S. HRG. 115–568

REAUTHORIZATION OF THE MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT: FISHERIES SCIENCE

HEARING

BEFORE THE

SUBCOMMITTEE ON OCEANS, ATMOSPHERE, FISHERIES, AND COAST GUARD

OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION
UNITED STATES SENATE

ONE HUNDRED FIFTEENTH CONGRESS

FIRST SESSION

OCTOBER 24, 2017

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SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ONE HUNDRED FIFTEENTH CONGRESS

FIRST SESSION

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REAUTHORIZATION OF THE MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT: FISHERIES SCIENCE

TUESDAY, OCTOBER 24, 2017

U.S. SENATE,
SUBCOMMITTEE ON OCEANS, ATMOSPHERE, FISHERIES, AND COAST GUARD,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Subcommittee met, pursuant to notice, at 2:34 p.m. in room SR–253, Russell Senate Office Building, Hon. Dan Sullivan, Chairman of the Subcommittee, presiding.

Present: Senators Sullivan [presiding], Wicker, Inhofe, Young, Peters, Cantwell, Blumenthal, Markey, and Booker.

OPENING STATEMENT OF HON. DAN SULLIVAN, U.S. SENATOR FROM ALASKA

The CHAIRMAN. The Subcommittee on Oceans, Atmosphere, Fisheries, and Coast Guard now come to order.

Today's hearing is the fourth in a series of hearings as we continue forward with the important process of reauthorizing, in a bipartisan way, the Magnuson-Stevens Fisheries Conservation and Management Act, what we refer to as the MSA.

Today's focus will be on fishery science and the importance that accurate, timely data plays in ensuring the most informed decisions are made in both the best interest of our economy and protecting this incredibly valuable natural resource.

I look forward to a robust discussion today. And I thank my friends across the aisle for coordinating with us—Senator Peters and his team, in particular—on this important hearing, and throughout this series of hearings on MSA reauthorization, which we think is critical for our country.

To make that point clear, the fishing industry—commercial, charter, and recreational combined—contributes over $90 billion annually to the U.S. economy and supports, in excess, of 1.5 million jobs.

At the same time, we need to make sure our resource is healthy. The fishing industry right now is stable and has the opportunity to grow, primarily because of the hard work our predecessors put into ensuring we had a solid framework for sustainably harvesting this incredibly important natural resource.

The foundational basis of this stable framework is scientifically accurate and reputable data upon which the regional councils can base their management decisions under the MSA framework.

The United States has the world's second largest exclusive economic zone. Second only, oddly enough, to France. And as stewards of that vast ocean, we are entrusted with not only safeguarding its biological health and sustainability, but also ensuring we are efficiently extracting the resources from within.

Ensuring that Congress supports the need for proper data, supported by reputable and consistent science, is critical to maintaining a sustainable, yet profitable, national fishery.

Technology needs to play a larger role in this, as it has the potential to provide efficiencies, and reduce administrative burdens, and increase the accuracy of the data used for the all-important stock assessments and catch accountability upon which our councils rely.

It should be of news to nobody that data does not come cheaply, and that while NOAA stretches its limited budget the best it can, it is only able to grab a small snapshot of the status and health of the biomass in our oceans.

I look forward to hearing today about how cooperative research can augment the information NOAA has available in order to make the most informed decisions possible for our fisheries and our country.

As we move forward with reauthorization, we face many emerging challenges, namely, balancing the needs of various user groups. I believe that the answer to this looming question lies in more fully understanding the status and health of the resource. Given the funding constraints Federal agencies face, we must embrace the efficiency offered by emerging science and technology.

I look forward to hearing from our witnesses today on the way forward on some of these critical issues, and also on existing data collection programs, and successes that are already working within our current Magnuson-Stevens framework.

With that, I want to thank all of our witnesses. We have, as usual, a very distinguished panel of experts, who we will learn from today.

I now want to recognize the Ranking Member, Senator Peters, who has been a great partner in these hearings with me as we look at MSA reauthorization.

Senator Peters.

STATEMENT OF HON. GARY PETERS, U.S. SENATOR FROM MICHIGAN

Senator PETERS. Well, thank you, Chairman Sullivan.

And thank you, as well, to the witnesses that are here to discuss a very important issue of reauthorizing the Magnuson-Stevens Act, or MSA.

Today, I am looking forward to the opportunity to hear about scientific advances that can help us improve management of Federal fisheries.

But first, I would like to welcome Dr. Michael Jones, who is the Peter A. Larkin Professor of Quantitative Fisheries, who founded

and is now the Co-Director of the Quantitative Fisheries Center at Michigan State University; truly a great university.

Dr. Jones' research focuses on fish population dynamics, fish ecology, resource management, and simulation modeling.

Thank you for making the trip here, Dr. Jones. I appreciate it. We all look forward to hearing your testimony.

Second, the fishery science community has many informative voices that could not all be with us here today, Mr. Chairman. Over 200 scientists have sent a letter outlining the importance of science to fisheries, and to the MSA.

So, Mr. Chairman, if I could enter that letter into the record without objection?

The CHAIRMAN. Without objection.

[The letter referred to follows:]

October 23, 2017

Dear Members of Congress,

The undersigned scientists write to urge you to oppose H.R. 200 and any other legislative efforts that would weaken science-based management of U.S. marine fish populations, so that current and future generations of Americans can enjoy fishing and healthy oceans teeming with fish for years to come.

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) is the primary law governing marine fisheries management in U.S. Federal waters. Congress passed the original law in 1976 to phase out foreign fishing in U.S. waters and to promote domestic fishing opportunities. In 1996 and 2006, the MSA was amended to strengthen its conservation provisions and ensure scientific advice provided the basis of fishery management decisions. These changes have enabled the United States to become a global leader in well-managed and profitable fisheries, with over 40 domestic fish stocks rebuilt since 2000. Preventing overfishing with science-based sustainable catch limits and timely rebuilding of fish populations that are depleted, as required under the MSA, are fundamental to good management of fishery resources and should be maintained to continue improving the health of our Nation's fisheries.

Yet, several pieces of legislation have been introduced this Congress that would unwind science-based conservation of U.S. marine fish populations. Chief among them is H.R. 200, which undermines the cornerstones of MSA's success in several ways, including weakening or eliminating science-based management requirements and reducing the quality of science used in management decisions.

