract: $10,650. Source: Communications with Tim Tynan, Joseph Hinton, and Caroline Peterschmidt, 16 May 2007.

xxv. Estimate: Broodstock holding and spawning: $9,216 (4 FTE @ $32/day * 6 days x 12 years); Materials: 1) Spawn & sampling supplies and equipment: $7,800 ($650 annually * 12 years); 2) MNFH iso-building set-up and annual operating costs: Unknown. Source: Communications with Tim Tynan, Joseph Hinton, and Caroline Peterschmidt, 16 May 2007.

xxvi. Estimate: Sockeye rearing and release: $504,000 (2.5 FTE @ $112/day * 150 days * 12 years); Sockeye marking: $220,320 (6 FTE @$204/day * 15 days * 12years); Materials: 1) Alarm systems: $24,450; 2) Feed & medications: $7,500; 3) Marking materials: $9,350. Source: Communications with Tim Tynan, Joseph Hinton, and Caroline Peterschmidt, 16 May 2007.

xxvii. Estimate: $34,100 * 12 years. Source: Communications with Tim Tynan, Joseph Hinton, and Caroline Peterschmidt, 16 May 2007.

xxviii. Estimate: Weir placement and removal: $2,250 annually (6 FTEs @ $125.00/day x 3 days/year); Weir monitoring and operation: $6,600 annually (0.4 FTEs @ $165/day x 100 days/year); Weir data collection and evaluation: $13,600 annually (1 FTEs @

$170/day x 80 days/year); Report writing: $3,920 (1 FTE @ $280/day * 14 days/year). Materials: 1) VCR tapes: $120/year; 2) Underwater camera: $200/year; 3) Misc repair and replacement parts: $400/year; 4) Weir replacement cost: $5,000 (VERY rough estimate); 5) Other costs: $4,500 (one time costs of viewing chamber + computer & VCR equipment estimate); Travel costs: Unknown (1 vehicle * 80 miles round trip daily * $0.35/mile * Unknown number of days). Source: Communications with Tim Tynan, Joseph Hinton, and Caroline Peterschmidt, 16 May 2007.

xxvix. Estimate: Trap placement and removal: $3,840 annually (4 FTEs @ $240/day x 4 days/year); Trap monitoring and operation: $8,100 annually (1 FTEs @ $180/day x 45 days/year); Trap data collection and evaluation: $3,920 annually (1 FTEs @ $280/day x 14 days/year); Materials: 1) Misc supplies (paper, nets, waders, batteries): $300/year; 2) Smolt trap repair and maintenance: $400/year; 3) With Calcein monitoring, one-time cost Calcein detection light and special glasses: $3,600; 4) Screw Trap one time cost: $25,000; Travel costs: Unknown (1 vehicle * 80 miles round trip twice daily * $0.35/mile * Unknown number of days). Source: Communications with Tim Tynan, Joseph Hinton, and Caroline Peterschmidt, 16 May 2007.

xxx. Estimate: Beach surveys: $3,200 annually (3 FTEs @ $213/day x 5 days/year); Tributary surveys: $7,200 annually (2 FTEs @ $180/day x 20 days/year); Survey data collection and stock status assessment: $1,120 annually (1 FTEs @ $280/day x 4 days/year); Materials: 1) Waders and raingear, msc supplies: $500/year; 2) Boat operations and maintenance for beach surveys: $400/year; 3) Wetsuit and associated gear one time cost: $500; 4) Assessment of otolith thermal marks: $3,000/year ($15/sample, 200 samples/year); Travel costs: Unknown (1 vehicle * 80 miles round trip per survey day * $0.35/mile * Unknown number of days); Miscellaneous: Any analyses of genetic information collected would be additional cost at approximately $45/sample. Source: Communications with Tim Tynan, Joseph Hinton, and Caroline Peterschmidt, 16 May 2007.

10 CITATIONS

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APPENDIX A- List of Steering Committee Member Participants

Name	Organization/Affiliation
Almond, Lyle	Makah Fisheries Management
Antrim, Liam	Olympic Coast National Marine Sanctuary
Barkhuis, Selinda	Clallam County
Barnes, Seth	WA Department of Natural Resources
Baumann, Cheryl	NOPLE (North Olympic Peninsula Lead Entity)
Bell, Harry	Green Crow
Bowen, Ed	Ozette Citizen
Brastad, Andy	Clallam County
Brenkman, Sam	Olympic National Park
Bruch, Lynn	Citizen and Landowner
Byrnes, Chris	WA Department of Fish and Wildlife
Byrnes, Coleman	Citizen and Property Owner
Christiansen, David	WA Department of Natural Resources
Crain, Pat	Olympic National Park
Creasey, Carol	Clallam County
Crewson, Mike	Tulalip Tribes
Crow, Tyler	Green Crow
Daily, Denise	Makah Tribal Member
Doherty, Mike	Clallam County Commissioner
Dunne-Devaney, Denise	Forks Forum, Editor
Field, Cam	Merrill and Ring
Fradkin, Steven	Olympic National Park
Freymond, Bill	WA Department of Fish and Wildlife
Furfey, Rosemary	National Marine Fisheries Service
Gaar, Elizabeth	National Marine Fisheries Service
Geyer, Frank	Quileute Tribe, Fisheries Biologist
Gilman, Jeremy	Makah Fisheries Management
Good, Tom	National Marine Fisheries Service
Haggerty, Mike	National Marine Fisheries Service Consultant
Hamerquist, Don	Citizen, Pysht River
Hinton, Joe	Makah Fisheries Management
Hooper, Thomas	National Marine Fisheries Service
Horton, Scott	WA Department of Natural Resources
Joner, Steven	Makah Fisheries Management
Knox, Randi	Citizen and Private Landowner
Krueger, Katie	Quileute Tribe, Staff Attorney
Lear, Cathy	Clallam County
Low, David	WA Department of Fish and Wildlife
MacIver, Ian	Rayonier
Martin, Doug	Martin Environmental Consulting
McBride, Mary	US Senator Patty Murray's Office
Miller, John	Clallam County
Miller, Phil	WA Governor's Salmon Recovery Office
Morris, Roy	Citizen
Murray, Joseph	Merrill and Ring

Ness, Pat	Citizen/Landowner
Northcut, Kris	Quileute Tribe, Fisheries Biologist
Osborne, Rich	North Pacific Coast Lead Entity
Peterschmidt, Caroline	USFWS, at Makah National Fish Hatchery
Plummer, Mark	National Marine Fisheries Service: Northwest Fisheries Science Center
Poon, Derek	EPA Region 10, Regional Salmon Ecologist
Porter, Janeen	Citizen
Riedel, Bill	Citizen
Ritchie, Andy	University of Washington
Rochelle, Jim	Rochelle Environmental Consulting
Rymer, Tim	WA Department of Fish and Wildlife
Sands, Norma Jean	NOAA, Puget Sound TRT
Schaaf, Norm	Merrill and Ring
Shaffer, Ann	WA Department of Fish and Wildlife
Shellberg, Jeff	Former Makah Tribe Staff
Sims, Gary	National Marine Fisheries Service
Snyder, Rob	Lost Resort at Lake Ozette
Solomon, Shelley	Clallam County
Sones, Dave	Makah Tribal Council
Springer, Jim	WA Department of Natural Resources
Svec, Russell	Makah Fisheries
Trask, Blake	Triangle Association, Inc.
Turner, Brian	WA Department of Natural Resources
Tynan, Tim	National Marine Fisheries Service
Vaughan, Al	WA Department of Natural Resources
Voner, Al	Olympic National Park
Wheeler, Bob	Triangle Associates, Inc. – Facilitator

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APPENDIX B- Habitat Based Population Recovery Goals

APPENDIX B. HABITAT-BASED POPULATION RECOVERY GOALS

1 INTRODUCTION

The purpose of this appendix is to explore the biological limits for Lake Ozette sockeye production. Since the Lake Ozette sockeye ESU is known to have been more abundant historically, it can be assumed that the lake could support increased production. Habitat capacity could be limited by food availability or spawning habitat capacity. A review of the available data and modeling results provides a basis for setting recovery goals.

2 FOOD AVAILABILITY AND COMPETITION

Lake Ozette provides a large rearing area capable of producing extremely large age 1+ sockeye smolts. Lake Ozette sockeye predominately emigrate as age 1+ smolts (LaRiviere 1990; MFM 1991; Jacobs et al. 1996). Recently collected otolith data (broodyears [BY] 2000, 2001, and 2002) indicate that less than 1 percent of sockeye emigrate as age 2+ smolts (n=981; MFM, unpublished otolith age data). Age 1+ smolt emigration is a common life history strategy employed by sockeye salmon within the southern range of the species (e.g., Lake Washington sockeye). Lake Ozette sockeye salmon smolts average between 113 to 130 mm (FL) for years 1978, 1984, 1989, 1990, 1991, and 1992 (Blum 1988; Jacobs et al 1996). Dlugokenski et al. (1981) evaluated the length and weight of Ozette sockeye smolts and concluded that they were the third largest yearling sockeye smolts in the documented literature. Recently collected smolt size data measured total length; smolts averaged 140 mm (TL; n=107) in 2003 and 144 mm (TL; n=231) in 2004.

Sockeye prey composition and availability, as well as competition for prey in Lake Ozette have been investigated in part or whole by Bortleson and Dion (1979), Dlugokenski et al. (1981), Blum (1988), Beauchamp and LaRiviere (1993), and Meyer and Brenkman (2001). Past surveys in Lake Ozette indicated that juvenile *O. nerka* occur at higher frequencies in the pelagic zone than all other fish species combined (Beauchamp and LaRiviere 1993). Approximately 94 percent of the fish >100mm (FL) caught in vertical gill nets in April 1991 were sockeye salmon pre-smolts or kokanee (Beauchamp et al 1995). *Daphnia pulicaria* dominate the diet of juvenile *O. nerka* salmon throughout the year (Beauchamp et al. 1995). Benthic invertebrates, adult insects, and copepods comprised 7-46 percent of the adult kokanee salmon diets from late-summer through early-spring (Beauchamp et al. 1995). Beauchamp et al. (1995) estimated that juvenile sockeye and all year classes of kokanee consumed far less than 1 percent of the monthly standing stock of *Daphnia pulicaria* > 1.0 mm in size, suggesting that food availability for rearing fish was not limiting *O. nerka* productivity.

All researchers (Bortleson and Dion 1979; Dlugokenski et al. 1981; Blum 1988; Beauchamp and LaRiviere 1993), independent of methodologies, have concluded that

Lake Ozette sockeye productivity and survival are not limited by food availability or competition. No direct estimates of total smolt production capacity of the lake have been developed. Blum (1988) used the Acre Plankton Index (API) model to estimate the carrying capacity of the lake and concluded that the lake could support total adult sockeye runs in the range of 306,000 to 563,000 (back calculations of adult run sizes based on API model results suggest smolt yields would range from 1.8 to 3.3 million per year at 17 percent marine survival). Blum (1988) concluded that spawning area limitations may represent the natural constraint to Lake Ozette sockeye abundance potential.

Beauchamp et al. (1995) determined that food supply is unlikely to limit large sockeye salmon enhancement efforts. They determined that competition for food resources would not limit extensive increases (10 – 50 fold) in age 0 sockeye fry production. Based on age 0 *O. nerka* population estimates during their study, it is suggested that the lake's zooplankton community could support annual fry production in the range of 40 to 80 million. Their analysis further suggests that the lake could support an annual smolt production of 2 to 8 million smolts (at 5 to10 percent fry to smolt survival[5]), given sufficient fry production. Smolts per spawner data are generally lacking for Ozette sockeye, but preliminary data for BY 2004 and return year (RY) 2008 suggest a range of 16 to 24 smolts[6] were produced per female spawner (MFM, unpublished sockeye population data). Given this range of current freshwater productivity it would require at least 640,000 spawners (assuming a 1:1 sex ratio) to fully seed the lake and produce 8 million sockeye smolts (see Figure B 1) and 80,000 spawners to produce 1 million smolts. If it is assumed that freshwater survival will double during the next 30 to 50 years, to 50 sockeye smolts per female spawner, then it would require 40,000 to 320,000 spawners to produce 1 to 8 million sockeye smolts.

[5] Literature average values for fry-to-smolt survival average 25.6 percent (summarized in Quinn 2005).
[6] Literature average values for smolts per female spawner average 75 (summarized in Quinn 2005).

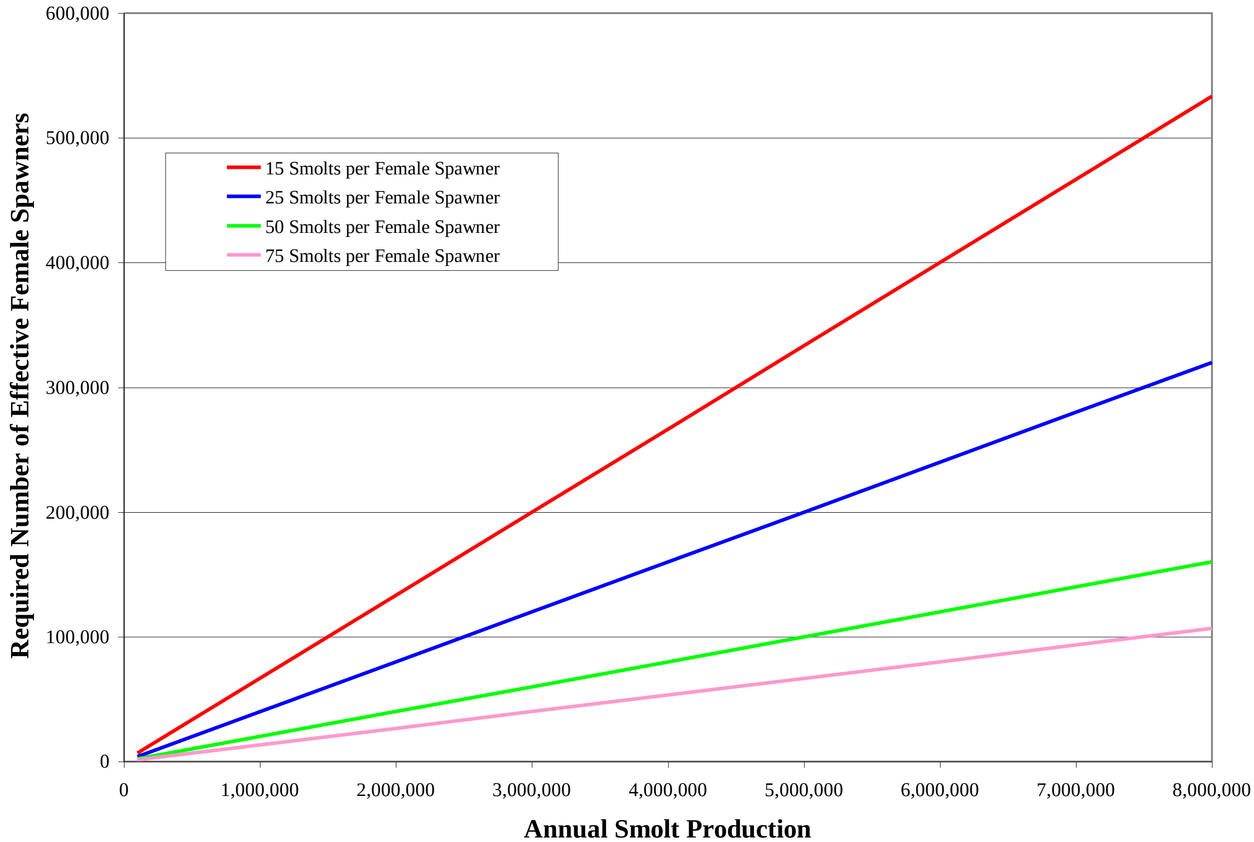


Figure B 1. Relationships between the required number of effective female spawners and the resulting range of annual smolt production values based on different smolts per female production yields.

The maximum sustainable annual smolt production capacity for Lake Ozette remains unknown. Future monitoring of the juvenile O. nerka population and the zooplankton community will help refine estimates of capacity. Currently (2002 to present) the lake is producing 35,000 to 70,000 sockeye smolts per year. Current smolt production has been 4 to 10 times higher than reported in Jacobs et al. (1996) for emigrations occurring between 1977 and 1992. Smolt size and smolts per spawner have remained constant or slightly increased, further suggesting that food limits in the lake are not being affected by increased juvenile abundance.

3 SPAWNING HABITAT CAPACITY

Spawning habitat availability and sockeye spawning capacity have been evaluated by past researchers working in Ozette but were re-evaluated based on extensive freshwater habitat inventories conducted in recent years and summarized in Haggerty and Ritchie (2004) and Haggerty et al. (2009). In addition, past efforts have not established beach spawning aggregation targets.

3.1 BEACH SPAWNING HABITAT CAPACITY

There are two known active beach spawning sites along the shores of Lake Ozette: Allen's and Olsen's Beaches. Spawning ground surveys conducted in 1978 and 1979 also found ~30 sockeye spawning just north of the confluence with Umbrella Creek (Umbrella Beach; Dlugokenski et al. 1981). The only other record of beach spawning sockeye locations is a one-time observation of a pair of sockeye spawning on the southwest shoreline of Baby Island (Meyer and Brenkman 2001). It is important to note that current and recent spawning locations, as well as vegetation and substrate conditions along the lake shoreline, may not be representative of past spawning distribution and shoreline conditions. Kemmerich (1926) stated that, "*The shores of the lake afford many ideal spawning beds and over a large area, also numerous small streams of gravel bottom empty into the lake which are ideal spawning beds*." Kemmerich (1939) also recalled that, "*We made no special investigations of spawning beds during the years* [1923-1926] *but merely observed from time to time that most of the spawning seemed to be along the lake shore in suitable places and especially at the mouths of the several creeks.*" Nonetheless spawning habitat capacity for Ozette beaches in this analysis was only calculated for Allen's, Olsen's, Baby Island, and Umbrella Beaches.

Spawning habitat quality and quantity have been greatly reduced during the last 50 to 100 years from historical conditions. Factors contributing to decline in beach spawning habitat quality and quantity are discussed in detail in the Lake Ozette Sockeye LFA (Haggerty et al. 2009). Spawning habitat capacity estimates assume restored beach conditions for spawning habitat area calculations. In a review of the scientific literature no methods for determining spawning habitat capacity for beach spawning sockeye could be found. Beach spawning sockeye require both suitable substrate size and adequate flow for egg incubation (Foerster 1968). Sufficient intra-gravel flow may be provided by upwelling from springs and seeps, wave action, and/or lake currents. Intra-gravel flow data are not available for Ozette spawning beaches. Spawning use along Olsen's and Allen's Beaches, categorized as concentrated or dispersed, is thought to be a good indicator of where intra-gravel flow is sufficient to incubate eggs. Experiments with beach spawners in Lake Dalnee (Kamchatka) have shown that sockeye placed in penned-off areas with suitable substrate size but no intra-gravel flow do not deposit their eggs and die (Krogius and Krokhin 1956 *in* Foerster 1968).

3.1.1 Olsen's Beach Estimate

The quantity of suitable habitat for Olsen's Beach was estimated using recent spawning ground observations (1978-2004; summarized in Haggerty et al. 2009), and high resolution geo-rectified aerial photos. Spawning habitat was categorized based on current use: concentrated (including core use) and dispersed (Figure B 2). Spawning habitat polygons were delineated in ArcMap using aerial photos, where depths were estimated to be 1-3 meters during the spawning season along the entire length of Olsen's Beach.

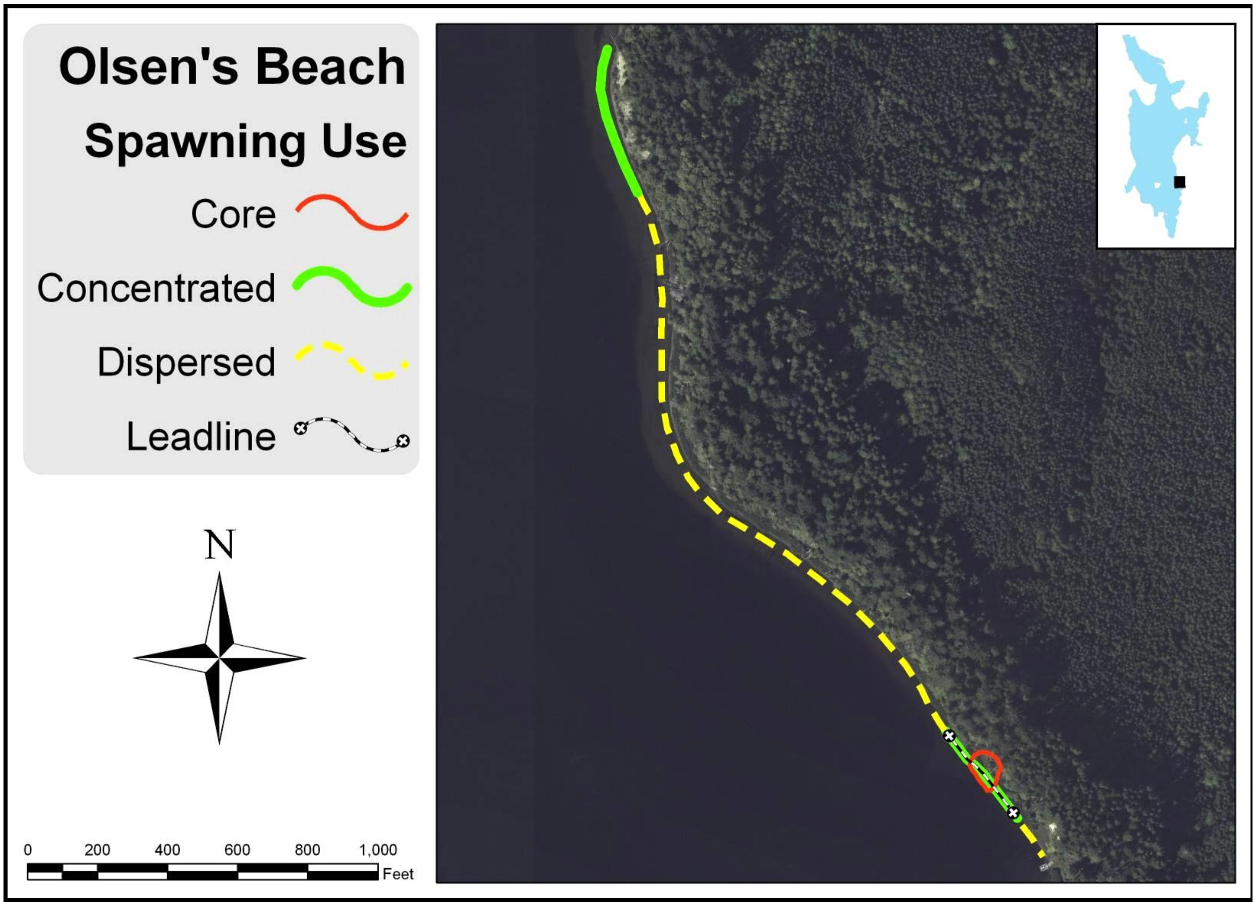


Figure B 2. Depiction of current Olsen's Beach sockeye spawning use categorized as concentrated, core, and dispersed, as well as the relative position of the spawning ground survey lead line used for data collection in 1999, 2000, and 2001 (source: Haggerty et al. 2009).

Two methods were used to estimate total spawning capacity on Olsen's Beach. Both methods assume a 1:1 sex ratio. Method 1 assumes the use of 3 square meters per female[7] and 100 percent suitable area utilization (defined by polygons) without overlapping redds within the concentrated spawning use habitat type. Spawning capacity in dispersed habitat areas was assumed to be one-third that of concentrated (based upon maximum range of spawning densities reported at full seeding levels of suitable habitat). Method 2 assumes 3 female spawners per linear meter of spawning beach in concentrated use areas and 1 female spawner per linear meter of spawning habitat in dispersed use areas. Spawning capacity for Olsen's Beach using methods 1 and 2 were 3,416 and 2,622 spawners respectively (Table B 1).

[7] The 3 square meters/per female is based on a review of natural spawning densities presented in Foerster 1968.

Table B 1. Summary of spawning habitat length and area and estimated spawning capacity using methods 1 and 2.

Sockeye Use Category	Habitat Length (Meters)	Habitat Area (Sq. Meters)	Method 1		Method 2	
			Sockeye Redd Capacity	Total Sockeye Spawners	Sockeye Redd Capacity	Total Sockeye Spawners
Concentrated	232	3,186	1,062	2,124	695	1,390
Dispersed	616	5,815	646	1,292	616	1,233
TOTAL	848	9,001	1,708	3,416	1,311	2,622

3.1.2Allen's Beach Estimate

The quantity of suitable habitat for Allen's Beach was estimated using recent spawning ground observations (1978-2004; summarized in Haggerty et al. 2009), spawning substrate characterization, and high resolution geo-rectified aerial photos. Spawning habitat was categorized based on current use: concentrated and dispersed (Figure B 3). Spawning habitat polygons were delineated in ArcMap using aerial photos where depths were estimated to be 1-3 meters during the spawning season along the entire length of Allen's Beach. The two methods used to estimate spawning capacity at Allen's Beach were the same as those described above for Olsen's Beach. Spawning capacity for Allen's Beach using methods 1 and 2 were 8,903 and 7,318 spawners respectively (Table B 2).

Table B 2. Summary of spawning habitat length and area and estimated spawning capacity using methods 1 and 2.

Sockeye Use Category	Habitat Length (Meters)	Habitat Area (Sq. Meters)	Method 1		Method 2	
			Sockeye Redd Capacity	Total Sockeye Spawners	Sockeye Redd Capacity	Total Sockeye Spawners
Concentrated	699	7,569	2,523	5,046	2,097	4,193
Dispersed	1,562	17,359	1,929	3,858	1,562	3,124
TOTAL	2,261	24,928	4,452	8,903	3,659	7,318

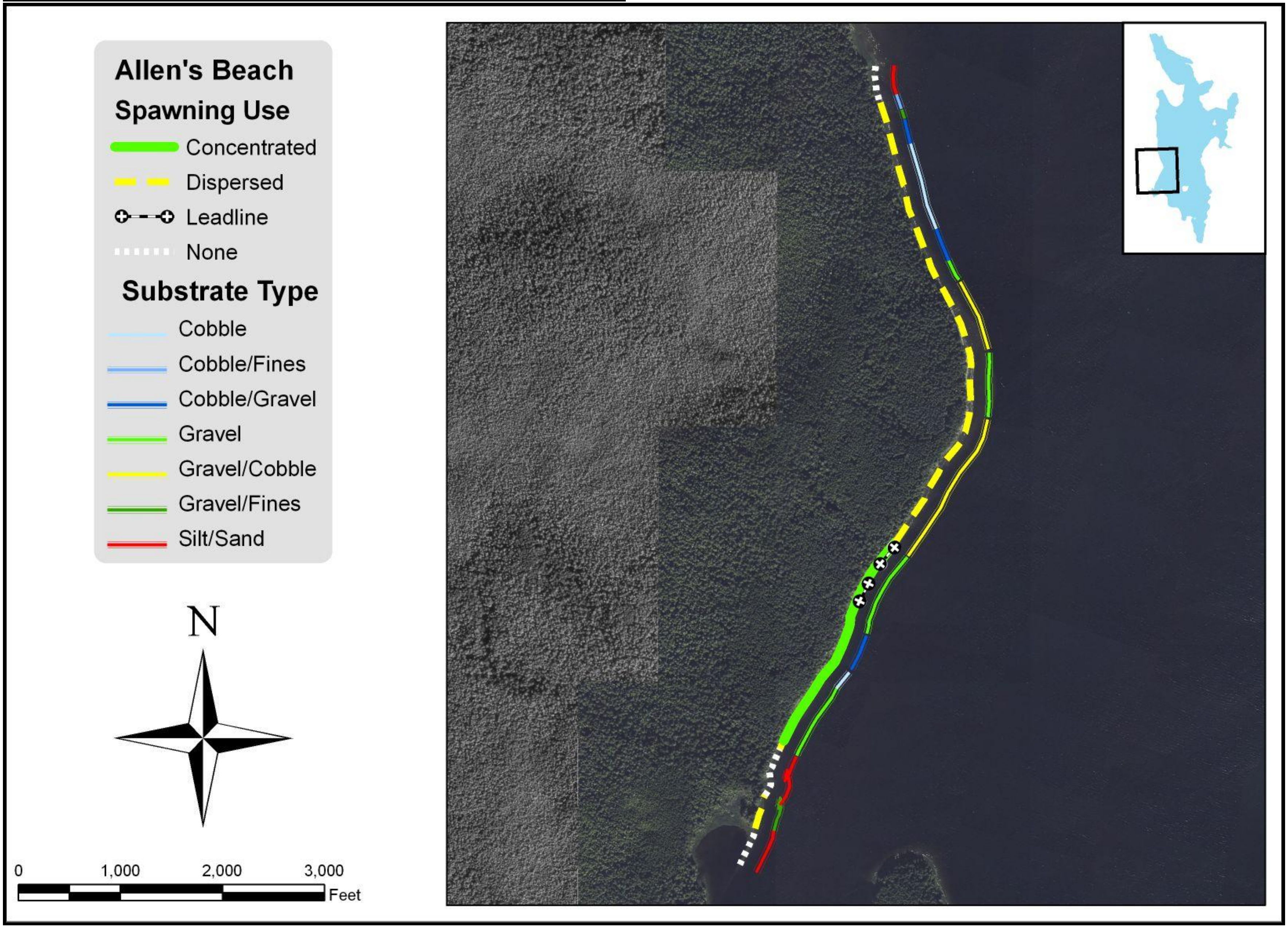


Figure B 3. Map depicting Allen's Beach spawning use and dominant substrate types (source: Haggerty et al. 2009).

3.1.3 Umbrella Beach Estimate

The quantity of future suitable habitat at Umbrella Beach was estimated using high resolution geo-rectified aerial photos in ArcMap. Beach spawning has not been documented since the 1970s at Umbrella Beach; therefore, it is difficult to anticipate how much suitable habitat can develop there and how fish utilization will occur. Three spawning habitat polygons were delineated in ArcMap using aerial photos where depths were estimated to be 1-3 meters during the spawning season along the south, north, and northwest portions of the Umbrella Creek beach. Due to the large potential area of suitable habitat that may be recovered, all habitat was assigned a dispersed spawning use for this capacity estimate. Methods to estimate spawner capacity were the same as those described above for Olsen's Beach. Spawning capacity estimates for Umbrella Beach using methods 1 and 2 were 2,661 and 924 spawners respectively.

3.1.4 Baby Island Estimate

The quantity of suitable habitat was estimated using recent spawning ground observations (1978-2004; summarized in Haggerty et al. 2009), spawning substrate characterization, and high resolution geo-rectified aerial photos. Very little spawning habitat at Baby Island has been documented. One spawning habitat polygon was delineated in ArcMap using aerial photos where depths were estimated to be 1-3 meters during the spawning season along the southwest side of Baby Island. The total length and area of this potential spawning site are 34 meters and 198 square meters respectively. Methods to estimate spawner capacity were the same as those described above for Olsen's Beach. The entire area was assumed to have concentrated spawning use. Spawning capacity estimates for Baby Island using methods 1 and 2 were 132 and 204 spawners respectively.

3.1.5 Summary of Beach Spawning Habitat Capacity

All spawning habitat capacity estimates are crude, but based on the best available information for Lake Ozette sockeye spawning beaches. These estimates could drastically underestimate the total lake spawning habitat capacity because many areas where suitable habitat historically existed or where future habitat may develop were not included in these calculations. In addition, spawning at depths greater than 3 meters could be an important component of the spawning population in the future. Table B 3 depicts the estimated spawning capacity for Allen's, Olsen's, Baby Island, and Umbrella Beaches.

Table B 3. Summary of spawning habitat lengths and areas and estimated spawning capacity using methods 1 and 2 for historic and currently utilized Lake Ozette spawning beaches.

Beach Area	Concentrated Use		Dispersed Use		Method 1		Method 2	
	Length (m)	Area (sq m)	Length (m)	Area (sq m)	Redds	Total Sockeye Spawners	Redds	Total Sockeye Spawners
Allen's Beach	699	7,569	1,562	17,359	4,452	8,903	3,659	7,318
Olsen's Beach	232	3,186	616	5,815	1,708	3,416	1,311	2,622
Umbrella Beach	na	na	462	11,977	1,331	2,661	462	924
Baby Island	34	198	na	Na	66	132	102	204
TOTALS	**965**	**10,953**	**2,641**	**35,151**	**7,557**	**15,113**	**5,534**	**11,068**

3.2 TRIBUTARY SPAWNING HABITAT CAPACITY

Researchers (Bortleson and Dion 1979; Dlugokenski et al. 1981; Blum 1988) in the past have attempted to quantify tributary spawning habitat capacity for Ozette tributaries. All of these estimates were made during a period when sockeye salmon were not utilizing spawning habitat in tributaries. These estimates of spawning habitat capacity are included below. Currently sockeye salmon spawn in several areas that were not identified as suitable spawning habitat in past estimates. In addition, extensive channel and habitat data were collected for all sockeye spawning streams in 1999 and 2000, allowing for more accurate estimates of available spawning habitat. Therefore, new estimates of spawning habitat capacity were conducted as part of this analysis.