First, H.R. 200 will weaken the MSA's successful recovery of depleted fish populations by establishing broad loopholes that effectively eliminate the requirement for managers to set reasonable and scientifically based rebuilding timelines. Decades of fisheries science shows that in order to succeed in rebuilding overfished stocks, managers must implement strong and timely management measures based on sound science.

Second, H.R. 200 would increase the risk of overfishing by removing the requirement for science-based annual catch limits for many species, including some that may be overfished or subject to overfishing. Annual catch limits are vital to the health of fish populations and provide the guardrails to make and keep fisheries sustainable. Removal of these key management tools will hurt our fisheries, our oceans and the U.S. economy.

Third, H.R. 200 undermines crucial environmental laws such as the National Environmental Policy Act (NEPA), the Endangered Species Act (ESA) and the Antiquities Act. It is unacceptable to exempt fishery management plans from the bedrock requirements of NEPA that provide for public participation in management and adequate analysis of decision-making. The MSA is effective at managing fisheries, but is not designed to achieve broader ocean management objectives, particularly with regard to maintaining the biological integrity of protected species and populations, or protecting special places and ecosystems. These essential laws must continue to preserve marine species and habitats, and to strongly protect our country's marine national monuments, *i.e.,* our Nation's blue parks.

Lastly, H.R. 200 and other legislative proposals roll back science-based management and lessen accountability in recreational fisheries. Recreational fisheries across the country are already able to use flexible management strategies so long as they comply with annual catch limits and ensure accountability for their catches.

It is essential that recreational fisheries continue to be accountable for the fish they remove from the ocean to ensure future opportunities for recreational anglers and other resource users.

The last version of this bill was opposed by over 170 organizations, representing fishermen, business owners, chefs and community leaders. We, the undersigned scientists, similarly urge Congress to oppose H.R. 200 and other legislation that would weaken science-based management and the health of U.S. fish populations, and exempt fisheries managers from complying with other laws that protect our ocean resources.

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Senator PETERS. This hearing, as was mentioned by the Chairman, marks the fourth hearing on MSA reauthorization. And throughout this process, I have heard a common theme from a variety of different stakeholders: having robust data, and a science-driven process, are critical to the success of our fisheries.

So for this fourth hearing, it is appropriate that we are taking a look at fisheries science.

The MSA lays out a fisheries management process that directs NOAA to rely on the best scientific information available. This science informs regional stock assessments which, in turn, determine how many fish can be sustainably caught or if a stock is being overfished. Making sure that we have sound science underpinning these decisions is absolutely critical.

In recent years, this scientific process has proven successful. As fisheries decline across the globe, the U.S. has become a beacon of sustainable fishing.

Using science to develop annual catch limits has proven to be effective and, along with ensuring accountability, has reduced the number of overfished stock, and the number of stocks undergoing overfishing to all time lows. The ability of science to assist us in managing fisheries cannot be understated.

In the Great Lakes, we were forced into learning this lesson the hard way. At the last MSA hearing, I discussed the devastating impact of sea lamprey on Great Lakes fisheries, reducing the most abundant fisheries in the Lakes to just 2 percent of their former production within just a couple of decades.

This historical event is a testament, not only to the importance of management accounting for the whole ecosystem, but it is also a testament to the power of science to assist fisheries management.

Scientists and managers did not sit idly by as the Great Lakes fisheries were crashing due to this devastating parasite. They were rapidly collecting data and studying the Great Lakes' ecosystem like never before, all in an effort to control sea lamprey.

With the concerted bi-national and multistate efforts, a breakthrough came in 1957 with the discovery of TFM. After testing nearly 6,000 chemicals, TFM was the first to selectively impact lamprey without harming other aquatic animals or plants.

This was the first of several scientific advances that supported the management and control of sea lamprey, and facilitated the resurgence of Great Lakes fisheries.

Science, together with management, helped to bring the Great Lakes fisheries back, and today they are worth $7 billion annually, support 75,000 jobs, and provide opportunities for 5 million anglers of all ages.

And that is why I introduced the Great Lakes Fishery Research Authorization Act of 2017 to provide for critical science and research necessary to continue supporting these fisheries in the Great Lakes.

The best thing is that science and research never stop. Scientists continue researching lamprey control methods by manipulating lamprey senses, targeting lamprey genetics, and adapting video shape recognition in the development of selective fish passage systems in Traverse City, Michigan.

Science, research, and technology helping to improve fisheries are fortunately not confined to one region.

For example, the advances in shape recognition software are not only helping to control sea lamprey, but they are also helping to advance electronic monitoring systems and improve data, recording, and recordkeeping.

The prospect of electronic video systems that can let a fisherman know what is in the net before hauling it aboard is, indeed, exciting and fascinating.

New technologies and technological developments in fishery science will continue to improve management outcomes.

NOAA and private companies are beginning to embrace autonomous systems in a variety of ways, not the least of which is gathering fisheries' data.

These systems are being used aerially on the water surface and throughout the water column to aid fishermen in locating fish, help regulators monitor fishing fleets and report illegal activity, and assist researchers tracking wildlife, habitats, and climate.

Fishery science and technology has undergone a lot of change since the last MSA reauthorization a decade ago. So I think this hearing will be a very informative one, and I am eager to learn from the scientists here today about the latest research, new and emerging technologies, and explore ways to make smarter decisions to ensure the long-term sustainability of our Nation's fisheries.

So once again to our witnesses, thank you for being here today.

[The prepared statement of Senator Peters follows:]

PREPARED STATEMENT OF HON. GARY PETERS, U.S. SENATOR FROM MICHIGAN

Thank you, Mr. Chairman, and thanks to our witnesses for being here this afternoon as we continue a series of hearings to discuss the important issue of reauthorizing the Magnuson-Stevens Act or MSA. Today, I am looking forward to the opportunity to hear about scientific advances that can help us improve management for Federal fisheries.

First I would like to welcome Dr. Michael Jones, the Peter A. Larkin Professor of Quantitative Fisheries who founded and is now Co-Director of the Quantitative Fisheries Center at Michigan State University. Dr. Jones' research focuses on fish population dynamics, fish ecology, resource management, and simulation modeling. Thank you for making the trip and I look forward to hearing your testimony.

Second, the fisheries science community has many informative voices that could not all be with us today, and over 200 scientists have sent a letter outlining the importance of science to fisheries and the Magnuson-Stevens Act, so Mr. Chairmen I ask that this letter be entered into the record.

This hearing marks the fourth hearing on MSA reauthorization. Throughout this process I have heard a common theme from a variety of different stakeholders: having robust data and a science-driven process are critical to the success of our fisheries. So, for this fourth hearing, it is appropriate that we are taking a look at fisheries science.

The Magnuson-Stevens Act lays out a fisheries management process that directs NOAA to rely on the best scientific information available. This science informs regional stock assessments, which, in turn, determine how many fish can be sustainably caught or if a stock is being overfished. Making sure that we have sound science underpinning these decisions is absolutely critical to the management and sustainability of our fisheries.

In recent years, this scientific process has proven successful. As fisheries decline across the globe, the U.S. has become a beacon for sustainable fishing. Using science to develop annual catch limits has proven to be effective and along with ensuring accountability, has reduced the number of overfished stocks and the number of stocks undergoing overfishing to all-time lows. The ability of science to assist us in managing fisheries cannot be understated.

In the Great Lakes, we were forced into learning this lesson. At the last MSA hearing, I discussed the devastating effect of sea lamprey on Great Lakes fisheries, reducing the most abundant fishery in the Lakes to 2 percent of its former production within just a couple decades.

This historical event is a testament not only to importance of management accounting for the whole ecosystem, but it is also a testament to the power of science to assist fisheries management.

Scientists and managers did not sit idly by as the Great Lakes fisheries were crashing due to this devastating parasite. They were rapidly collecting data and studying the Great Lakes ecosystem like never before; all in an effort to control sea lamprey.

With concerted bi-national and multi-state efforts, a breakthrough came in 1957 with the discovery of TFM. After testing nearly 6,000 chemicals, TFM was the first to selectively impact lamprey without harming other aquatic animals or plants.

This was the first of several scientific advances that supported the management and control of sea lamprey and facilitated the resurgence of the Great Lakes fisheries.

Science, together with management, helped to bring the Great Lakes fisheries back, and today they are worth $7 billion annually, support 75,000 jobs, and provide opportunities for 5 million anglers of all ages. And that is why I introduced the Great Lakes Fishery Research Authorization Act of 2017 to provide for the critical science and research necessary to supporting fisheries in Great Lakes.

The best thing is that science and research never stop. Scientists continue researching lamprey control methods by manipulating lamprey senses, targeting lamprey genetics, and adapting video shape recognition in the development of selective fish passage systems in Traverse City, Michigan.

Science, research, and technology helping to improve fisheries are fortunately not confined to one region. For example, the advances in shape recognition software are not only helping control sea lamprey, but they are also helping to advance electronic monitoring systems and improve data collection and record keeping.

The prospect of electronic video systems that can let a fishermen know what is in the net before hauling it aboard is indeed exciting and fascinating. New techniques and technological developments in fisheries science will continue to improve management outcomes.

NOAA and private companies are beginning to embrace autonomous systems in a variety of ways, not the least of which is gathering fisheries data. These systems are being used aerially, on the water's surface, and throughout the water column to: aid fishermen in locating fish; help regulators monitor fishing fleets and report illegal activity; and assist researchers tracking wildlife, habitats, and climate.

Fisheries science and technology has undergone a lot of change since the last MSA reauthorization a decade ago. So, I think this hearing will be very informative and I'm eager to learn from the scientists with us today about the latest research, new and emerging technologies, and explore ways to make smarter decisions to ensure the long-term sustainability of our Nation's fisheries.

The CHAIRMAN. Thank you, Senator Peters.

Again, I want to thank our panel of witnesses. I think everybody will see that this is quite the expert panel, and thank you for traveling far distances to come to this hearing.

The witnesses, I do want to introduce each of them.

Dr. Ray Hilborn, Professor at the University of Washington School of Aquatic and Fishery Sciences; Dr. Larry McKinney, Director, Texas A&M University Harte Research Institute for Gulf of Mexico Studies; Mr. Karl Haflinger, Founder and President of Sea State, Inc.; and Dr. Michael Jones, Professor, Michigan State University Quantitative Fisheries Center.

You will each have 5 minutes to deliver an oral statement, and if you would like, we will include a longer written statement for the record.

Dr. Hilborn, the floor is yours, sir.

STATEMENT OF RAY HILBORN, PH.D., PROFESSOR, SCHOOL OF AQUATIC AND FISHERY SCIENCES, UNIVERSITY OF WASHINGTON

Dr. HILBORN. Thank you for this opportunity to address you.

As a point of full disclosure, my research program receives substantial funding from a range of sources including U.S. philanthropic foundations, fishing industry groups in the U.S. and overseas, environmental NGOs, U.S. Government agencies, and the Food and Agriculture Organization of the United Nations.

The number of fish in the sea is rising in all regions of the United States, and the proportion of stocks at low abundance is consistently decreasing.

This success has been achieved by funding of science, stopping the race to fish through various forms of rationalization, engaging in a consultative process with stakeholders, and most of all, requiring managers to follow science advice regarding allowable levels of harvest.

The rebuilding of stocks can be directly attributed to the reduction in fishing pressure that began in the 1990s, and that the science advice has been guided by the objective of stopping overfishing.

The major threats to U.S. fish stocks, and marine ecosystems' biodiversity, are now ocean acidification, warming temperatures, degraded coastal habitats, exotic species, land-based runoff, and pollution.

Overfishing remains a concern for a limited number of stocks, but should not continue to be the most important concern for U.S. Federal fisheries policy.

If Congress were to decide what the relative importance of various objectives of fisheries management should be—be it profit, jobs, yield, environmental protection—the science community could give guidance on recommended harvests.

The social and economic record of U.S. fisheries is much more mixed than the biological success.

Where we have found ways to stop the race to fish, profitability has almost always increased, fisheries are safer, and fishing seasons grow longer, while total fishing effort and costs have reduced.

However, we have not found any methods to allocate fishing opportunities that are considered fair by all stakeholders.