3.2.1 Past Tributary Spawning Habitat Capacity Estimates

Three separate estimates of tributary spawning habitat capacity were conducted between 1977 and 1988. These capacity estimates are depicted in Table B 4. Bortleson and Dion (1979) estimated spawning habitat capacity for Umbrella Creek and Big River using peak-unit spawnable area obtained from equations using average wetted channel width at preferred flows and visual estimates of the length of stream channel suitable for sockeye spawning. Dlugokenski et al. (1981) used the results from Bortleson and Dion (1979) and applied the same methods to Siwash Creek, Crooked Creek, and one unnamed tributary (others in Table B 4). Bortleson and Dion (1979) and Dlugokenski et al. (1981) also present spawnable area estimates produced by Washington Department of Fisheries based on field surveys. Blum (1988) presents an estimated capacity of total redds but does not provide details on the methods used.

All researchers, independent of method, produced estimates within a fairly tight range; however, all the researchers based their methods on the same general assumptions, and likely made their suitable area calculations from the same set of field measurements. Spawning capacity estimates for tributaries ranged from 33,732 (Bortleson and Dion 1979 [low end estimate]) to 64,720 sockeye spawners (Dlugokenski et al 1981 [high end of range]).

Table B 4. Summary of spawning habitat capacity estimates.

Study (Citation)	Capacity Parameter	Umbrella Creek	Big River	Other Tributaries
Bortleson and Dion (1979)	River Mile Usage	RM 0.0 - 4.0	RM 3.0 - 9.0	na
	Area of spawning habitat at preferred flow (sq meters)	25,920 ± 6,940	32,610 ± 9,198	na
	Number of potential redds at preferred flow (2.51 sq m/ redd)	10,333 ± 2,767	13,000 ± 3,700	na
WDF *in* Dlugokenski et al. (1981)	River Mile Usage	RM 0.0 - 4.0	RM 3.0 - 9.0	na
	Area of suitable spawning habitat	25,084	32,610	na
	Number of potential redds (2.51 sq m/ redd)	10,000	13,000	na
Dlugokenski et al. (1981)	River Mile Usage	RM 0.0 - 4.0	RM 3.0 - 9.0	na
	Area of spawning habitat at preferred flow (sq meters)	25,920 ± 6,940	32,610 ± 9,198	5,017 ± 1,421
	Number of potential redds at preferred flow (2.51 sq m/ redd)	10,333 ± 2,767	13,000 ± 3,700	2,000 ± 560
Blum (1988)	Total Redds	30,000		

3.2.2 New Tributary Spawning Habitat Capacity Estimates

Two methods were used to estimate the quantity of suitable spawning habitat in Lake Ozette sockeye tributaries. Spawning habitat availability was only estimated for streams designated as Critical Habitat under the ESA. However, a significant quantity of suitable spawning habitat not designated as Critical Habitat could also be used by sockeye salmon in Ozette tributaries. No tributary sockeye salmon spawning has been documented outside of the stream segments currently designated as Critical Habitat. Each method presented below assumes that each female sockeye utilizes 3 square meters of suitable habitat. Measurements of redd size are not available for Ozette sockeye in tributaries but redd area data are available for other stream spawning sockeye stocks and range from 1.3 to 2.0 square meters (Foerster 1968). Past spawning habitat capacity methods employed in Ozette have used a similar range in redd size and have estimated capacity based upon the space required to separate individual redds with no overlapping redds. The assumption of 3 square meters per spawning female was used in this analysis so that comparisons between methods (past and new) were based upon similar spawning densities and focused more on distinguishing differences in suitable area.

Back calculations of actual female spawning densities on spawning grounds show that sockeye salmon can spawn at much higher densities than 3 square meters per female and still result in increased fry production. Data summarized in Foerster (1968) provide examples of densities as high as 1 female sockeye per 0.6 to 1.3 square meters in high density spawning populations. In the Adams River, during the dominant brood cycles in 1950, 1954, and 1958, female spawners per square meter of spawning habitat area utilized were 0.5, 1.4, and 2.2 respectively (IPSFC 1971; range of 2 to 0.45 square meters/female). The IPSFC (1971) found that optimal spawning densities in utilized spawning habitat for the Adams River were one female per 0.8 to 1.2 square meters. Within the Adams River suitable/utilized spawning habitat relative to average wetted width during the spawning season ranged from 51 to 89 percent. Burgner (1991) reports that in Bristol Bay stream spawning areas, capacity estimates are based on one female sockeye per 2 square meters. Maximum fry production per unit area in spawning channels in the Babine Lake system are achieved at a spawner density of about 1 female per square meter (Burgner 1991).

Streamflow measurements and other observations in Ozette tributaries indicate that average streamflow during the sockeye season results in wetted widths equal to 50-90 percent of the channel width depending upon cross-section site. Streamflow records and suitable flow conditions within channel cross-sections relative to channel width were examined in Umbrella Creek and Big River. It was determined that within areas where suitable substrate exists, at mean winter discharge 80 to 60 percent of the channel width could be utilized for sockeye spawning. However, these estimates are derived from only a few channel cross-sections.

Estimates of spawning habitat availability and spawning habitat capacity are based upon thousands of channel and habitat measurements conducted in Lake Ozette tributaries during 1999 and 2000. Channel data (slope, channel width, summer low flow wetted width) were collected at 15 to 33 meter intervals. Habitat data were collected continuously throughout each stream system. Stream channels were divided into major channel segments based upon channel confinement, slope, channel width, and major tributary confluences. Within each channel segment habitat sub-segments were established at ~500 meter intervals (see Haggerty and Ritchie 2004). These data are the basis for all spawning habitat availability calculations presented below. A summary of results and data are included in Appendix B-1

Method 1: Suitable spawning habitat area was calculated for each habitat sub-segment based on the following set of assumptions: 1) 80 percent of the channel width is suitable for sockeye spawning, 2) 80 percent of riffle habitat length is suitable spawning habitat, 3) Within pool habitat units, 20 percent of the pool length provides suitable spawning habitat (glides and pool tailouts).

Method 2: Suitable spawning habitat area was calculated for each habitat sub-segment based on the following set of assumptions: 1) 60 percent of the channel width is suitable for sockeye spawning, 2) 80 percent of the riffle length is suitable spawning habitat, 3) Within pool habitat units, 20 percent of the pools length provides suitable spawning habitat (glides and pool tailouts).

The resulting spawning habitat capacity from Methods 1 and 2, reported in total spawners per habitat sub-segment for the Umbrella, Big, and Crooked subbasins, is depicted in Figure B 4 through Figure B 6. Each figure also contains a segment level spawner capacity estimate for each method. These two methods of estimating spawning capacity result in a range of 79,247 to 105,528 sockeye spawners (assuming a 1:1 sex ratio). Table B 5 depicts the stream length containing suitable spawning habitat, estimated spawning habitat area, and spawning habitat capacity for each subbasin for each of the methods used to estimate capacity. Note that these estimates were only conducted for streams currently utilized for sockeye spawning and/or streams containing suitable spawning habitat designated as Critical Habitat. Additional suitable habitat outside of these habitat sub-segments may be used by spawning sockeye salmon in the future. All of the channel segments containing suitable sockeye spawning habitat that were not included in the sockeye spawning capacity estimate are currently used by coho salmon for spawning.

Table B 5. Spawning habitat capacity estimates using Methods 1 and 2 for the Umbrella, Big, and Crooked subbasins.

Subbasin	Total Stream Length Containing Suitable Habitat (Meters)	Method 1		Method 2	
		Area (Sq. Meters)	Spawners	Area (Sq. Meters)	Spawners
Umbrella Creek	13,898	64,205	42,803	48,304	32,202
Big River	14,629	75,971	50,648	56,978	37,986
Crooked Creek	6,072	18,115	12,077	13,588	9,059
TOTAL	**34,599**	**158,291**	**105,528**	**118,870**	**79,247**

Sub-Basin	Stream	Segment	Length (Meters)	Method 1 Total Spawners	Method 2 Total Spawners
UMBRELLA CREEK	Umbrella Creek	1	1,300	4,021	3,015
	Umbrella Creek	2	4,700	15,561	11,671
	Umbrella Creek	3	1,500	5,218	3,914
	Umbrella Creek	4	1,000	4,350	3,262
	Umbrella Creek	5	1,700	6,315	4,736
	Umbrella Creek	6	772	1,611	1,208
	Hatchery Creek	1	457	400	400
	EB Umbrella Creek	1	1,600	3,725	2,794
	EB Umbrella Creek	2	869	1,602	1,202
	UMBRELLA CREEK TOTAL			42,803	32,202

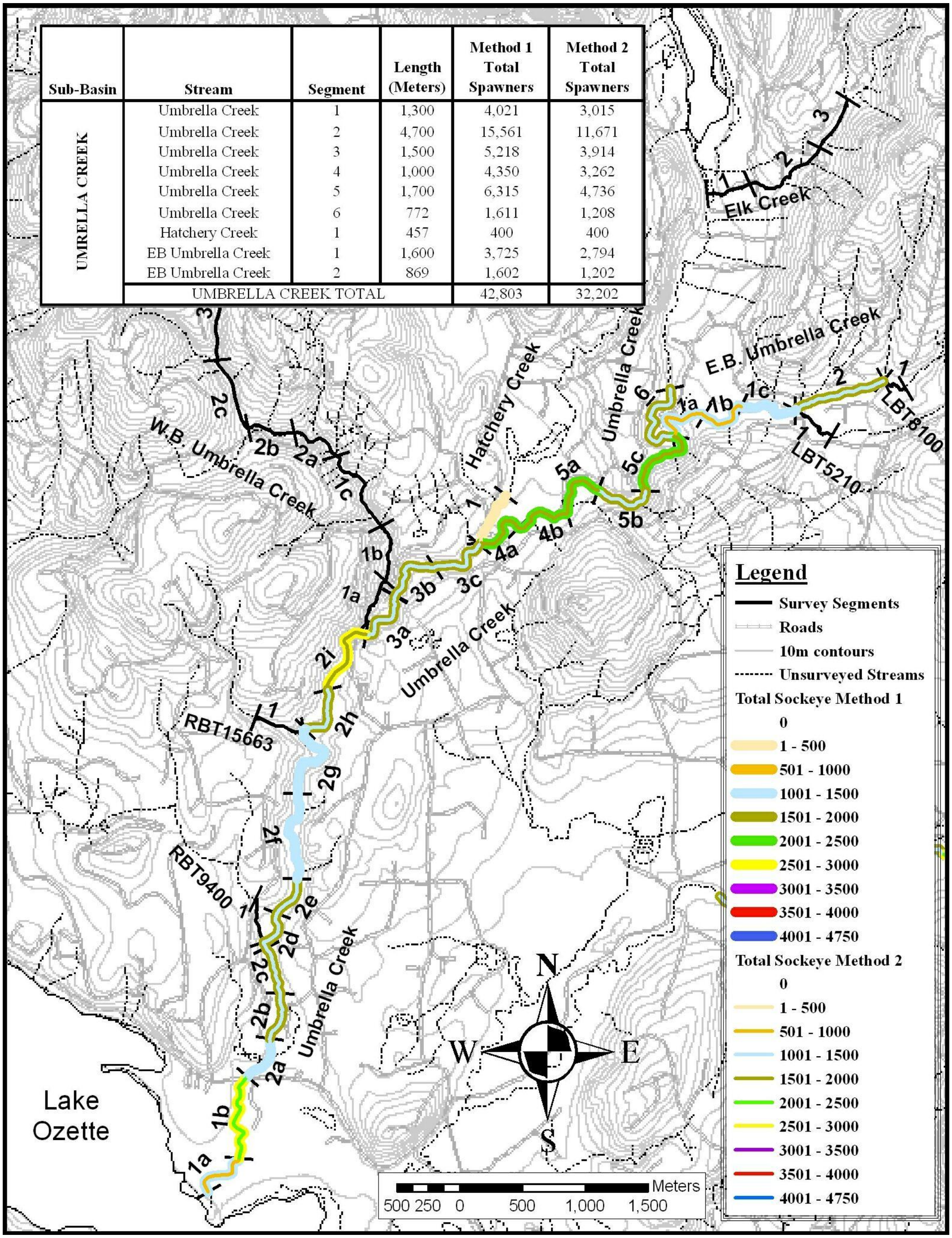
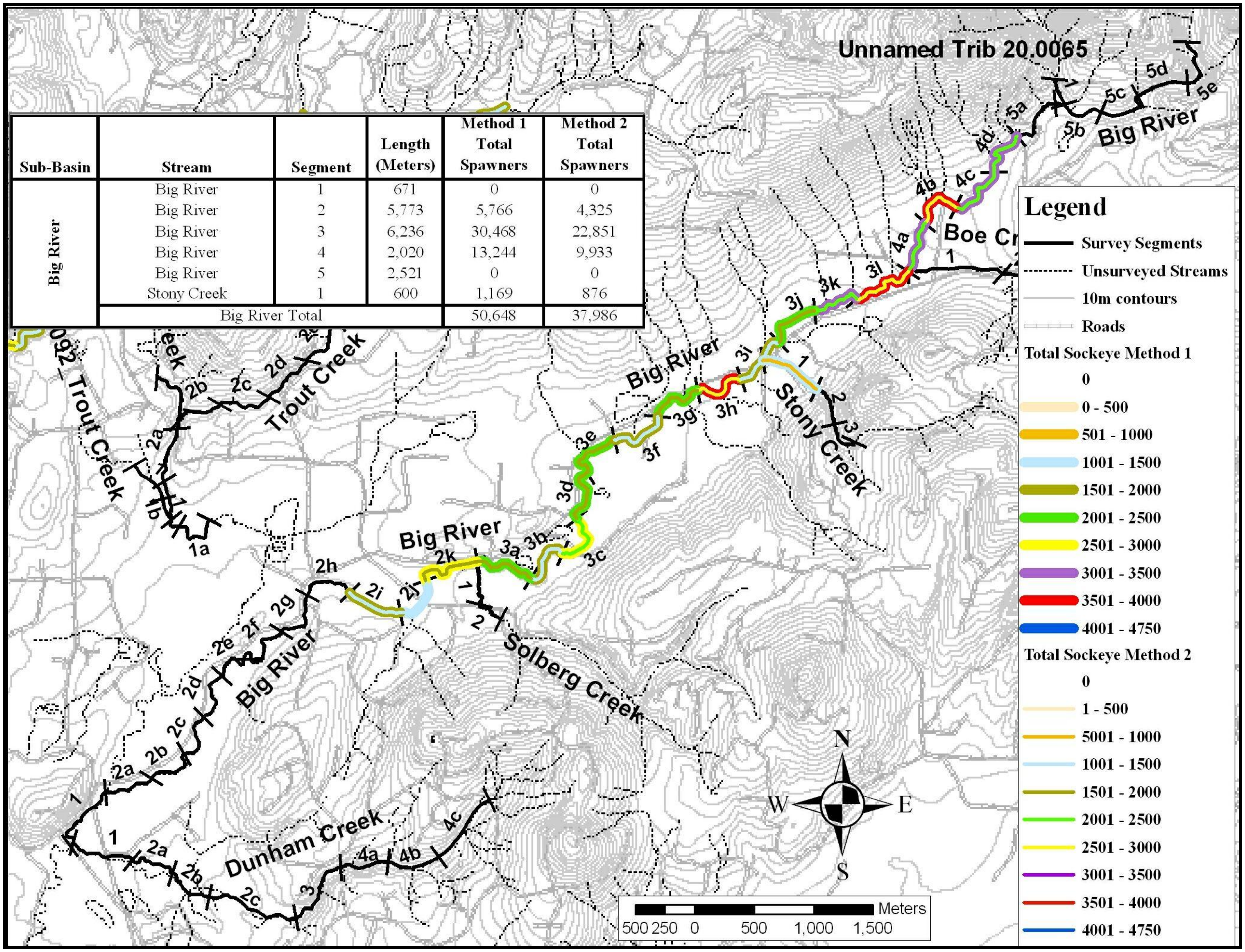
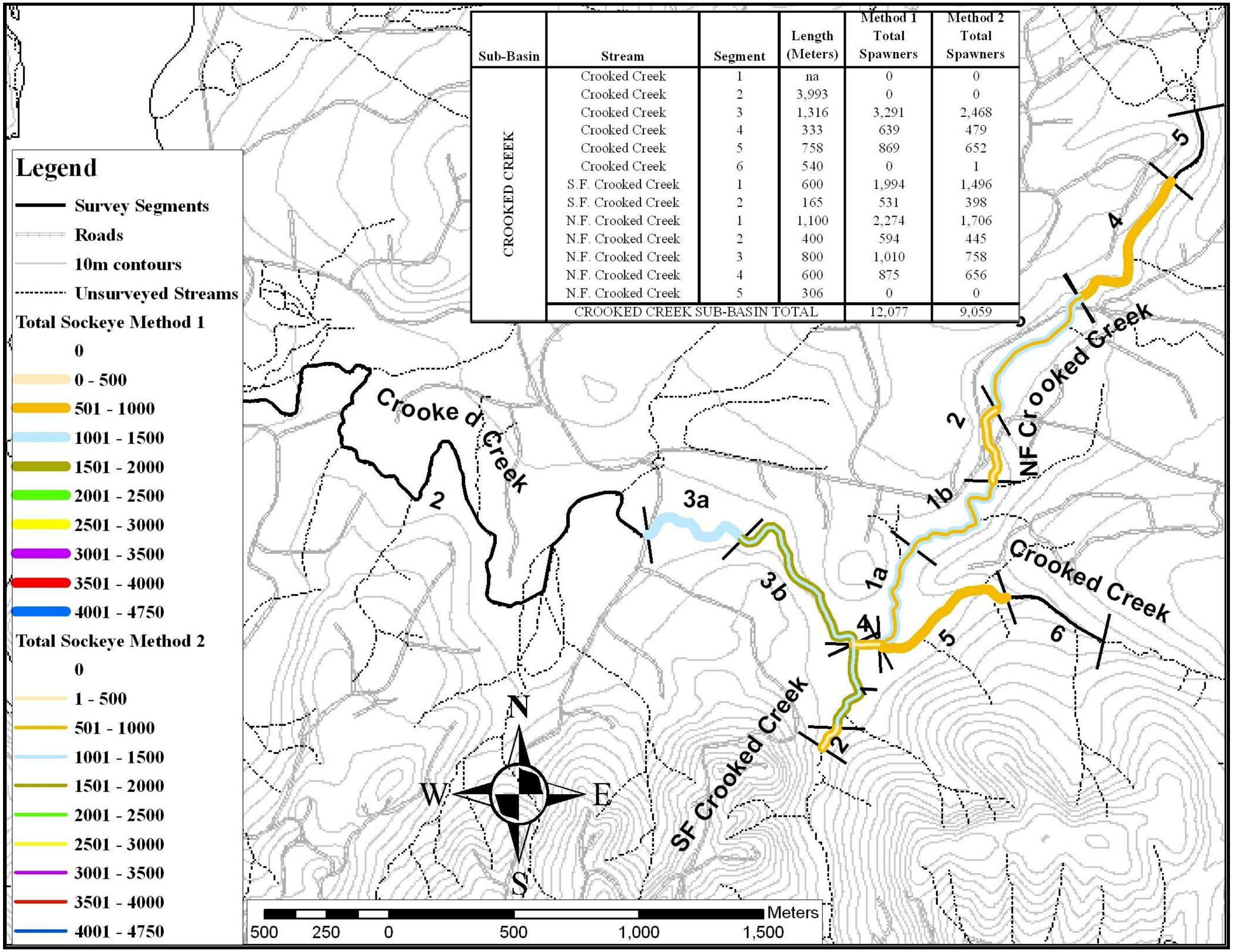