There is the potential to increase U.S. fisheries' yield by as much as 50 percent through fuller utilization of our fish resources.

First, and of most importance, is fuller utilization of the total allowable catches that are set.

In many U.S. fisheries, particularly the mixed fisheries of the East and West Coast, Gulf of Alaska, we catch much less than the TAC, which themselves are set conservatively to prevent overfishing.

In the West Coast, we actually caught 38 percent of the potential value of the fish resources as set by the TACs. Maximizing yield from mixed fisheries will generally involve some stocks above the target and some stocks below the target in what we now call overfishing.

These mixed fisheries have seen dramatic reductions in fishing pressure and rebuilding of the stocks, but they have not seen in-

creases of catch. As a policy to provide more catch to the fishing fleets, our current approach for mixed stock fisheries has largely failed.

I emphasize that we should not move away from science-based management and the existing council process. The current rebuilding system is designed to achieve the management objective of stopping overfishing regardless of the cost to total catch in markets and communities.

If the science community was directed to maximize economic value of the U.S. fisheries or yield, the rebuilding plans would be quite different.

I would like to address the importance of recreational fishing and small scale fisheries. I serve on the Science and Statistics Committee of the Western Pacific Regional Fisheries Management Council.

The national standards are appropriate for the major industrial tuna fisheries of the region, but they are totally inappropriate for the small scale and recreational fisheries, where we have hundreds of species with poor catch and abundance data. Trying to estimate allowable biological catch and status relative to reference points, for even a dozen of them, is not possible.

If the SSC or NOAA were directed to provide advice on how best to achieve specific objectives for these types of fisheries with the budgets and the tools available, we could do so, but it would not involve hard catch limits and most certainly would be some form of effort and spatial management.

In summary, I wish to emphasize that U.S. fisheries management has succeeded by relying on science advice. This should not change.

However, there certainly is the potential to change U.S. fisheries management to try to achieve more benefits from the ocean. This can be achieved by directing the science community to design fisheries management policies to achieve our social objectives.

It is up to the legislators and councils to explicitly state what we want to achieve.

Thank you very much.

[The prepared statement of Dr. Hilborn follows:]

PREPARED STATEMENT OF RAY HILBORN, PH.D., PROFESSOR, SCHOOL OF AQUATIC AND FISHERY SCIENCES, UNIVERSITY OF WASHINGTON

Qualifications

I am an ecologist working in fisheries management for over 45 years. I have published over 300 peer reviewed articles and several books, including a text book on fisheries stock assessment and management, and "overfishing, what everyone needs to know." I have received the Volvo Environmental Prize, the American Fisheries Societies Award of Excellence, The Ecological Society of America's Sustainability Science Award, and the International Fisheries Science Prize. I am a Fellow of the Royal Society of Canada, the American Academy of Arts and Sciences, the American Fisheries Society and the Washington State Academy of Sciences. I have helped lead international study teams examining the status of fish stocks and the relationship between management and outcomes, the impact of bottom trawling on benthic biota, and the impact of fishing forage fish on their predators.

Funding

My research program receives substantial funding from a range of sources including U.S. Philanthropic Foundations (Walton Family Foundation, David and Lucile Packard Foundation, Gordon and Betty Moore Foundation, Pew Institute of Ocean

Sciences), fishing industry groups in the U.S. and overseas, environmental NGOs (Environmental Defense, The Nature Conservancy), U.S. government agencies (NOAA and NSF), and the Food and Agriculture Organization of the United Nations.

Testimony

U.S. Federal fisheries policy has led to rebuilding of fish stocks and some of the most successful fisheries in the world. The number of fish in the sea is rising in all regions of the U.S. and the proportion of stocks at low abundance is consistently decreasing (See Figures 1 and 2).

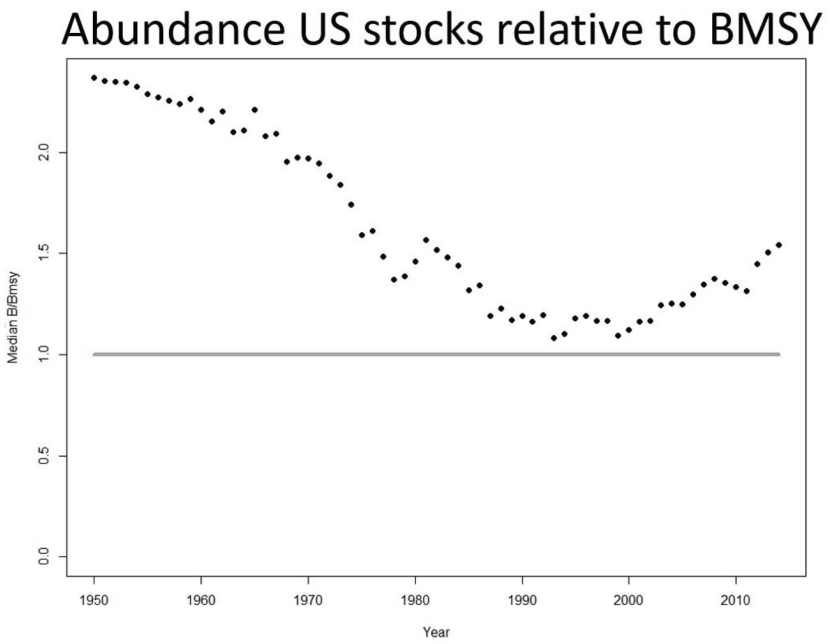

Figure 1. Trend in U.S. average stock biomass in relation to the level that would produce long term maximum sustainable yield. The green line is the stock biomass that would produce maximum sustainable yield. All data from NOAA assessments.

This success has been achieved by funding of NOAA, regionalizing fisheries management decisions, stopping the race-to-fish through various forms of rationalization, engaging in a consultative process and most of all requiring managers to follow science advice regarding allowable levels of harvest.

In many cases, but certainly not all, moving away from effort limits to hard "total allowable catch" has made a big difference in reducing fishing pressure where it was too high. The rebuilding of stocks can be directly attributed to the reduction in fishing pressure that began in the 1990s and the science advice has been guided by the objective of stopping overfishing.

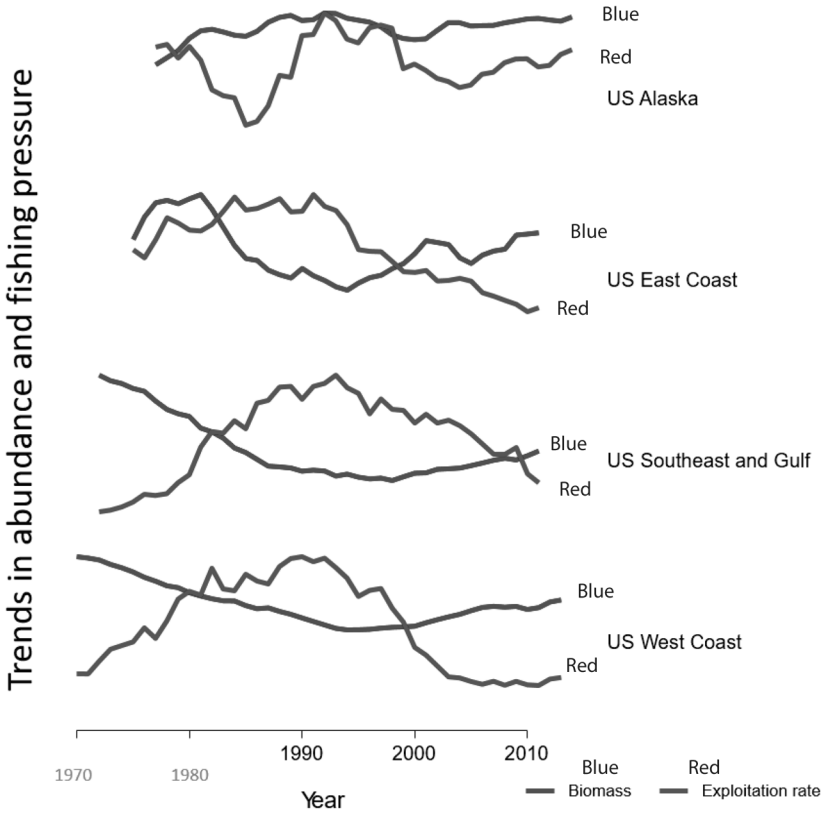

Figure 2. Trend in average abundance of fish stocks (blue line) in individual regions of the U.S. and fishing mortality rate (red line).

The major threats to U.S. fish stock and marine ecosystem biodiversity are now ocean acidification, warming temperatures, degraded coastal habitats, exotic species, land based run off, and pollution. Overfishing remains a concern for a limited number of stocks but should not continue to be the most important concern for U.S. Federal fisheries policy. If Congress were to decide what the relative importance of various objective of fisheries management should be (profit, jobs, yield, environmental protection) the science community could give guidance on the recommended harvest.

The social and economic record of U.S. fisheries is much more mixed than the biological success. Where we have found ways to stop the race-to-fish, profitability has almost always increased, fisheries are safer, and fishing seasons have grown longer while total fishing effort and cost has been reduced. However many of the methods used to stop the race-to-fish have led to declines in owner operated small boat fleets and concentration of ownership, and we have not found any methods to allocate fishing opportunity that are considered fair by all stakeholders.

The overall approach of reference points, TACs for each species and rebuilding plans works well for individually targeted, large scale industrial fisheries, but is totally inappropriate for recreational, small scale, and highly mixed fisheries where dozens or even hundreds of species may be caught together and the science is not affordable assess and measure catch of each species.

There is potential to increase U.S. fisheries yield, jobs and economic value, but this potential may be limited by the ability to manage stocks individually, concerns about environmental protection, profitability of fishing, and markets for stocks that are lightly fished (Figure 3).

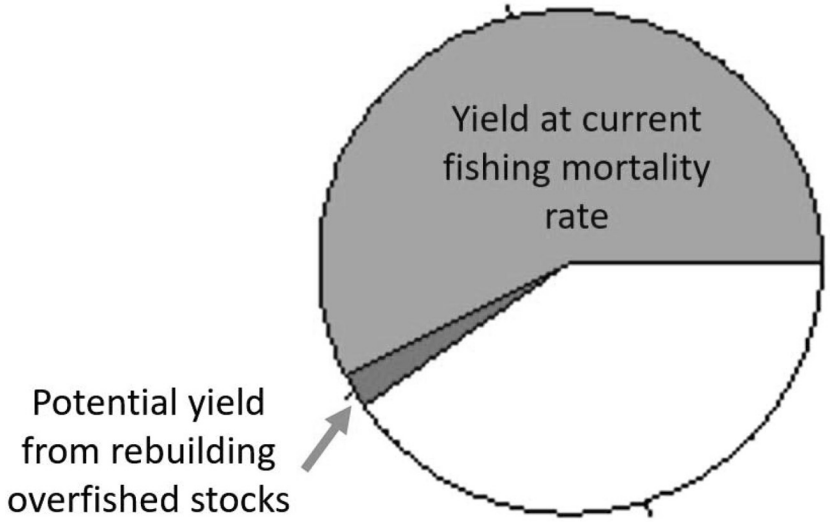

Figure 3. Graph showing how much yield will be achieved at current levels of fishing pressure (green), how much yield can be increased by rebuilding overexploited stocks (red), and the remaining area is a theoretical gain that could be achieved if we were able to and wanted to manage each stock to its MSY.

Fuller use has three aspects.

First and of the most importance, is fuller utilization of the TACs being set. In many U.S. fisheries, particularly the mixed bottom fisheries of the east coast, west coast, and Gulf of Alaska, we catch much less than the TACs which themselves are set conservatively to prevent overfishing. In the West coast, the potential landed value of all TACs in 2015 was $168 M, the landed catch as worth $65 M, thus we only actually caught 38 percent of the potential value. In the Gulf of Alaska we left 1/3 of the economic value uncaught. In the East Coast groundfish fishery the percent used is somewhere below 50 percent. In the Bering Sea the catch may be less than ½ the catch level science says could be achieved. It is impossible to have all species in a mixed stock fishery produce MSY at the same time, and if we want to have no species overfished or collapsed we have to forgo most of the potential catch. Maximizing yield from mixed fisheries will generally involve some stocks above BMSY and some stocks below BMSY. (See Figure 4.)