Figure B 4. Estimated number of sockeye spawners at 100 percent usage of suitable spawning habitat, by habitat sub-segment using Methods 1 and 2 for the Umbrella Creek subbasin.



Sub-Basin	Stream	Segment	Length (Meters)	Method 1 Total Spawners	Method 2 Total Spawners
Big River	Big River	1	671	0	0
	Big River	2	5,773	5,766	4,325
	Big River	3	6,236	30,468	22,851
	Big River	4	2,020	13,244	9,933
	Big River	5	2,521	0	0
	Stony Creek	1	600	1,169	876
	Big River Total			50,648	37,986

Figure B 5. Estimated number of sockeye spawners at 100 percent usage of suitable spawning habitat, by habitat sub-segment using Methods 1 and 2 for the Big River subbasin.



Sub-Basin	Stream	Segment	Length (Meters)	Method 1 Total Spawners	Method 2 Total Spawners
CROOKED CREEK	Crooked Creek	1	na	0	0
	Crooked Creek	2	3,993	0	0
	Crooked Creek	3	1,316	3,291	2,468
	Crooked Creek	4	333	639	479
	Crooked Creek	5	758	869	652
	Crooked Creek	6	540	0	1
	S.F. Crooked Creek	1	600	1,994	1,496
	S.F. Crooked Creek	2	165	531	398
	N.F. Crooked Creek	1	1,100	2,274	1,706
	N.F. Crooked Creek	2	400	594	445
	N.F. Crooked Creek	3	800	1,010	758
	N.F. Crooked Creek	4	600	875	656
	N.F. Crooked Creek	5	306	0	0
	CROOKED CREEK SUB-BASIN TOTAL			12,077	9,059

Figure B 6. Estimated number of sockeye spawners at 100 percent usage of suitable spawning habitat, by habitat sub-segment using Methods 1 and 2 for the Crooked Creek subbasin.

4 TOTAL ADULT ABUNDANCE GOALS

Spawning habitat capacity estimates for Ozette beaches and tributaries range from 90,315 (Beach Method 2 and Stream Method 2) to 120,641 (Beach Method 1 and Stream Method 1). These estimates are based upon a relatively low spawning density target (1 female per 3 sq meters of suitable habitat). At higher spawning densities (e.g., 1 female/sq meter) the spawning capacity would be three times higher than the range presented above. The results from Method 1 for the beaches and tributaries, presented above, are a conservative estimate of the watershed's spawning habitat capacity. As habitat conditions continue to recover and the sockeye population expands, a review of these goals will be necessary in order to refine watershed spawning and smolt production capacity estimates. Population abundance data at different life-history stages will be critical to refinement of these goals.

Based upon a spawning escapement of 120,600 sockeye (60,300 females), under the current freshwater productivity range of 16 to 24 smolts per female, resulting smolt production would range between 0.96 and 1.45 million (near the lower range of estimated smolt production capacity of the lake). Under improved freshwater survival conditions where 50 smolts per female could be produced, smolt production would be closer to 3.0 million. Smolt production of 1 to 3 million sockeye smolts/year and average marine survival conditions (~17 percent) would result in adult run sizes in the range of 170,000 to 510,000.

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APPENDIX B.1: Channel and Habitat Sub-Segment Data Summaries and Estimated Spawning Areas Using Methods 1 and 2

Appendix B.1. Channel and Habitat Sub-Segment Data Summaries and Estimated Spawning Areas Using Methods 1 and 2.

Stream Name	WRIA No.	Habitat Sub-Segment	PS-ID	Length (m)	Gradient Percent	Channel Confine-ment	Channel Width	Spawn Segment ID	Percent Pool	Riffle Length (m)	Method 1 Suitable Area (Sq. M)	Method 2 Suitable Area (Sq. M)
Umbrella Creek	20.0052	1a	PS-22	500	<1	U	15.9	22	87	65.0	1,768	1,326
Umbrella Creek	20.0052	1b	PS-23	800	<1	U	18.4	23	73	216.0	4,263	3,197
Umbrella Creek	20.0052	2a	PS-24	500	<1	U	14.7	24	72	140.0	2,164	1,623
Umbrella Creek	20.0052	2b	PS-25	500	<1	U	18.6	25	71	145.0	2,783	2,087
Umbrella Creek	20.0052	2c	PS-26	500	<1	U	16.7	26	74	130.0	2,378	1,784
Umbrella Creek	20.0052	2d	PS-27	500	<1	U	15.8	27	66	170.0	2,553	1,915
Umbrella Creek	20.0052	2e	PS-28	500	<1	U	17.1	28	72	140.0	2,517	1,888
Umbrella Creek	20.0052	2f	PS-29	500	<1	U-M	16.4	29	81	95.0	2,060	1,545
Umbrella Creek	20.0052	2g	PS-30	500	<1	U	16.5	30	79	105.0	2,152	1,614
Umbrella Creek	20.0052	2h	PS-31	500	<1	U	17.1	31	62	190.0	2,928	2,196
Umbrella Creek	20.0052	2i	PS-32	700	<1	U-M	13.6	32	50	350.0	3,808	2,856
Umbrella Creek	20.0052	3a	PS-33	500	1-2	M	12.7	33	46	270.0	2,662	1,996
Umbrella Creek	20.0052	3b	PS-34	500	1-2	M-C	12.8	34	59	205.0	2,284	1,713
Umbrella Creek	20.0052	3c	PS-35	500	1-2	M-C	11.4	35	28	360.0	2,882	2,161
Umbrella Creek	20.0052	4a	PS-36	500	1-2	U-M	13.5	36	37	315.0	3,121	2,341
Umbrella Creek	20.0052	4b	PS-37	500	1-2	U-M	15.7	37	43	285.0	3,404	2,553
Umbrella Creek	20.0052	5a	PS-38	500	1-2	C	13.0	38	25	375.0	3,380	2,535
Umbrella Creek	20.0052	5b	PS-39	500	1-2	C	10.1	39	22	390.0	2,699	2,024
Umbrella Creek	20.0052	5c	PS-40	700	1-2	C	9.5	40	27	511.0	3,394	2,546
Umbrella Creek	20.0052	6	PS-41	772	1-2	M-C	6.7	41	36	494.1	2,417	1,812
E.B. Umbrella Creek	20.0057	1a	PS-49	500	0-2	M-C	7.8	49	28	360.0	1,972	1,479
E.B. Umbrella Creek	20.0057	1b	PS-50	500	0-2	M-C	7.3	50	42	290.0	1,600	1,200
E.B. Umbrella Creek	20.0057	1c	PS-51	600	0-2	M	8.2	51	48	312.0	2,015	1,511
E.B. Umbrella Creek	20.0057	2	PS-52	869	1-2	U-M	5.8	52	34	573.5	2,403	1,802
Hatchery Creek	20.0056	1	PS-117	457	2.80	M-C	5.5	117	0	457.0	na	na
Big River	20.0058	2i	PS-65	500	<1	U	20.6	65	77	115.0	2,785	2,089
Big River	20.0058	2j	PS-66	500	<1	U	22.1	66	95	25.0	2,033	1,525
Big River	20.0058	2k	PS-67	744	<1	U	20.9	67	82	133.9	3,831	2,874
Big River	20.0058	3a	PS-68	556	0.1-2	U	20.7	68	74	144.6	3,278	2,458
Big River	20.0058	3b	PS-69	500	0.1-2	U	20.6	69	81	95.0	2,587	1,941

Stream Name	WRIA No.	Habitat Sub-Segment	PS-ID	Length (m)	Gradient Percent	Channel Confine-ment	Channel Width	Spawn Segment ID	Percent Pool	Riffle Length (m)	Method 1 Suitable Area (Sq. M)	Method 2 Suitable Area (Sq. M)
Big River	20.0058	3c	PS-70	500	0.1-2	U	20.0	70	43	285.0	4,336	3,252
Big River	20.0058	3d	PS-71	500	0.1-2	U	25.0	71	76	120.0	3,440	2,580
Big River	20.0058	3e	PS-72	500	0.1-2	U	20.0	72	68	160.0	3,136	2,352
Big River	20.0058	3f	PS-73	500	0.1-2	U	18.5	73	72	140.0	2,723	2,042
Big River	20.0058	3g	PS-74	500	0.1-2	U	23.7	74	71	145.0	3,546	2,659
Big River	20.0058	3h	PS-75	500	0.1-2	U	32.4	75	57	215.0	5,936	4,452
Big River	20.0058	3i	PS-76	500	0.1-2	U	23.0	76	79	105.0	2,999	2,249
Big River	20.0058	3j	PS-77	500	0.1-2	U	20.5	77	69	155.0	3,165	2,374
Big River	20.0058	3k	PS-78	500	0.1-2	U	27.4	78	64	180.0	4,559	3,420
Big River	20.0058	3l	PS-79	680	0.1-2	U	25.4	79	61	265.2	5,997	4,498
Big River	20.0058	4a	PS-80	520	0.1-2	U	19.5	80	40	312.0	4,543	3,407
Big River	20.0058	4b	PS-81	500	0.1-2	U	26.2	81	47	265.0	5,429	4,071
Big River	20.0058	4c	PS-82	500	0.1-2	U	26.1	82	55	225.0	4,907	3,680
Big River	20.0058	4d	PS-83	500	0.1-2	M	23.8	83	46	270.0	4,988	3,741
Stony Creek	0.0000	1	PS-90	600	1-3	C	5.10	90	14	516.0	1,753	1,315
Crooked Creek	20.0067	3a	PS-97	507	<1	U	15.2	97	76	121.7	2,121	1,591
Crooked Creek	20.0067	3b	PS-98	809	<1	U	14.7	98	84	129.4	2,816	2,112
Crooked Creek	20.0067	4	PS-99	333	<1	U	10.1	99	74	86.6	958	718
Crooked Creek	20.0067	5	PS-100	758	1-2	U-M	5.4	100	67	250.1	1,303	977
SF Crooked Creek	20.0068	1	PS-102	600	1-2	U	16.4	102	70	180.0	2,991	2,244
SF Crooked Creek	20.0068	2	PS-103	165	1-2	C	14.5	103	64	59.4	796	597
NF Crooked Creek	20.0071	1a	PS-104	500	<1	U	10.1	104	60	200.0	1,778	1,333
NF Crooked Creek	20.0071	1b	PS-105	600	<1	U	9.1	105	71	174.0	1,634	1,225
NF Crooked Creek	20.0071	2	PS-106	400	1-2	M	9.4	106	84	64.0	890	668
NF Crooked Creek	20.0071	3	PS-107	800	1-2	C	8.0	107	84	128.0	1,516	1,137
NF Crooked Creek	20.0071	4	PS-108	600	2-3	M	6.3	108	61	234.0	1,312	984
NF Crooked Creek	20.0071	5	PS-109	306	2-4	C	6.2	109	53	143.8	732	549

APPENDIX C- Summary of November 17, 2007 Landowner Meeting with the National Marine Fisheries Service

Meeting Summary
Ozette Basin Property Owners Meeting
Saturday, November 17, 2007
Lion's Club, Clallam Bay, WA
12:00 p.m. – 4:00 p.m.

Meeting Purpose: To hear Ozette basin property owners' questions and comments about the Lake Ozette sockeye recovery planning process.

Note to Readers: The November 17, 2007 meeting held in Clallam Bay, Washington was organized by several residents who own land along Lake Ozette and its tributaries. The meeting was intended for private landowners who reside in the Ozette basin; therefore, neither commercial nor tribal landowners were in attendance; thus, the term "landowner" or "property owner" in this summary is specific to meeting participants and not representative of all landowners throughout the entire basin.

The meeting organizers invited National Marine Fisheries staff to attend and listen to comments and questions. National Marine Fisheries staff agreed to attend, as they had for several other meetings previously requested by other stakeholders, including co-managers and other interested parties (e.g. the Quileute Tribe, Makah Nation, Olympic National Park, and the Washington Forest Protection Association). National Marine Fisheries staff stated during the meeting that the November 17, 2007 meeting did not constitute official public comment.

A meeting summary was prepared at the request, and with the review, of the Ozette basin landowners who attended the November 17, 2007 meeting. The summary includes their questions, observations, and any National Marine Fisheries' responses. At the request of meeting participants, this summary was included as an appendix to the recovery plan. The inclusion of this summary as an appendix does not indicate the National Marine Fisheries Service's endorsement, approval, agreement, or disagreement with the opinions expressed herein. The reader is encouraged to consult the recovery plan or the Lake Ozette Limiting Factors Analysis for information relating to physical and biological processes in the Lake Ozette watershed, and/or their impacts on sockeye salmon, that were discussed in the meeting.

Introductions, review agenda, announcements and purpose

Lake Ozette resident Ed Bowen welcomed the Ozette Basin property owners to the meeting. The meeting participants (including about 35 property owners, 4 National Marine Fisheries Service employees, 2 Olympic National Park employees, and 2 Triangle Associates employees) introduced themselves. The Lake Ozette Sockeye Salmon Recovery Planning process was explained briefly and Ed described what the plan does and does not entail. He explained the meeting format for questions, comments, and responses whereby all meeting participants will have a chance to speak. Ed then introduced the facilitator for the meeting, Bob Wheeler from Triangle Associates.

Bob Wheeler welcomed everyone, thanked them for coming, and explained his role in the recovery planning process (he is a contractor to National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service at the firm, Triangle Associates) and at the meeting. He noted that following the meeting there will be a meeting summary available to the group.

Bob then introduced Rob Walton, Assistant Regional Administrator for Salmon Recovery, of the National Marine Fisheries Service.

Rob explained that the role of the National Marine Fisheries Service individuals at the meeting was to listen to the Ozette Basin property owners. Some highlights of his introduction included:

- The role of the National Marine Fisheries Service and other federal agencies in the implementation of the Endangered Species Act, which requires a recovery planning process.
- The Ozette Basin property owners meeting is not part of the official public hearing process of recovery planning, though input from this meeting will be considered and incorporated into the next draft of the Recovery Plan.
- The Recovery Plan is still a work in progress.
- The Recovery Plan is not a regulatory document—all actions are voluntary.
- The Recovery Plan is a roadmap about where we are and where to go, but it does not lock people into doing anything.
- Recovery plans are more effective with community input, involvement, and participation.
- Much more work will be done on sockeye salmon recovery with the upcoming implementation plan, which will be written after the Recovery Plan has been completed in 2009.

Questions, comments, and answers

According to the meeting format, each attendee was given five minutes to ask questions or make comments. If requested, the National Marine Fisheries Service would respond to the property owner's questions/comments (*note*: shown by the "*Q*" and "*R*" in sections where questions were responded to by the National Marine Fisheries Service or Olympic National Park staff). Additionally, background to various themes was provided by National Marine Fisheries staff. Primarily, National Marine Fisheries Service staff listened and took notes.

Summary of Key Issues and Concerns:

• Lake level	• Ozette River
• Large Woody Debris	• Predators' impact on sockeye
• Logging and Habitat Conservation Plans	• Commercial fishery harvest
• Who benefits from the return of sockeye?	• Sediment, including beach sediment and sources of sediment / erosion
• Multiple uses and economics—farming and logging	• What happens when the sockeye are delisted?
• Science and prioritization in the Recovery Plan	• Research and monitoring recommended in the Recovery Plan
• Concern that "voluntary" actions will lead to requirements or regulations in the future	• Recommended road changes
	• Control from outside the Ozette Basin
• Plans for other salmon species	• What are landowner rights?
• Property taking concerns	• Government trust concerns
• Hatcheries	• Recovery Plan process

Lake Levels

<u>Ozette Basin property owners' questions and comments:</u>

- Questions and concerns about flooding and property damage as a result of lake level rises if the Ozette River becomes jammed up with large wood. Is there money or compensation for losses due to flooding that would occur from implementing this Recovery Plan?
- The lake outlet is silted up with a sand bar, which ultimately floods my land. There is mud where there were sandy beaches before.
- Why are more logjams necessary for the Ozette River?
- Lake levels are higher than ever before (lake levels have risen 2-3 feet in the past 20 years).

- Built up siltation at the lake outfall will dam up the river and reduce river flows.
- Worried about raising the lake levels. It is understood that the intention is to raise lake levels to kill plants, but the lake edge is used by wildlife that forage around the lake shore for these same plants. There are 52 miles of shoreline and that should be sufficient for sockeye spawning. If you raise levels, you're impacting other species.
- Concern that the raising of the lake level is unhealthy for the lake. When lake levels are high, the lake cannot effectively drain.
- Not opposed to the fish or Olympic National Park, but opposed to raising lake levels.
- Erickson Bay is deeper than it once was. Swan Bay is covered with mud. Lake Ozette has changed. It is higher. It's already flooded, so why raise it more?
- What lake levels are necessary for the fish in Lake Ozette?
- Concerned that raised lake levels would flood family property.
- If lake flooding occurs, what will be done to protect family gravesites that surround Lake Ozette?
- Increasing lake levels will damage people's property.
- Concerned about lake levels changing.
- There is a need to open up the outlet of the Ozette River because Lake Ozette is rising.
- Lake Ozette is coming up faster, higher, and staying high longer. The water cannot get out of the lake because it is building up with mud. With logjams, fish can pass, but the water cannot flow out of Lake Ozette.
- Raising the levels of Lake Ozette up is foolish.
- There is plenty of water at Lake Ozette.
- Troubles with high water and erosion already exist. Worried about Umbrella Creek. My cabin originally was built away from the beach and now erosion has caused Lake Ozette to encroach on it.
- If raising lake levels is a possibility, then the Makah Tribe and the Olympic National Park will be interested in placing large woody debris in the Ozette River. If this happens it would then be too late for landowners to respond to the resulting effects of flooding.
- The language in the Recovery Plan related to raising the lake levels needs be removed now. To leave it in there would be problematic. Research can be proposed to study the plug at the Ozette River outfall. Research on sockeye recovery could include questions like, "What percentage improvement will occur if certain actions are implemented?"
- Higher lake levels won't help the salmon's access to streams.
- Concerned about flooding.
- The Olympic National Park built the Lake Ozette campground on fill that may have affected the lake outlet to the Ozette River.

National Marine Fisheries Service comments related to Lake Levels: It was noted that it would be hard to conceive of raising lake levels without considering many of the important issues mentioned at the Ozette Basin Property Owners meeting. National Marine Fisheries Service staff indicated that they will look into including a more thorough section on information about flooding and lake levels in the Recovery Plan.

It was mentioned that one of the fundamental challenges in the recovery planning process is to address the issue of lake spawning sockeye. With respect to hydrologic restoration projects, National Marine Fisheries Service attendees noted that a goal would be to conduct more modeling studies to help improve the understanding of the current factors affecting lake levels on Lake Ozette. Future modeling studies could analyze how a lake level adjustment could help sockeye, and affect property owners

Ozette River

Ozette Basin property owners' questions and comments:

- The river is full of trees; don't alter a pristine river.
- The river is much higher now than in my 40 years of living here.

- Olympic National Park comments related to Ozette River: In the case of managing the Ozette River, Olympic National Park has jurisdiction.

Large Woody Debris (LWD)

Ozette Basin property owners questions and comments:

- Don't think that adding LWD will enhance the fisheries—LWD would be harmful to salmon.
- In the past the Olympic National Park dynamited logjams.
- Much of the LWD are cut wads or cut root wads. Cut wood indicates human activities.
- Wood jams are dangerous—precautions should be made for human safety.
- Blocking up the Ozette River is ludicrous. It sounds like the National Marine Fisheries Service wants to do the reverse of the Hoh Tribe's effort to clear rivers of large wood ten years ago. Why is the National Marine Fisheries Service doing the opposite?
- 100 years ago logjams were cleared out by Indians.
- Logjams should be removed from the Ozette River
- Landowners feel that LWD is a bad option. For phase one the Recovery Plan could focus on predators. If LWD is necessary then we should consider the impacts on landowners. A compensation package for landowners would have to be developed if LWD projects are built. It is important to know how and what happens if properties are impacted. I have great-grandparents in the area listed as "floodplain 4" in the Recovery Plan maps. How my family's concerns be addressed?
- Why not use riprap instead of LWD? Rocks are much safer and provide similar fish habitat to LWD.
- Placement of LWD might represent good science in some regions, but the Olympic Peninsula stands apart because of the large amount of rainfall. The best science fails to adequately address the rainfall and water flows that happen locally around the Ozette Basin. The peninsula is bad for large wood projects.
- Streams should be cleared of LWD.
- LWD placement is a joke.
- People have drowned by getting trapped under logjams in rivers. Safety is a concern with LWD placement in rivers.
- At Lake Pleasant landowners were asked to remove the wood debris from the shores. That was part of their Recovery Plan. Why is this Recovery Plan different? Why has the policy on LWD reversed?
- It is true that some larger logs would facilitate salmon migration.
- In the 1950s the state fisheries took all of the stumps out of the Ozette River.
- If LWD is placed in streams, it will flood land. Will you pay for the flood damage that it will cause?
- Is the Makah Tribe going to fix the bridge [that a LWD project affected]? That logjam is a mess. Will future logjams be built like this? It is important to tie the logs into the stream bed.
- Holes should be cut through LWD to allow for fish passage. Logjams on the Big River should have holes cut through them and they should be tied to the banks of the Big River to prevent blowouts.

National Marine Fisheries Service comments related to Large Woody Debris: The National Marine Fisheries Service spoke about large wood placement projects, specifically where they would be most useful in the watershed, but it was noted that LWD needs to be done correctly. Additional comments included:

- It was noted that in the 1950s the Washington Department of Fish and Wildlife cleared the Ozette River of LWD.
- The working draft Recovery Plan focuses on Umbrella Creek where large wood placement opportunities were identified.
- Not as many large wood projects have been identified on the Big River.
- Large wood placements will not happen where there are farms and houses at risk on the Big River. If in the future land uses changed, one might then consider identifying additional locations for large wood placement.

Predators' impact on sockeye

Ozette Basin property owners' questions and comments:

- The National Marine Fisheries Service was encouraged to pursue killing sea lions around the mouth of the Ozette River. It was noted that predation problems exist with sea otters.
- Squawfish (northern pikeminnow) fishing was suggested as a way to reduce the numbers of sockeye predators.
- Place a bounty on squawfish.
- Fishing for squawfish should be allowed.
- What impact are lampreys having on sockeye?
- Seals at the mouth of the river are a problem that should be addressed.
- 4,000 seals have been counted in the ocean off of the mouth of the Ozette River.
- Predator numbers need to be reduced. Seals have been spotted in Big River (3 times in the last 10 years).
- Seals have been spotted in the Big River.
- The seal population off of the mouth of the Ozette River should be at about 1/16 of what it is now.
- Cutthroat trout fishing was banned. Cutthroat trout is a predator that eats sockeye eggs.
- Concern about cutthroat being a predatory fish to sockeye and yet they cannot be caught in Lake Ozette because of Olympic National Park fishing regulations.
- Studies on the predatory fish should be conducted.
- The fish weir needs to be fixed because otters have used it to prey on fish—the Ozette River shouldn't be blocked like that.
- Predator control is necessary.
- Fish were mutilated by predators.

Q: Can we have a fishery on cutthroat trout?
R: Yes a cutthroat trout fishery could be permitted in the future. It was explained that it is a priority to understand the cutthroat trout population better. It was also noted that there would be a plan to do more research.

National Marine Fisheries Service comments related to predators' impact on sockeye: The National Marine Fisheries Service recognized that there were a number of comments at this meeting related to predators' impact on sockeye. The working draft Recovery Plan contains a large section on predator control. It was explained that there has been an emphasis in the plan to address the impact of predators on sockeye and it has been included in the plan's text. Additional comments included:

- The Recovery Plan recognizes the role of predators in the different lifecycles of sockeye salmon.
- An incentive program could be developed to look at where fishing could be useful to control predators that eat sockeye. The National Marine Fisheries Service would have to look at what strategies are successful for predator control.
- Cutthroat trout are predators.
- On the topic of marine mammal control it was noted that the Marine Mammal Protection Act has strong advocates that do not want sockeye predators like seals and otters killed. Right now a lethal take of marine mammals is prohibited, except by permit. Still the National Marine Fisheries Service will look at appropriate methods for marine predator control.
- Big mouth minnows and cutthroat can get out of balance and it is important to determine how to rebalance the Ozette Basin system. Rebalancing the system would be an option if an entity has the money to pay for such a strategy.

Logging & Habitat Conservation Plans (HCPs)

Ozette Basin property owners' questions and comments:

- What is the Forest Practices Habitat Conservation Plan (FPHCP)? I want to know more about the HCP. What are the basic regulations that the timber industry is required to abide by? Are these regulations being enforced? Are certain properties along Umbrella Creek going to be acquired for increased habitat protection?
- I log, but leaving stream buffers is wrong and is not working.
- When windstorms occur the thin strips of stream buffers are blown down, which causes power outages. The downed trees' root wads then wash dirt into the streams, which causes a sediment problem.
- The FPHCP are state rules and regulations. Note that the FPHCP is separate from the Recovery Plan. The roads maintenance package was another element changed in 2001.
- It is a concern with the timber companies that the FPHCP is not accepted by some people on the peninsula. The timber companies have observed that those same individuals who are critical of the FPHCP hope to use the Recovery Plan to stop what timber companies are doing in the FPHCP.
- Concerned about Limiting Factors Analysis data that indicates that the FPHCP needs to be changed. A concern exists about how the Limiting Factors analysis data is used in the Recovery Plan process. Timber companies think the Recovery Plan is off the mark.
- Some streams are fouled by logging operations.
- The Recovery Plan is blaming timber and forestry, but the decline of the sockeye is a result of the netting in the Ozette River.
- Don't believe that it is all the fault of logging. Olympic National Park has not helped the sockeye either.
- Lake Ozette has been logged to death.

National Marine Fisheries Service comments related to Logging & Habitat Conservation Plans (HCPs):

The FPHCP directs all of the actions for private timber companies. Those actions are intended to be supportive of sockeye salmon recovery. The HCP is a key action within the plan. Forest practices are detailed in this Recovery Plan. Additionally the Washington Department of Natural Resources has an HCP that, while similar, is different from the timber companies' FPHCP. State land holdings amount to roughly 11% of the land in the Ozette watershed. Both HCPs are long-term plans. Adaptive management is also included as an element in both HCPs.

Commercial fishery harvest

Ozette Basin property owners' questions and comments:

- All netting of fish should be stopped in the Ozette River and extending from the mouth of the River out 2 miles into the ocean. Nets on commercial boats should be less than 300 feet long.
- Losing good fishing ground due to timber activities.
- Sockeye don't bite on fishing lures. As a result sports fishermen don't get any value from increasing the numbers of sockeye salmon.
- Rotting fish left in delinquent nets have been observed in the Ozette River.
- Abandoned nets drifting around the lake have been problematic in the past for boating. These same abandoned nets have been observed full of unharvested dead fish.
- We need a guarantee that landowners would be able to fish for sockeye, too.
- The fishery is poorly managed.

Q: Are the tribes on the Steering Committee? Is the goal to commercialize salmon?
R: The Tribes are part of the Steering Committee. The potential for a commercial salmon harvest exists, but the point of the Endangered Species Act is to initially get sockeye off the endangered species list. Once they are delisted the fisheries will be open.

National Marine Fisheries Service comments related to commercial fishery harvest: National Marine Fisheries Service staff indicated that, to their knowledge, the federal government has never shut down an industry due to the Endangered Species Act. It was noted that the U.S. has to address its obligation to tribal treaty rights, and that is why the issue of tribal fishing is addressed in the Recovery Plan. Additional comments included:

- It was suggested that there would be a goal to improve sockeye salmon numbers so that recreational fishing is possible. It was explained that sockeye salmon are catchable with certain lures and that there is a very healthy recreational fishery in other parts of Washington State for sockeye salmon.

Sediment, including beach sediment and sources of sediment/ erosion

Ozette Basin property owners' questions and comments:

- Why do we consider additional actions that will not help so long as high levels of sediment exist?
- Can we clean the beaches?
- Need to get to the root of the sediment problem and how sediment levels will affect lake levels.
- Need to identify the source of sedimentation.
- The outlet of the Ozette River is clogged by sediment.
- All of the streams pour mud during heavy rainstorms. It used to take six hours of heavy rain before the streams would get muddy, but now it takes only two hours.
- Flushing sediment from Lake Ozette is difficult—if you restrict the river outlet more, there will be greater problems in the future. Flushing Lake Ozette helps clean gravel that is important to fish spawning.
- No quick fix to clean out sedimentation in Lake Ozette.
- There should be lower water levels in Lake Ozette in order to reduce lake sediment levels.
- The beaches have changed and are now muddier.

Facilitator comments: Bob Wheeler recapped that he heard from the group that silt is covering the gravel beds. He also noted that he heard the group explain that because the lake levels are too high the lake cannot adequately flush out the sediment that is silting up the beaches–more flow is needed in the lake. He heard the group mention erosion is another problem.

National Marine Fisheries Service comments related to sediment, including beach sediment and sources of sediment/ erosion: A variety of habitat conservation practices are included in the Recovery Plan, such as identifying places to improve habitat along streams. One of the broad scale portions of the working draft Recovery Plan is to reduce soil erosion. There are activities described to make sure Best Management Practices are used. Other habitat considerations include the effects on landowners' property.

Rob Walton noted that the National Marine Fisheries Service would investigate sedimentation that plugs the outlet of Lake Ozette. The tasks include:

- Investigating the sources of sedimentation.
- Reviewing the plug's effect on sockeye, specifically as a limiting factor in inhibiting salmon migration in the Ozette River during periods of low summer flows.

Multiple uses and economics—farming and logging

Ozette Basin property owners' questions and comments:

- If the Recovery Plan is going to impact private land, how much will be paid to landowners if they can't use their land for farming or growing trees?
- All the land around the watershed is only good for logging.

National Marine Fisheries Service comments related to multiple uses and economics: It was emphasized that this is a voluntary plan and that actions will not be imposed on individuals.

What happens when the sockeye are delisted?

Ozette Basin property owners' questions and comments:

- What happens when the sockeye are delisted?
- If sockeye are delisted, will they be again harvested unsustainably in the future?
- Sockeye salmon will come off the list, regardless.

National Marine Fisheries Service comments related to "what happens when sockeye are delisted?": The benefit of delisting is the ability to have recreational fishing and to boost tourism due to increased salmon runs. It was noted that it will be important to try and figure out how to keep sockeye salmon off the Endangered Species list after it has been delisted.