Why are we catching such a small fraction of the TAC—primarily because these mixed fisheries are heavily constrained markets and by-catch of choke species, most commonly stocks under rebuilding plans. Commonly the fishing fleet cannot catch valuable species because there are strong catch limits on other species that are caught at the same time. Markets are also very important. Fishing is a highly competitive business, and the volatility in the actual catch due both to natural fluctuations and fisheries regulations has meant it is difficult to develop or even maintain markets for some of our fish. Many of the highest value markets for our fish are overseas and government trade policies strongly affect these markets.

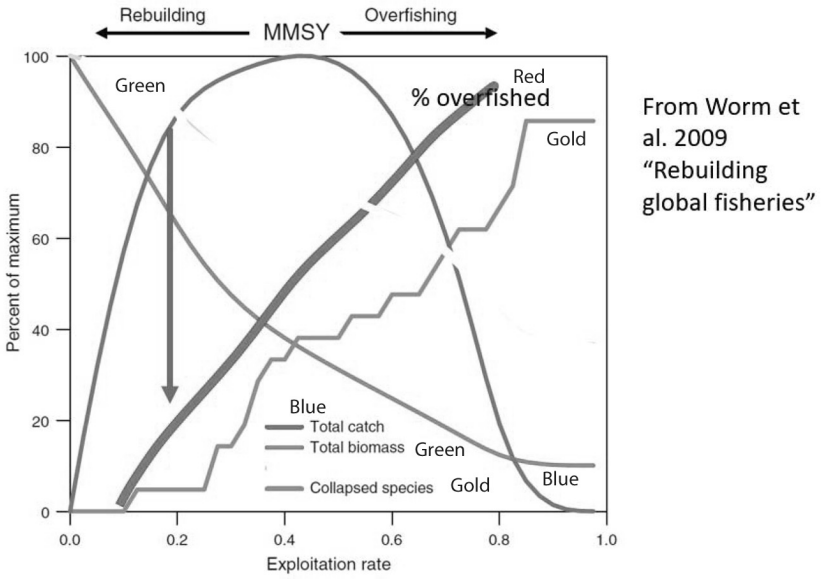

Figure 4. The relationship between catch (blue) and total exploitation rate for mixed fisheries. Redrawn from Worm *et al.,* 2009. The total abundance of fish is shown in green and declines as fishing pressure increases. In gold is the number of species that would be collapsed, and in red the number overfished. We can reduce the number of overfished and collapsed stocks by reducing fishing pressure lower than would maximize yield (the downward arrow), but if we want to have no overfished stocks, we must give up most of the potential catch.

These mixed fisheries have seen dramatic reductions in fishing pressure, and rebuilding of stocks, but they have not seen increases in catch. As a policy to provide more catch to the fishing fleets our current approach for mixed stock fisheries has largely failed.

The second potential for increasing U.S. food from fish, jobs and economic benefits come from increased harvest of our underexploited fish resources. According to a recent analysis (Costello *et al.,* 2016; Hilborn and Costello 2017) U.S. total yield could potentially increase by 50 percent if we could obtain the maximum sustainable yield of all species. We cannot actually achieve MSY for each species, and we may not want to maximize sustainable yield, but there is potential for more food, jobs and economic value. If scientists were directed to calculate quotas that would maximize long term catch, or jobs or profit, the science recommendations would be different from current science advice built around stopping overfishing.

Third, we can increase our fish production by using more of the fish we catch. This has happened in many fisheries where stopping the race-to-fish has placed incentives on getting more value from the fish one is allowed to catch rather than rushing to catch a bigger share of the total catch.

I know that there is considerable interest in adding flexibility to the law. I support the conclusions of the National Academy of Sciences 2013 NRC (2013) report on rebuilding plans and their conclusion

> *"Rebuilding plans that focus more on meeting selected fishing mortality targets than on exact schedules for attaining biomass targets may be more robust to assessment uncertainties, natural variability and ecosystem considerations, and have lower social and economic impact."*

I emphasize that we should not move away from science based management and the existing Council process. The current rebuilding system is designed to achieve the management objective of stopping overfishing—regardless of the cost to total catch, markets and communities. If the science community was directed to maximize economic value of U.S. fisheries or yield, the rebuilding plans would be quite different.

I would like to address the importance of recreational fishing and small scale fisheries. I serve on the Science and Statistics Committee of the Western Pacific Re-

gional Fisheries Management Council where we evaluate the small scale commercial and recreational fisheries of the Hawaiian Islands, American Samoa, Guam, and the Northern Mariana Islands. The National Standards are appropriate for the major industrial tuna fisheries of the region but totally inappropriate for the small scale reef fisheries where we have hundreds of species with poor catch and abundance data. Trying to estimate ABC and status relative to reference points for even a dozen of them is simply not possible. If our SSC (and other SSCs) were directed to provide advice on how best to achieve specific objectives for these types of fisheries with the budgets and tools available, we could do so, but it not involve hard TACs, and almost certainly be some form of effort and spatial management.

As an example of threats to our major fisheries that are unrelated to fishing, I would like to mention the proposed Pebble Mine in Bristol Bay Alaska. For 20 years I have spent much of each summer studying this ecosystem and the fishery. Over the last 50 years sockeye salmon has been the second most valuable species caught in the U.S. and Bristol Bay has been the major production region for sockeye salmon. The idea that highly toxic chemicals can be stored forever behind earthen dams in an ecosystem that is highly permeable, and subject to volcanic and seismic activity is laughable. The Pebble Mine poses a serious threat to one of America's premier fisheries.

In summary I wish to emphasize that U.S. fisheries management has succeeded by relying on science advice. This should not change. However, there certainly is the potential to change U.S. fisheries management to try to achieve more benefits from the ocean. This can be achieved by directing the science community to design fisheries management policies that achieve our societal objectives.

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The CHAIRMAN. Great. Thank you, Dr. Hilborn.

Dr. McKinney.

STATEMENT OF DR. LARRY MCKINNEY, EXECUTIVE DIRECTOR, HARTE RESEARCH INSTITUTE FOR GULF OF MEXICO STUDIES, TEXAS A&M UNIVERSITY CORPUS CHRISTI

Dr. MCKINNEY. Thank you, Mr. Chairman, and members of the Committee.

Thank you for inviting me to testify today.