Science and prioritization in the Recovery Plan

Ozette Basin property owners' questions and comments:

- We can't control Mother Nature. First you should deal with the predators. Second, erosion should be addressed, but the streamside buffers don't work because they are felled by windstorms. After they are uprooted there is nothing in the creek bottom and the sediment from the root wad moves down to Lake Ozette. The idea to retain streamside forest buffers was a good one, but it's not working.
- The simplest options should be addressed first and then we could get back to the more difficult options for sockeye salmon recovery.
- Simple issues need to be addressed.
- Important to emphasize that even if one option is not feasible, we can at least note that it is a priority.

National Marine Fisheries Service comments related to science and prioritization in the Recovery Plan: National Marine Fisheries Service staff asked property owners to look at the priority section in the working draft Recovery Plan to help prioritize or refine it. Additional comments included:

- It was acknowledged that prioritization is a very difficult issue to address.

- A Recovery Plan allows one to collect the information in order to identify what could be done.
- Another research priority is to look at lake level variability and its effects on people and fish, alike.
- Researchers decided that there may have been tributary sockeye in the Lake Ozette watershed. Lake spawning sockeye—like those found in Lake Ozette—are rare across the geographic range of sockeye salmon, and tributary spawning sockeye are more common and thus more likely to have existed in the tributaries of the Ozette watershed.

Research and monitoring in the Recovery Plan

Ozette Basin property owners' questions and comments:

- What is the scientific plan?
- How can the knowledge of the basin's residents be included in the Recovery Plan?
- The Herrera study is flawed. More information is necessary for the Recovery Plan before acting.
- Don't we already have answers to these questions on the sockeye? Don't previous studies answer some of the questions that are necessary for recovery?
- More studies need to be initiated.
- The impacts on landowners need to be studied more.
- Puzzled about the emphasis on listing only the sockeye salmon species (as opposed to other species of salmon).
- Using research data acquired by third parties is problematic.
- Listen to the old-timers who know about the watershed.
- After additional research is completed and if it is seen that certain actions need to be included, then you can add the more controversial actions (e.g. LWD) into the plan at that time.

Q: What do sockeye eat?
R: As juveniles they eat insects, and then as they grow they eat daphnia, which are abundant in the lake. In the ocean they eat small crustaceans. They don't eat other fish. After about four years sockeye salmon return to Lake Ozette or its tributaries to spawn.

<u>National Marine Fisheries Service comments related to research and monitoring in the Recovery Plan:</u> A large section on research and monitoring is included in the working draft Recovery Plan. It would then be important to prioritize research plans given what is known and not known. This research could be a part of the adaptive management process, where management actions and priorities are modified according to new research findings. Additional comments included:

- Modeling studies could consider the social and economic effects of different Recovery Plan scenarios.
- A desire exists to understand under what conditions land would be affected. Want to figure out the impacts of flooding by studying it further. Then one could say "would we do a LWD project at this location?" With a better understanding one could consider whether or not to go forward with a specific project.
- There have been some studies conducted in the watershed. The authors of the Limiting Factors Analysis document tried to capture all of that information. National Marine Fisheries Service staff then attempted to include this information in the Recovery Plan.
- There is a lot of uncertainty in this plan, thus there still is a lot of research to do.

Concern that voluntary actions will lead to requirements or regulations in the future

Ozette Basin property owners' questions and comments:

- Research and monitoring is a way to subvert the timber companies' forest practices. There is a direct connection between this voluntary plan and future state rulemaking—rule makers will use the findings of this Recovery Plan, thus making recovery plan actions not voluntary.

National Marine Fisheries Service comments related to concern that voluntary will lead to requirements or regulations in the future: The Recovery Plan does not change what regulations authorities already have. Instead the plan simply says "if one wants to recovery sockeye, here are some things to do."

Recommended road changes

Ozette Basin property owners' questions and comments:

- Where will the money come from to build a new road that is not in the floodplain?
- Even if a new road is built, we will still have to maintain the roads that go to homes [in the floodplain where a road change is identified].
- What will happen to Bow Bridge?

Control from outside of the Ozette Basin

Ozette Basin property owners' questions and comments:

- This Recovery Plan represents city people trying to tell country people how to live.
- Not a proponent of taking Department of Natural Resources land and transferring it to the Olympic National Park. Olympic National Park is not a good neighbor—anything that goes to the Park is not good.
- Tired of King County influencing what happens in the Ozette Basin (ecologists' research, etc.).
- Note the contrast between Lake Ozette and Lake Washington (Ozette landowners have less power because of economic differences of the two places). Residents on Lake Washington would not permit changes to lake levels and they would win, whereas Lake Ozette residents do not have this kind of power.
- Olympic National Park only takes away and doesn't give back. It is perplexing as to why the Park is interested in salmon now.

Plans for other salmon species

Ozette Basin property owners' questions and comments:

- What about the stocks of silver, king, and Coho salmon? One used to be able to walk across the river because the returning salmon were so abundant.
- Numeric declines observed with all fish.
- There were few fish in the lake to begin with.

Q: Why not try to bring back other species of salmon?
R: The hope is to try to recover sockeye salmon and that the actions carried out for sockeye salmon will also help other species of salmon, too.

Property taking concerns

Ozette Basin property owners' questions and comments:

- If an annexation threat existed, logging would be sped up prior to the annexation.
- What will become of our homes?
- Worried about eminent domain.
- Concern exists about Olympic National Park forcing owners out of property in the same way that the Park did to landowners who lived on ocean.

- A hidden goal is to flood out property owners.
- There are a lot of people that don't have enough land to be compensated for losing a portion of it. There is not enough money to compensate me. Maybe some residents could be compensated, but not me.
- Against property rights losses. Willing to sue to protect rights.
- Don't take away property rights.

National Marine Fisheries Service comments related to property taking concerns: The Upper Columbia River Salmon Plan was referenced as a recovery plan that addresses property taking issues and responds to questions about takings. NOAA will look at what it can include from that plan in this Recovery Plan

What are landowner rights?

Ozette Basin property owners' questions and comments:

- Now we have no rights.
- We have a lot to lose and very little to gain.
- Do homeowners have any rights to veto Recovery Plan actions?
- Concerned about the rights of property owners. Three acres of lost hay fields due to river erosion. There has to be common sense in regulations because right now they don't make sense.

Q: A bridge was lost due to flooding. There are no rights to stabilize one's own property. It is impossible to do anything without being regulated. There needs to be a contingency if something goes wrong with the plan, so that we can act to protect our property. One can resort to suing someone, but that does not help save the land. Had we been able to address the erosion problem when it began we could have avoided the flooding damages that have resulted.
R: This is a great point and that is not addressed in the Recovery Plan.

National Marine Fisheries Service comments related to Landowner Rights: It was noted that there is nothing about a recovery plan that will impact one's property rights.

Government trust concerns

Ozette Basin property owners' questions and comments:

- Don't trust the government, that's why we live here.

Who benefits from the return of sockeye?

Ozette Basin property owners' questions and comments:

- In response to a question about why Makah Tribal members were not present, it was noted that only landowners in the Ozette basin had been invited to this meeting.
- The natives will just net the fish.
- The Makah Tribe has written a letter supporting LWD placement in the first mile of the Ozette River. They will also be paid to do the large wood placement work. The Makah Tribe will benefit with commercial fisheries due to the plan.
- Not a proponent of the tribes—they're taking a lot more than they are giving.
- The tribe has the trump card.
- The sockeye fins are not clipped by the tribes.
- All the sockeye is for is for the Makah Tribe.
- Concern with fish overharvesting.

Q: The answer to who benefits from sockeye recovery is in the Recovery Plan. It says, "NOAA Fisheries has a responsibility to help the tribes restore fish in their Usual & Accustomed fishing grounds." This plan is aimed to help the tribes, not us.
R: The Endangered Species Act doesn't mention tribes. The statute the National Marine Fisheries Service is implementing is the Endangered Species Act. The treaty is a different issue. The National Marine Fisheries Service has a federal trust responsibility to uphold the treaties that the federal government signed. The National Marine Fisheries Service cannot address treaty concerns. The goal is to get the fish off the Endangered Species Act list. The goal is to remove the limiting factors that affect sockeye in a way that does not affect stakeholders.

Q: The tribe acts like they own this area. Who oversees them? Who regulates them? They do what they please.
R: The tribes are still subject to Endangered Species Act regulations; they had to undergo three years of Endangered Species Act review for the approval of the Ozette hatchery.

Facilitator comments: Bob Wheeler then said, "We need to say recovery is not just for the tribes, but for the citizens that are there." The plan mentions that recovery of sockeye is an issue not only for the tribes but for landowners and that when delisted there could be a recreational and commercial fishery.

Hatcheries

Ozette Basin property owners' questions and comments:

- Why not build more hatcheries? Why can't we just consider them recovered with the help of hatcheries?
- Doubts that there were many fish in the river or lake to begin with. I don't see where the big need is to invest the time and energy to increase their numbers.
- The hatchery is working.
- In 41 years I have never seen as many sockeye in Big River as in the past four years. It was noted that the most recent fish counts have trended upwards.

Q: Why not make a trial program for putting hatcheries in additional creeks?
R: There is a debate about the benefits of having too many hatchery fish in the Ozette sockeye salmon population.

Q: Are hatchery fish not as good?
R: Salmon fitness (health) problems are often higher in hatchery fish.

National Marine Fisheries Service comments related to hatcheries: Hatchery supplementation supported by the Makah Tribe has attempted to create a reserve population for Lake Ozette sockeye salmon. It is a short-duration program (12 years) and then it will end. After that program the plan has longer term actions, such as possibly seeding the beaches with eggs. This strategy is not something that is favored—there are other ideas to work on before pursuing this strategy further.

Recovery planning process

Ozette Basin property owners' questions and comments:

- 35 years ago we went through some problems with Olympic National Park. We hope that this meeting isn't a waste of our time, but we think it will be.
- Don't see the worth of meetings.

- Against the plan—would like to not see it implemented.
- There must be common ground between the different groups in the Ozette Basin.
- Can the summary of this meeting be placed in the plan appendix? That way it is part of the record.
- This meeting resembles a previous [non sockeye recovery plan] meeting held in Forks. People come to talk to landowners, but not to listen. A desire exists to have some assurance that landowners are being heard and listened to.
- Parallels observed in the Recovery Plan process to taking down the dams on the Elwha River. Both processes are intended to help salmon and both are unnecessary.

Q: What does “voluntary plan” mean?
R: We are providing options for whoever wants to work on projects to restore salmon. For example if I wanted to install a LWD project, it would have to go through a review process.

Q: How would I know if I would be listened to?
R: As an example, the Upper Columbia Recovery Plan provides a section for responses to comments and questions. We will provide official responses to questions and comments in this plan, as well.

Q: What is the use of getting more money if the Recovery Plan isn’t what we want?
R: We are trying to make the best plan via, public comment, technical review, peer review, national publication, etc.

Explanation of Recovery Plan process by the National Marine Fisheries Service

During the meeting National Marine Fisheries Service staff was asked to provide an explanation of the plan for meeting participants. They explained that according to the Endangered Species Act the National Marine Fisheries Service is required to write the Recovery Plan. The Endangered Species Act requires the National Marine Fisheries Service to:

- figure out what are the factors affecting (limiting) the sockeye salmon.
- have a technical science team to determine how many sockeye salmon are needed for a self-sustaining population.
- develop an overall strategy for achieving the goal of sockeye salmon recovery (e.g., predator control, habitat improvement, etc).
- determine site specific actions for the Recovery Plan.
- try to answer what is the range of strategies and actions that can be implemented. Not to say that all of those strategies and actions should be carried out, but it is important to have the roadmap to move forward, if so desired.

Additional National Marine Fisheries Service notes:

- The advantage of having a Recovery Plan is that it puts the area in question on the top of a list for receiving salmon recovery funding dollars. Without a Recovery Plan, one does not have the leverage to compete with other places across the region for salmon recovery funding.
- Essentially, a recovery plan helps to organize and coordinate issues that need to be addressed for recovery to move forward.
- The Recovery Plan does try to take a look at the Ozette Basin community. National Marine Fisheries Service staff asked the Ozette Basin property owners to look through the Recovery Plan to see if the plan does in fact adequately addresses the community.

- National Marine Fisheries Service has been meeting with the Lake Ozette Sockeye Steering Committee—a group made up of property owners, timber companies, tribes, individuals, and county and state agencies—for the past couple years to determine what is the vision for the future that includes not only more sockeye salmon, but also for the Ozette Basin's culture, community, and economy.
- Now the Recovery Plan is a working draft and when the draft Recovery Plan is published in the federal register public input will be sought. The final Recovery Plan is intended to be completed in 2009. It was noted that even after the plans are "finalized" they can be modified.
- Time and cost estimates have to be included in the plan. The implementation plan was briefly described, specifically how the implementation plan would then choose from the "menu" of voluntary actions originally identified in the Recovery Plan.

Meeting closing and prioritization

Bob Wheeler explained that there has been no prioritization in the Recovery Plan so far. Rosemary Furfey of the National Marine Fisheries Service affirmed this, and explained the plan is the menu from which one can choose recovery strategies and actions and that one would fine tune the actual actions in order to carry them out at the implementation planning stage. The meeting participants expressed a desire to vote on their priorities. Through their discussions the following were priorities from the meeting participant's standpoint:

- Do not increase Lake Ozette lake levels[8]
- Predator control
- Open the Lake Ozette plug to return the lake to its natural flow regime
- Develop a notification system between the National Marine Fisheries Service and the landowners (increase communications)
- Allow recreational fishing in Lake Ozette
- Increase hatchery capability

Ed Bowen agreed to keep up-to-date sockeye salmon Recovery Plan documents at the Clallam Bay Library.

At 4pm Bob Wheeler closed the meeting and thanked the Ozette Basin property owners

Attachment: Ozette Community Questions (Provided to NMFS as a handout at the Ozette Basin Property Owners Meeting)

[8] In subsequent conversations, Lake Ozette property owners affirmed that not increasing lake levels in Lake Ozette is their highest priority.

"OZETTE COMMUNITY QUESTIONS"

November 17, 2007

I. Why was 50 years chosen for the time period of this recovery plan?

II. What process stipulated that the National Marine Fisheries Service was the responsible agency for the ESA recovery of this sockeye population, located in a freshwater inland environment, instead of USFWS or the National Park Service?

III. Who are the co-managers of this recovery plan? ONP?

i. Has NMFS/NOAA conducted individual co-manager meetings with other entities, such as WDFW?
ii. Why hasn't NMFS/NOAA conducted site visits with the landowners to identify issues directly?
iii. How does this plan's level of involvement from the local area compare to plans created elsewhere in Washington State?
iv. List what public outreach has taken place to date on this recovery effort.

IV. Is NMFS/NOAA committed to making this recovery plan transparent and open to the local community and affected landowners by insuring the following actions:

i. Developing a mailing list of all landowners in the Ozette basin for direct contact from NMFS/NOAA?
ii. Make available copies of the completed plan, including all referenced research and appendixes to all?
iii. Soliciting comments from these affected landowners, either by direct mail or private group meetings, and incorporating them into direct changes in the plan?
iv. Notifying affected landowners of any future updates to this plan for review, comment and editing prior to implementation?
v. How can NMFS/NOAA develop a working relationship with the landowners to allow mutual efforts to benefit the recovery of this sockeye population, while meeting the needs of the landowners and protecting their rights, especially from retaliatory actions as a result of speaking out at this time?

V. How will the recovery plan protect the cultural resources of the Ozette basin to include:

i. Protection of the homesteads and historical features, such as the cemeteries, from recommendations such as floodplain connectivity actions?
ii. How will this recovery plan evaluate and minimize it's affects on cultural resources so as not to be in conflict with protections to those resources such as applications to the National Historic Register?
iii. Have plans for moving the Hoko-Ozette road considered the historical significance of this particular roadway?

VI. How will NMFS/NOAA address the resulting legal issues from this recovery plan?

i. Why does the plan not mitigate the TAKE clause of the US Constitution's Fifth Amendment?
ii. What legislative actions, or changes to the law, need to be suggested or an action in this plan; for example, regarding predation or environmental alterations within a wilderness designated area?
iii. How will this plan balance Tribal Rights and judgments that conflict with Citizens US Constitutional Rights?

iv. Is it appropriate to conduct an ESA recovery plan for the eventual commercial profits for any group? If so, explain the authority for taking that bigger step?
v. What safeguards and recourse will the plan provide when implemented actions fail and actually cause harm to private landowners?

VII. How can these identified flaws within this recovery plan be fixed?

i. Why doesn't the plan reflect the desires/vote of the LOSC to assess what lake levels – both higher and lower – would be most beneficial to the recovery efforts?
ii. Can the plan reflect what actions, or lessons learned in the Ozette basin have been successful in improving conditions for the recovery efforts?
iii. Can the plan address the limited amount of growth in the basin as a component of identifying current land uses?
iv. Will the plan include solutions to new problems created during implementation, such as LWD projects restricting fish passage due to low instream flows (Kitsap County, Chico Creek, Log Steps/Chum issues)?
v. Will the plan's recommended LWD projects create restrictions on both current and future water rights?
vi. Why are unpublished or non-peer reviewed reports/references incorporated throughout this plan?
vii. Why were other proposed actions not incorporated, discussed to not include, or at least captured as an appendix of additional actions considered but not supported?
viii. NMFS/NOAA Fisheries has stated that as time progresses, the tributary spawners will change (diverge) in their likeness (genetics) to the lake spawners. At some point the tributary spawners will become less of an option for protecting the Ozette sockeye from becoming extinct and it will be solely dependent on the lake spawners. What is the anticipated point in time this will occur and will the plan take a dramatic change in how/what population it is obligated to recover?

VIII. Should the plan take into consideration…

i. Toxic runoff to salmon habitats (e.g., significant findings from the NOAA Coastal Storms Program)?
ii. Effects of environmental contaminant exposure on salmonid fertility and overall spawning success?
iii. Direct economic impact on all landowners (and individually) themselves within the Ozette basin? Can a period of time be specified for conservation easements/lease in-lieu of outright acquisitions?

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APPENDIX D- Summary of Programmatic, Site-Specific, and Broad-Scale Actions

Table D-1. Summary of programmatic actions and their linkage to recovery models, watershed processes, locations, and primary and secondary limiting factor hypotheses.

Programmatic Actions	Recovery Model	Watershed Process	Location	Description of Action	Primary Hypothesis Addressed	Secondary Hypothesis Addressed	Recovery Strategy Number
Programmatic Action 1	All Population Segments	Coastal	Coastal Strip/Nearshore	Implement ONP Wilderness Management Regulations to maintain and protect coastal processes.	Important data gap. No current hypothesis.	na	RS #1
Programmatic Action 2	All Population Segments	Coastal	Coastal Strip/Nearshore	Implement Olympic Coast National Marine Sanctuary Management Plan to maintain and protect coastal processes.	Important data gap. No current hypothesis.	na	RS #1
Programmatic Action 3	All Population Segments	Hydrology	All Tribs	Enforce State Water Right Laws that limit exempt wells to less than 5000gpd.	H#3 (Q)	na	RS #28
Programmatic Action 4	All Population Segments	Hydrology	All Tribs	Enforce State Water Right Laws that limit the location of water withdrawals (e.g., illegal surface water diversions).	H#3 (Q)	na	RS #28

Programmatic Actions	Recovery Model	Watershed Process	Location	Description of Action	Primary Hypothesis Addressed	Secondary Hypothesis Addressed	Recovery Strategy Number
Programmatic Action 5	All Population Segments	Hydrology	All Tribs	Enforce county zone laws limiting septic tanks that are hydrologically connected to water courses, (e.g., leach field draining directly into river).	H#3 (Q)	na	RS #28
Programmatic Action 6	All Population Segments	Sediment	Ozette River Tribs	Implement FFA and State Lands HCP, including RMAPs.	H#2 (WQ)	H#1 (Pred) H#3 (Q) H#4 (Hab)	RS #3, RS #4, RS #6, RS #7, RS #16, RS #17, RS #27, RS #28, RS #29, RS #30
Programmatic Action 7	All Population Segments	Sediment	Ozette River Tribs	Hire additional regulatory staff to enforce EPA Clean Water Act, DOE Water Quality WACs, and WDNR Water Quality WACs on all federal and private land within the Ozette Watershed.	H#2 (WQ)	H#1 (Pred) H#3 (Q) H#4 (Hab)	RS #6, RS #7, RS #18, RS #20, RS #29, RS #30

Programmatic Actions	Recovery Model	Watershed Process	Location	Description of Action	Primary Hypothesis Addressed	Secondary Hypothesis Addressed	Recovery Strategy Number
Programmatic Action 8	All Population Segments	Sediment	Ozette River Tribs	Implement Clallam County noxious weed control program to eradicate non-native invasives. Reestablish native species more effective at protecting soil/banks.	H#2 (WQ)	H#1 (Pred) H#3 (Q) H#4 (Hab)	RS #20, RS #21, RS #22, RS #29, RS #30
Programmatic Action 9	All Population Segments	Riparian/Floodplain	Ozette River	Implement ONP Wilderness Management Regulations to maintain and protect riparian processes.	H#3 (Q)	H#1 (Pred) H#2 (WQ) H#4 (Hab)	RS #8
Programmatic Action 10	All Population Segments	Biological	Lake Ozette and Ozette River	Implement ONP and Tribal fishing regulations that prohibit the harvest of Lake Ozette sockeye until numbers of returning adults are sufficient to allow for limited harvest.	Not currently limiting	NA	RS #9, RS #10, RS #11, RS #12, RS #13, RS #24, RS #25

Programmatic Actions	Recovery Model	Watershed Process	Location	Description of Action	Primary Hypothesis Addressed	Secondary Hypothesis Addressed	Recovery Strategy Number
Programmatic Action 11	All Population Segments	Biological	Ozette River, Ozette River Estuary, and Nearshore	Encourage the Makah Tribe to reinstate their traditional, treaty protected, rights to hunt for seals and sea lions in their Usual and Accustomed hunting and fishing area, consistent with applicable law.	H#1 (Pred)	NA	RS #9, RS #10, RS #11, RS #12, RS #13
Programmatic Action 12	All Population Segments	Biological	Pacific Ocean and Strait of Juan de Fuca	NOAA, Tribes, WDFW, and ONP will monitor annual fishing regulations and continue to ensure that non-directed LOS fisheries have a negligible impact on LOS.	Not currently limiting	NA	RS #9, RS #10, RS #11, RS #12, RS #13
Programmatic Action 13	All Population Segments	Thermal	Lake Ozette and Ozette River	Develop and implement local, regional, national, and global atmospheric anti-pollution program to reduce emissions of greenhouse gases.	H#2 (WQ)	H#3 (Q) H#5 (MS)	RS #14

Programmatic Actions	Recovery Model	Watershed Process	Location	Description of Action	Primary Hypothesis Addressed	Secondary Hypothesis Addressed	Recovery Strategy Number
Programmatic Action 6	Beach Spawners	Hydrology	Priority II and III Sub-Basins	Implement FFA and State Lands HCP, including RMAPs.	H#6 (BSH), H#9 (LL)	H#8 (WQ)	RS #3, RS #4, RS #6, RS #7, RS #16, RS #17, RS #27, RS #28, RS #29, RS #30
Programmatic Action 14	Beach Spawners	Hydrology	Priority II and III Sub-Basins	Implement Clallam County critical areas ordinance and storm water management rules.	H#6 (BSH), H#9 (LL)	H#8 (WQ)	RS #3, RS #4, RS #16, RS #17
Programmatic Action 6	Beach Spawners	Sediment	Priority II Sub-Basins	Implement FFA and State Lands HCP, including RMAPs.	H#6 (BSH), H#8 (WQ)	H#7 (Pred), H#10 (Comp)	RS # 3, RS #4, RS #6, RS #7, RS #16, RS #17, RS #27, RS #28, RS #29, RS #30

Programmatic Actions	Recovery Model	Watershed Process	Location	Description of Action	Primary Hypothesis Addressed	Secondary Hypothesis Addressed	Recovery Strategy Number
Programmatic Action 7	Beach Spawners	Sediment	Priority II Sub-Basins	Hire additional regulatory staff to enforce EPA Clean Water Act, DOE Water Quality WACs, and WDNR Water Quality WACs on all federal and private land within the Ozette Watershed.	H#6 (BSH), H#8 (WQ)	H#7 (Pred), H#10 (Comp)	RS #6, RS #7, RS #18, RS #20, RS #29, RS #30
Programmatic Action 8	Beach Spawners	Sediment	Priority II Sub-Basins	Implement Clallam County noxious weed control program to eradicate non-native invasives. Reestablish native species more effective at protecting soil/banks.	H#6 (BSH), H#8 (WQ)	H#7 (Pred), H#10 (Comp)	RS # 20, RS #21, RS #22, RS #29, RS #30
Programmatic Action 8	Beach Spawners	Vegetation	All Tribs	Implement Clallam County noxious weed control program to stop of the spread of invasive species across the watershed.	H#6 (BSH)	H#7 (Pred), H#10 (Comp)	RS #20, RS #21, RS #22, RS #29, RS #30

Programmatic Actions	Recovery Model	Watershed Process	Location	Description of Action	Primary Hypothesis Addressed	Secondary Hypothesis Addressed	Recovery Strategy Number
Programmatic Action 16	Beach Spawners	Vegetation	Lake Ozette	Implement ONP noxious weed program.	H#6 (BSH)	H#7 (Pred), H#10 (Comp)	RS #20, RS #21, RS #22
Programmatic Action 17	Beach Spawners	Riparian	Lake Ozette	Implement ONP Wilderness Management Regulations to maintain, protect, and/or restore riparian processes.	H#6 (BSH)	H#7 (Pred), H#10 (Comp)	RS #23
Programmatic Action 18	Beach Spawners	Riparian	Lake Ozette	Scenic or conservation easements	H#6 (BSH)	H#7 (Pred), H#10 (Comp)	RS #23
Programmatic Action 10	Beach Spawners	Biological	Lake Ozette	Encourage the Makah Tribe to reinstate their traditional, treaty protected, rights to hunt for seals and sea lions in their Usual and Accustomed hunting and fishing area, consistent with applicable law.	H#7 (Pred)	H#6 (BSH)	RS #9, RS #10, RS #11, RS #12, RS #13, RS #24, RS #25

Programmatic Actions	Recovery Model	Watershed Process	Location	Description of Action	Primary Hypothesis Addressed	Secondary Hypothesis Addressed	Recovery Strategy Number
Programmatic Action 6	Tributary Spawners	Habitat Connectivity	All Tribs	Implement FFA and State Lands HCP, including RMAPs.	Not currently limiting	NA	RS #3, RS # 4, RS #6, RS #7, RS #16, RS #17, RS #27, RS #28, RS #29, RS #30
Programmatic Action 19	Tributary Spawners	Habitat Connectivity	All Tribs	Implement WDFW hydraulic code for fish passage.	Not currently limiting	NA	RS #3, RS #4, RS #6, RS #7, RS #16, RS #17, RS #27, RS #28, RS #29, RS #30
Programmatic Action 20	Tributary Spawners	Habitat Connectivity	All Tribs	Implement Clallam County road maintenance program.	Not currently limiting	NA	RS #3, RS #4, RS #6, RS #7, RS #16, RS #17, RS #27, RS #28, RS #29, RS #30
Programmatic Action 3	Tributary Spawners	Hydrology	Sockeye spawning tributaries	Enforce State Water Right Laws that limit exempt wells to less than 5000gpd.	H#15 (Q)	H#12 (Stab)	RS #28
Programmatic Action 4	Tributary Spawners	Hydrology	Sockeye spawning tributaries	Enforce State Water Right Laws that limit the location of water withdrawals	H#15 (Q)	H#12 (Stab)	RS #28

Programmatic Actions	Recovery Model	Watershed Process	Location	Description of Action	Primary Hypothesis Addressed	Secondary Hypothesis Addressed	Recovery Strategy Number
Progammatic Action 5	Tributary Spawners	Hydrology	Sockeye spawning tributaries	Enforce county zone laws limiting septic tanks that are hydrologically connected to water courses	H#15 (Q)	H#12 (Stab)	RS #28
Programmatic Action 6	Tributary Spawners	Hydrology	Sockeye spawning tributaries	Implement FFA and State Lands HCP, including RMAPs.	H#15 (Q)	H#12 (Stab)	RS #3, RS #4, RS #16, RS #17, RS #27, RS #28, RS #29, RS #30
Programmatic Action 14	Tributary Spawners	Hydrology	Sockeye spawning tributaries	Implement Clallam County critical areas ordinance and storm water management rules.	H#15 (Q)	H#12 (Stab)	RS #3, RS #4, RS #16, RS #17
Programmatic Action 6	Tributary Spawners	Sediment	Sockeye spawning tributaries	Implement FFA and State Lands HCP, including RMAPs.	H#11 (TSH)	H#13 (WQ)	RS #3, RS #4, RS #6, RS #7, RS #16, RS #17, RS #27, RS #28, RS #29, RS #30

Programmatic Actions	Recovery Model	Watershed Process	Location	Description of Action	Primary Hypothesis Addressed	Secondary Hypothesis Addressed	Recovery Strategy Number
Programmatic Action 7	Tributary Spawners	Sediment	Sockeye spawning tributaries	Hire additional regulatory staff to enforce EPA Clean Water Act, DOE Water Quality WACs, and WDNR Water Quality WACs on all federal and private land within the Ozette Watershed.	H#11 (TSH)	H#13 (WQ)	RS #6, RS #7, RS #18, RS #20, RS #29, RS #30
Programmatic Action 8	Tributary Spawners	Sediment	Sockeye spawning tributaries	Implement Clallam County noxious weed control program to eradicate non-native invasives. Reestablish native species more effective at protecting soil/banks.	H#11 (TSH)	H#13 (WQ)	RS #20, RS #21, RS #22, RS #29, RS #30
Programmatic Action 20	Tributary Spawners	Sediment	Big River	Implement Clallam County road maintenance program.	H#11 (TSH)	H#13 (WQ)	RS #3, RS #4, RS #6, RS #7, RS #27, RS #28, RS #29, RS #30

Programmatic Actions	Recovery Model	Watershed Process	Location	Description of Action	Primary Hypothesis Addressed	Secondary Hypothesis Addressed	Recovery Strategy Number
Programmatic Action 21	Tributary Spawners	Sediment	Big River	Implement Natural Resources Conservation Service, Best Management Practices (NRCS BMPs) on agricultural lands.	H#11 (TSH)	H#13 (WQ)	RS # 29, RS #30
Programmatic Action 22	Tributary Spawners	Sediment	Big River	Implement Natural Resources Conservation Service, Conservation Reserve Enhancement Program (NRCS CREP) on agricultural lands.	H#11 (TSH)	H#13 (WQ)	RS # 29, RS #30
Programmatic Action 23	Tributary Spawners	Sediment	Big River	Implement and strictly enforce WDFW hydraulic code for gravel mining.	H#11 (TSH)	H#13 (WQ)	RS # 29, RS #30

Programmatic Actions	Recovery Model	Watershed Process	Location	Description of Action	Primary Hypothesis Addressed	Secondary Hypothesis Addressed	Recovery Strategy Number
Programmatic Action 24	Tributary Spawners	Sediment	Big River	Enforce all County rules pertaining to small landowners along Big River. Specifically, zoning laws, critical areas ordinances, development in the 100-year floodplain and/or CMZ.	H#11 (TSH)	H#13 (WQ)	RS #29, RS #30
Programmatic Action 25	Tributary Spawners	Sediment	Big River	Enforce state laws restricting cattle access to rivers to protect WQ.	H#11 (TSH)	H#13 (WQ)	RS #29, RS #30
Programmatic Action 6	Tributary Spawners	Riparian	Big River	Implement FFA and State Lands HCP, including RMAPs.	H#11 (TSH)	H#13 (WQ)	RS #3, RS #4, RS #6, RS #7, RS #16, RS #17, RS #27, RS #28, RS #29, RS #30

Table D-2. Summary of broad scale actions and their linkage to recovery models, watershed processes, locations, and primary and secondary limiting factor hypotheses.