For the record, my name is Dr. Larry McKinney. I am the Director of the Harte Research Institute at Texas A&M Corpus Christi.

HRI is a trans-disciplinary institute focused on directed research, and includes the Center for Sportfish Science and Conservation, uniquely focused on developing foundational science for sustainable fisheries in the Gulf of Mexico.

Before coming to HRI, I managed saltwater fisheries for the State of Texas. So I have both a management and a science perspective. And for that reason, I was asked to chair the working committee of the Morris-Deal Commission.

The 2014 Commission report, "A Vision for Managing America's Saltwater Recreational Fisheries," has enjoyed significant attention, and more importantly, the ideas summarized there have had a positive impact on Federal fisheries' policy and science.

We have the science-based tools with which to manage our recreational fisheries. What we need is the legislative framework within which to apply those tools. Management of recreational fish-

based fisheries cannot be accomplished by modifying management tools largely developed for the commercial fishery.

My point is neither to diminish the importance of commercial fisheries nor the effective management tools now in place because of the MSA, which have been key to assuring their sustainable future.

My request is that recreational fisheries have their own similarly effective, appropriate Federal framework to assure their future.

The framework is not the current one-size-fits-all fisheries management paradigm to which we are confined. Recreational fisheries cannot be managed by a quota based, annual catch limit approach.

That may work well and successfully for commercial fisheries, but access-based management approaches such as practice by state, successfully recovering and managing recreational fisheries, like the red drum and spotted sea trout, should be the Federal focus.

Sport fish should be managed not as a commodity, but as a natural resource belonging to all Americans and accessible by all Americans. Unlike commercial fisheries, recreational anglers do not seek to maximize pounds landed, but the opportunity to fish for a range of mostly non-consumptive reasons.

Using an access-based approach, fishery managers in states like Texas and Florida have been able to provide predictability and regulations, while also sustaining a healthy population with broad access.

We need reasonable latitude in stock building timelines. Magnuson-Stevens does not currently allow for this consideration. The National Research Council reached this same conclusion in their report evaluating the effectiveness of fish stock rebuilding plans in the United States.

They found that rebuilding plans based on monitoring and controlling fishing levels, rather than on requiring fish populations recover to pre-specified target sizes within certain timeframes, would be less disruptive to the fisheries and less subject to uncertainty.

Magnuson-Stevens should address and facilitate regional cooperative management. Not all recreational species, often found in both State and Federal waters, can be managed as a single population. Yet, that is often the case for Federal management. Red snapper in the Gulf of Mexico is an example where such an approach is sorely needed.

Flexibility to meet different regional angler needs, as well as ecological and biological subtleties across large geographic regions, is essential. It can be complex and take more effort, but the resource and economic benefits far outweigh the costs.

Reauthorization should be explicit in providing for and encouraging cooperative management on a regional basis. Some of the very best and most successful fisheries expertise lies within State agencies, and that is not accessed given the current management system. Integration into Federal management processes through truly cooperative management, they bring expertise, resources, and credibility.

For me, the defining example of the different motivations between recreational and commercial fisheries, and the power of an appropriate and sustained science foundation occurred when I was the head of Texas fisheries.

Our data showed that because of a successful recovery effort, we could increase the daily bag limit of red drum from three fish to four. Texas anglers were loud and clear about that proposal, a resounding no. "Even if the data says we can, leave it alone," was their message. The bag limit remains at three today.

Anglers simply want reasonable access and quality fishing, not maximizing their take. An involved and educated recreational angling community can help generate that response.

Anglers that have access to and trust in their fisheries management agency and the data on which they transparently operate are allies in conservation, not opposition. We need this for our Federal fisheries and for our Federal recreational fisheries management.

Incorporating the ideas that I have briefly summarized here today, and that are more fully detailed in my written testimony, and the Commission report, can make that a reality for Federal fisheries.

Thank you for the opportunity to provide this brief testimony.

I am certainly happy to answer questions.

[The prepared statement of Dr. McKinney follows:]

PREPARED STATEMENT OF DR. LARRY MCKINNEY, EXECUTIVE DIRECTOR, HARTE RESEARCH INSTITUTE FOR GULF OF MEXICO STUDIES, TEXAS A&M UNIVERSITY CORPUS CHRISTI

Mr. Chairman and members of the Committee, thank you for inviting me to testify before you today. For the record, I am Dr. Larry McKinney—Director of the Harte Research Institute (HRI) of Texas A&M University—Corpus Christi. HRI is a transdisciplinary organization with a focus on directed research and includes the Center for Sportfish Science and Conservation, uniquely focused on developing the foundational science for sustainable fisheries in the Gulf of Mexico. Before coming to HRI I managed saltwater fisheries for the state of Texas, so I have a management and science perspective, which is why I was asked to chair the working committee of The Morris-Deal Commission on Saltwater Recreational Fisheries Management. The commission was established in 2013 to provide a vision and framework for the modernization of Magnuson-Stevens Act (MSA) in its next reauthorization specifically to address pressing issues related to Sportfishing. The working committee brought together the very best policy, management and scientific expertise. These included a former director of the National Marine Fisheries Service, respected state and Federal fisheries managers, leading academics, NGOs and industry leaders.

The report released by the Commission in 2014, *A Vision for Managing America's Saltwater Recreational Fisheries,* reflected that collective input and has received significant attention and more importantly, the ideas summarized there have had positive impact on Federal fisheries policy. NOAA's National Marine Fisheries Service worked closely with the Morris-Deal Commission and in 2015 adopted a National Saltwater Recreational Fisheries Policy, acknowledging Morris-Deal, as the impetus for its development. NOAA Fisheries is also addressing other Commission recommendations as reflected in a recent *Progress Update: A Vision for Managing America's Saltwater Fisheries.* These are welcome efforts but further progress is limited by current legislation. We have the science-based tools with which to manage our recreational fisheries, but lack the legislative framework within which we can apply them.

The Commission and I hope that any reauthorization of MSA will focus on this issue specifically as it relates to recreational fisheries, the single largest component of our Nation's fisheries not yet specifically addressed by our most important Federal fisheries legislation. Securing the economic health, sustainability, and access to the most economically significant fisheries sector is achievable, but legislation should provide for and encourage application of long-established and successful science-based tools well known to fisheries managers and scientists.