Broad Scale Action	Watershed Process	Location	Description of Action	Primary Hypothesis Addressed	Secondary Hypothesis Addressed	Recovery Strategy Number
Broad Scale Action 1	Hydrology	Coal Creek	Implement rigorous sediment reduction and retention program designed to reduce coarse and fine sediment delivery to the Ozette River.	H#3 (Q)	H#2 (WQ) H#3 (Q)	NA
Broach Scale Action 2	Hydrology	Big River	Where interest exists, purchase full riparian conservation easements to reestablish riparian zones along Big River and allow natural flooding to take place.	H#15 (Q)	H#3 (Q)	NA
Broad Scale Action 3	Sediment	Ozette River Sub-Basin	Within the Coal Creek sub-basin, quantitatively assess sediment production impacts from logging (gully creation, debris flows, landslides), road building, and LWD removal. Develop program to reduce land use related sediment inputs at the site level.	H#2 (WQ)	H#1 (Pred) H#3 (Q) H#4 (Hab)	RS #6, RS#7
Broad Scale Action 4	Sediment	Ozette River Sub-Basin	Where interest and funding exists, purchase entire sub-watershed and restore back to old-growth, unroaded conditions.	H#2 (WQ)	H#1 (Pred) H#3 (Q) H#4 (Hab)	RS #6, RS #7
Broach Scale Action 5	Sediment	Ozette River Sub-Basin	Reconnect floodplains by reintroducing LWD to all tributaries to improve floodplain connectivity and sediment deposition / storage.	H#2 (WQ)	H#1 (Pred) H#3 (Q) H#4 (Hab)	RS #6, RS #7
Broad Scale Action 6	Hydrology	Priority II and III Sub-Basins	Where interest and funding exists, purchase entire sub-watersheds within Ozette and restore back to old-growth unroaded conditions.	H#6 (BSH), H#9 (LL)	H#8 (WQ), H#10 (Comp)	RS #3, RS #4, RS #16, RS #17, RS #28

Broad Scale Action	Watershed Process	Location	Description of Action	Primary Hypothesis Addressed	Secondary Hypothesis Addressed	Recovery Strategy Number
Broad Scale Action 7	Hydrology	Priority II and III Sub-Basins	Restore or improve permanent vegetative hydrologic maturity throughout watershed.	H#6 (BSH), H#9 (LL)	H#8 (WQ), H#10 (Comp)	RS #3, RS #4, RS #16, RS #17, RS #28
Broad Scale Action 8	Hydrology	Priority II and III Sub-Basins	Remove and/or disconnect hydrologically connected road systems via road decommissioning (full removal), abundant road cross-drain installation, and adequate culvert sizes at tributary crossings to ensure passage of LWD, sediment and water at the 100 yr RI flood.	H#6 (BSH), H#9 (LL)	H#8 (WQ), H#10 (Comp)	RS #3, RS #4, RS #16, RS # 17, RS #28
Broad Scale Action 9	Hydrology	Priority II and III Sub-Basins	Plant or under-plant conifer riparian forests in fields and disturbed hardwood zones.	H#6 (BSH), H#9 (LL)	H#8 (WQ), H#10 (Comp)	RS #3, RS #4, RS #16, RS #17, RS #28
Broad Scale Action 10	Hydrology	Priority II and III Sub-Basins	Reconnect floodplains by reintroducing LWD to all tributaries to improve floodplain connectivity, water retention, and peak flow attenuation.	H#6 (BSH), H#9 (LL)	H#8 (WQ), H#10 (Comp)	RS #3, RS #4, RS #16, RS #17, RS #28
Broad Scale Action 11	Sediment	Priority II Sub-Basins	Where interest and funding exist, purchase entire sub-watersheds and restore back to old-growth, unroaded conditions.	H#6 (BSH), H#8 (WQ)	H#7 (Pred), H#10 (Comp)	RS #18, RS #19, RS #20

Broad Scale Action	Watershed Process	Location	Description of Action	Primary Hypothesis Addressed	Secondary Hypothesis Addressed	Recovery Strategy Number
Broad Scale Action 12	Sediment	Priority II Sub-Basins	Within priority II sub-basins, quantitatively assess sediment production impacts from logging (gully creation, debris flows, landslides), road building, and LWD removal. Develop program to reduce land use related sediment inputs at the site level. Examples include: Where stream-adjacent roads have been built, decommission these roads or pull back side-cast fill and overburden or install cross-drains so as to eliminate sediment delivery. Where old road culverts have created gullies or debris flows on hillslopes below road drainage structures, fully disconnect upslope road drainage and use engineered LWD structures to fill gullies and slow accelerated water runoff rates through these features.	H#6 (BSH), H#8 (WQ)	H#7 (Pred), H#10 (Comp)	RS #18, RS #19, RS #20
Broad Scale Action 13	Sediment	Priority II Sub-Basins	Reconnect floodplains in Priority II Sub-Basin by reintroducing LWD to all tributaries to improve floodplain connectivity and sediment deposition/storage.	H#6 (BSH), H#8 (WQ)	H#7 (Pred), H#10 (Comp)	RS #18, RS #19, RS #20
Broad Scale Action 14	Sediment	Priority II Sub-Basins	Plant or under-plant conifer riparian forests in fields and disturbed hardwood zones to increase bank rooting strength, increase hydrologic roughness, and aid in sediment storage / deposition.	H#6 (BSH), H#8 (WQ)	H#7 (Pred), H#10 (Comp)	RS #18, RS #19, RS #20
Broad Scale Action 15	Sediment	Priority II Sub-Basins	Eradicate non-native plants (e.g., knotweed) in the riparian zone and replace with native species more effective at protecting soil / banks (e.g., conifers).	H#6 (BSH), H#8 (WQ)	H#7 (Pred), H#10 (Comp)	RS #18, RS #19, RS #20

Broad Scale Action	Watershed Process	Location	Description of Action	Primary Hypothesis Addressed	Secondary Hypothesis Addressed	Recovery Strategy Number
Broad Scale Action 16	Vegetation	Lake Ozette	Conduct a high resolution, detailed survey of the lake shoreline and riparian zone, documenting non-native plant species. Develop program to eliminate non-native, invasive plant species.	H#6 (BSH)	H#7 (Pred), H#10 (Comp)	RS #20, RS #21, RS #22
Broad Scale Action 17	Biological	Umbrella Beach	Develop comprehensive program to restore beach spawning habitat at Umbrella Beach (in addition to Umbrella Creek recovery efforts). Upon habitat recovery, implement an experimental sockeye re-introduction program.	H#6 (BSH)	H#7 (Pred), H#10 (Comp)	RS #10, RS #24, RS #25
Broad Scale Action 18	Biological	Lake Ozette	Identify other potential sockeye beach spawning habitats and attempt re-introducing sockeye salmon in conjunction with habitat and watershed process rehabilitation efforts.	H#6 (BSH)	H#7 (Pred), H#10 (Comp)	RS #10, RS #24, RS #25
Broad Scale Action 6	Hydrology	Big River and Umbrella Creek	Where interest and funding exist, purchase entire sub-watersheds within Ozette and restore back to old-growth unroaded conditions.	H#15 (Q)	H#12 (Stab)	RS #3, RS #4, RS #16, RS #17, RS #28
Broad Scale Action 7	Hydrology	Big River and Umbrella Creek	Restore or improve permanent vegetative hydrologic maturity throughout watershed.	H#15 (Q)	H#12 (Stab)	RS #3, RS #4, RS #16, RS #17, RS #28

Broad Scale Action	Watershed Process	Location	Description of Action	Primary Hypothesis Addressed	Secondary Hypothesis Addressed	Recovery Strategy Number
Broad Scale Action 8	Hydrology	Big River and Umbrella Creek	Remove and/or disconnect hydrologically connected road systems via road decommissioning (full removal), abundant road cross-drain installation, and adequate culvert sizes at tributary crossings to ensure passage of LWD, sediment, and water at the 100 yr RI flood.	H#15 (Q)	H#12 (Stab)	RS #3, RS #4, RS #16, RS #17, RS #28
Broad Scale Action 9	Hydrology	Big River and Umbrella Creek	Plant or under-plant conifer riparian forests in fields and disturbed hardwood zones.	H#15 (Q)	H#12 (Stab)	RS #3, RS #4, RS #16, RS #17, RS #28
Broad Scale Action 10	Hydrology	Big River and Umbrella Creek	Reconnect floodplains by reintroducing LWD to all tributaries to improve floodplain connectivity, water retention, and peak flow attenuation.	H#15 (Q)	H#12 (Stab)	RS #3, RS #4, RS #16, RS #17, RS #28
Broad Scale Action 11	Sediment	Big River and Umbrella Creek	Where interest and funding exist, purchase entire sub-watersheds and restore back to old-growth, unroaded conditions.	H#11 (TSH)	H#12 (Stab), H#13 (WQ), H#15 (Q), H#16 (HP)	RS # 18, RS #19, RS #20
Broad Scale Action 14	Sediment	Big River and Umbrella Creek	Plant or under-plant conifer riparian forests in fields and disturbed hardwood zones to increase bank rooting strength, increase hydrologic roughness, and aid in sediment storage / deposition.	H#11 (TSH)	H#12 (Stab), H#13 (WQ), H#15 (Q), H#16 (HP)	RS # 18, RS #19, RS #20

Broad Scale Action	Watershed Process	Location	Description of Action	Primary Hypothesis Addressed	Secondary Hypothesis Addressed	Recovery Strategy Number
Broad Scale Action 19	Sediment	Big River and Umbrella Creek	Within the sockeye spawning tributaries, quantitatively assess sediment production impacts from logging (gully creation, debris flows, landslides), road building, and LWD removal. Develop program to reduce land use related sediment inputs at the site level. Examples include: Where stream-adjacent roads have been built, decommission these roads or pull back side-cast fill and overburden or install cross-drains so as to eliminate sediment delivery. Where old road culverts have created gullies or debris flows on hillslopes below road drainage structures, fully disconnect upslope road drainage and use engineered LWD structures to fill gullies and slow accelerated water runoff rates through these features.	H#11 (TSH)	H#12 (Stab), H#13 (WQ), H#15 (Q), H#16 (HP)	NA
Broad Scale Action 20	Sediment	Big River and Umbrella Creek	Reconnect floodplains in sockeye spawning tributaries by reintroducing LWD to all tributaries to improve floodplain connectivity and sediment deposition/storage.	H#11 (TSH)	H#12 (Stab), H#13 (WQ), H#15 (Q), H#16 (HP)	NA
Broad Scale Action 21	Sediment	Big River	Fence riparian areas to keep cattle out of Big River sockeye spawning reaches.	H#11 (TSH)	H#12 (Stab), H#13 (WQ), H#15 (Q), H#16 (HP)	NA

Broad Scale Action	Watershed Process	Location	Description of Action	Primary Hypothesis Addressed	Secondary Hypothesis Addressed	Recovery Strategy Number
Broad Scale Action 22	Sediment	Big River	Reconnect floodplains and stabilize raw eroding banks by reintroducing LWD to improve floodplain connectivity, sediment storage, water retention, and peak flow attenuation.	H#11 (TSH)	H#12 (Stab), H#13 (WQ), H#15 (Q), H#16 (HP)	NA

Table D-3. Summary of site-specific actions their linkage to recovery models, watershed processes, locations, and primary and secondary limiting factor hypotheses.

Site-Specific Actions	Watershed Process	Location	Description of Action	Primary Hypothesis Addressed	Secondary Hypothesis Addressed	Recovery Strategy Number
Site-Specific Action 1	Hydrology	Ozette River	As recommended by modeling results, add LWD to the Ozette River to restore natural hydraulic backwater condition and maintain the natural range of variability of lake levels.	H#3 (Q)	H#1 (Pred)	NA
Site-Specific Action 2	Hydrology	All Tribs	Remove or relocate floodplain roads and bank armoring (exact site locations to come).	H#11 (TSH)	H#12 (Stab)	NA
Site-Specific Action 3	Sediment	Ozette River Sub-Basin	Pave lower Seafield main line road (lower ¼-mile).	H#2 (WQ)	H#3 (Q)	RS #6, RS #7

Site-Specific Actions	Watershed Process	Location	Description of Action	Primary Hypothesis Addressed	Secondary Hypothesis Addressed	Recovery Strategy Number
Site-Specific Action 4	Sediment	Ozette River Sub-Basin	Utilize the results of sub-basin scale sediment budgets (see broad-scale actions) to define the relative contribution of different sediment sources and target specific sites for restoration activities.	H#2 (WQ)	H#3 (Q) H#4 (Hab)	RS #6, RS #7
Site-Specific Action 5	Riparian/Floodplain	Ozette River	Plant native tree species along the right bank of the Ozette River from the boat ramp, downstream 3,000 feet. Establish a 1 SPTH riparian forest where feasible. Maintain planting until trees are well established.	H#4 (Hab)	H#1 (Pred) H#2 (WQ) H#3 (Q)	RS # 8, RS #14
Site-Specific Action 6	Biological	Ozette River, Ozette River Estuary, and Nearshore	Encourage Tribes to reinstate ceremonial and subsistence hunting of seals and sea lions, consistent with applicable law.	H#1 (Pred)	NA	RS #9, RS #10, RS #11, RS #12, RS #13, RS #24, RS #25
Site-Specific Action 7	Biological	Ozette River	Re-introduce LWD into the Ozette River so as to prevent/block/hinder seal migrations into Lake Ozette and provide cover for migrating Ozette sockeye to avoid predation.	H#1 (Pred)	H#2 (WQ) H#3 (Q) H#4 (Hab)	RS #9, RS #10, RS #11, RS #12, RS #13, RS #24, RS #25
Site-Specific Action 8	Biological	Ozette River	Modify sockeye adult enumeration techniques at the Ozette River weir so as to reduce any predation mortality on adult and juvenile sockeye.	H#1 (Pred)	NA	RS #9, RS #10, RS #11, RS #12, RS #13

Site-Specific Actions	Watershed Process	Location	Description of Action	Primary Hypothesis Addressed	Secondary Hypothesis Addressed	Recovery Strategy Number
Site-Specific Action 9	Biological	Lake Ozette and Ozette River	Create an annual fishing derby or incentive program for large-mouth bass (exotic) with a goal of reducing or eliminating their population. Create regulations for fishery that will limit take of other species besides bass.	H#1 (Pred)	NA	RS #9, RS #10, RS #11, RS #12, RS # 13
Site-Specific Action 10	LWD Habitat Conditions	Ozette River	In conjunction with hydrologic and hydraulic process recovery action efforts and seal migration efforts, place LWD structures in the Ozette River to enhance habitat complexity.	H#4 (Hab)	H#1 (Pred) H#3 (Q) H#? (EST)	RS #15
Site-Specific Action 11	Sediment	Priority II Sub-Basins	Use the results of sub-basin scale sediment budgets (see broad-scale actions) to define the relative contribution of different sediment sources and target specific sites for restoration activities.	H#6 (BSH), H#8 (WQ)	NA	RS #18, RS #19, RS #20
Site-Specific Action 12	Vegetation	Lake Ozette	Within Lake Ozette, implement non-native vegetation eradication at sites identified in assessment.	H#6 (BSH)	H#7 (Pred), H#10 (Comp)	RS #20, RS #21, RS #22
Site-Specific Action 13	Vegetation	All Tribs	Within Lake Ozette tributaries, eradicate non-native vegetation.	H#6 (BSH)	H#7 (Pred), H#10 (Comp)	RS #20, RS #21, RS #22
Site-Specific Action 6	Biological	Ozette River, Ozette River Estuary,	Encourage Tribes to reinstate ceremonial and subsistence hunting of seals and sea lions, consistent with applicable law.	H#7 (Pred)	H#6 (BSH)	RS #9, RS #10, RS #11, RS #12, RS

Site-Specific Actions	Watershed Process	Location	Description of Action	Primary Hypothesis Addressed	Secondary Hypothesis Addressed	Recovery Strategy Number
		and Nearshore				#13, RS #24, RS #25
Site-Specific Action 7	Biological	Ozette River	Re-introduce LWD into the Ozette River so as to prevent/block/hinder seal migrations into Lake Ozette and provide cover for migrating Ozette sockeye to avoid predation.	H#7 (Pred)	H#6 (BSH)	RS #9, RS #10, RS #11, RS #12, RS #13, RS #24, RS #25
Site-Specific Action 16	Biological	Olsen's and Allen's Beaches	Initiate seal removal efforts on sockeye spawning beaches. Might include trapping, relocation, or lethal removal.	H#7 (Pred)	H#6 (BSH)	RS #9, RS #10, RS #11, RS #12, RS #13, RS #24, RS #25
Site-Specific Action 17	Hydrology	Big River	Relocate county road where road affects floodplain connectivity.	H#15 (Q)	H#12 (Stab)	RS #28
Site-Specific Action 18	Hydrology	Big River	Plant or under-plant conifer riparian forests in fields and disturbed hardwood zones.	H#15 (Q)	H#12 (Stab)	RS #28

Site-Specific Actions	Watershed Process	Location	Description of Action	Primary Hypothesis Addressed	Secondary Hypothesis Addressed	Recovery Strategy Number
Site-Specific Action 19	Hydrology	Big River	Where interest exists, purchase full riparian conservation easements to reestablish riparian zones along Big River and allow natural flooding to take place.	H#15 (Q)	H#12 (Stab)	RS #28
Site-Specific Action 17	Sediment	Big River	Relocate county road where road affects floodplain connectivity.	H#11 (TSH)	H#12 (Stab), H#13 (WQ), H#15 (Q), H#16 (HP)	RS #28
Site-Specific Action 18	Sediment	Big River	Plant or under-plant conifer riparian forests in fields and disturbed hardwood zones.	H#11 (TSH)	H#12 (Stab), H#13 (WQ), H#15 (Q), H#16 (HP)	RS #28
Site-Specific Action 19	Sediment	Big River	Where interest exists, purchase full riparian conservation easements to reestablish riparian zones along Big River and allow natural flooding to take place.	H#11 (TSH)	H#12 (Stab), H#13 (WQ), H#15 (Q), H#16 (HP)	RS #28