Management of recreationally based fisheries cannot be accomplished by modifying management tools largely developed for commercial fisheries. My point is not to diminish the importance of commercial fisheries nor the effective management tools now in place because of the MSA, which have been key to assuring their sus-

tainable future. My request is that recreational fisheries have their own similarly effective and appropriate Federal framework to assure their future. That framework is not in the current one-size-fits-all fisheries management paradigm to which we are now confined. I suggest that the means to do so resides within the Commission's Vision Report. Some key recommendations from the report include the following:

Recreational fisheries cannot be managed by quota-based, annual catch limit approaches. That may work well and successfully for commercial fisheries, but access-based management approaches, such as practiced by states successfully managing recreational fisheries, should be a Federal focus. Recreational fish should be managed, not as a commodity, but as a natural resource belonging to all Americans and accessible by all Americans. Unlike commercial fisheries, recreational anglers do not seek to maximize pounds landed but the opportunity to fish for a range of mostly non-consumptive reasons. Fisheries managers in the Atlantic striped bass fishery successfully employed the strategy of using long-term harvest rates, rather than strict poundage-based quotas, to successfully manage the most sought-after saltwater recreational fishery fish in the Nation. Using this access-based approach, fisheries managers in states like Texas and Florida have been able to provide predictability in regulations, sustain a healthy population, and ensure broad access.

Perhaps the best example of this success is the restoration of Red Drum and Spotted Seatrout in Texas. These species were severely overfished by the commercial fishery through the mid-1970s. The Coastal Fisheries Division of Texas Parks and Wildlife Department launched a robust monitoring program in 1975. This program covered four million acres of Texas bays and out to nine nautical miles offshore, with joint Federal management out to two hundred nautical miles. Some 900,000 recreational anglers and 1,700 commercial fishers were surveyed, including a 1,000 creel survey-days and 19,000 interviews. Over 780 gill net sets, 1,680 bay trawls, 1,200 oyster dredges and 2,160 bag seines were used to gather the fisheries independent data. The forty-two years of continuous data collection is the longest record of its kind in the world. A combination of legislative and regulatory actions fully recovered those species (see Figure 1 and 2, attached) with the support of an active and engaged angling public.

The program also allowed for the successful implementation of a commercial fishing license buy-back program. Through the 2014 license year, $14.2 million was spent to purchase and retire 2,145 commercial Bay and/or Bait Shrimp Boat licenses. This represents 66 percent of the original 3,231 licenses grandfathered into the fishery in 1995. Additionally, $1.8 million has been spent purchasing 63 Commercial Crab Fisherman's licenses and 241 Commercial Finfish Fisherman's licenses, retiring 22 percent and 44 percent of the licenses respectively.

We need reasonable latitude in stock rebuilding timelines. Magnuson-Stevens does not currently allow for this consideration. The National Research Council, a part of the National Academy of Sciences, Engineering and Medicine, reached the same conclusion in their report—*Evaluating the Effectiveness of Fish Stock Rebuilding Plans in the United States.* They found that rebuilding plans based on monitoring and controlling fishing levels, rather than requiring fish populations to recover to a pre-specified target size within a certain timeframe, would be less disruptive to the fisheries and less subject to uncertainty.

Magnuson-Stevens should address and facilitate regional and cooperative management. Not all recreational species, often found in both state and in Federal waters, can be managed as a single population, yet that is often the case for Federal management. Red snapper in the Gulf of Mexico is an example where such an approach is sorely needed. Flexibility to meet differing regional angler needs, as well as, ecological and biological subtitles across large geographic reaches is essential. It can be complex and take more effort but the resource and economic benefits far outweigh the costs. Reauthorization should be explicit in providing for and encouraging cooperative management on a regional basis. Some of the very best and most successful fisheries management expertise lies within state agencies; that expertise is not accessed given the current management system. Integrated into the Federal management process through truly cooperative management, they bring expertise, resources and credibility.

Economic Data in Allocation of Mixed Fisheries. MSA reauthorization must provide the framework to assure that where mixed fisheries exist, managers use not only the best available science but also data-driven economic information to assure their sustainable future and equitable allocation. Reauthorization should clearly mandate this approach to eliminate ambiguity in the existing legislation.

Stock Assessments are in need of Improvement. The most fundamental science-based tool for fisheries management is a robust stock assessment, including both fisheries dependent and independent data. This is not an area where reauthorization is necessary unless there is a desire to be prescriptive in the structure of this

process. Considering the diversity of fish stocks, that likely would not be a wise course of action. We can certainly improve these assessments and there are considerable scholarly recommendations, such as the National Research Council's *Improving Fish Stock Assessments.* Stock assessments are the principal tool we use to gauge the health and productivity of a particular fish population. Management advice hinges on the frequency and robustness of these assessments. The issue is not a question of science. I believe we know well enough what to do. The question resides in policy and resources available. Currently, in the South Atlantic region, for example, the number and frequency of assessments are astonishingly low when compared to other regions, obviously hindering the decision making process. The driving factors behind the turn-around time for assessments, whether it personnel, data, or other resources can be complex; however, as pointed out by several independent review groups, this is an area that should be addressed and drastically improved. There are, as a general rule of thumb, never enough resources to carry out all the stock assessments needed, nor frequently enough to adequately support management needs. NOAA Fisheries' policy decisions on where and when to allocate its limited funding would benefit from review and revision.

Building a Science Base for Fisheries Management Decisions. For me, a defining example of the different motivations between recreational and commercial fisheries occurred when I was the head of fisheries for Texas. Our data showed that because of a successful recovery effort we could increase the daily bag limit of Red Drum from three to four fish. Texas anglers were loud and clear about that proposal—a resounding no. Even if the data says we can, leave it alone, was their message. The bag limit remains at three to this day. Anglers simply want reasonable access and quality fishing, not maximizing their take. An involved and educated recreational angling community generated that response. Anglers who have access to—and trust in—their fishery management agency (and the data on which they transparently operate) are allies for conservation, not opponents. We need this for our Federal recreational fisheries management. Incorporating the ideas I have briefly summarized can make that a reality for Federal fisheries. Thank you for the opportunity to provide this brief testimony, and I am certainly happy to answer any questions.

Figures

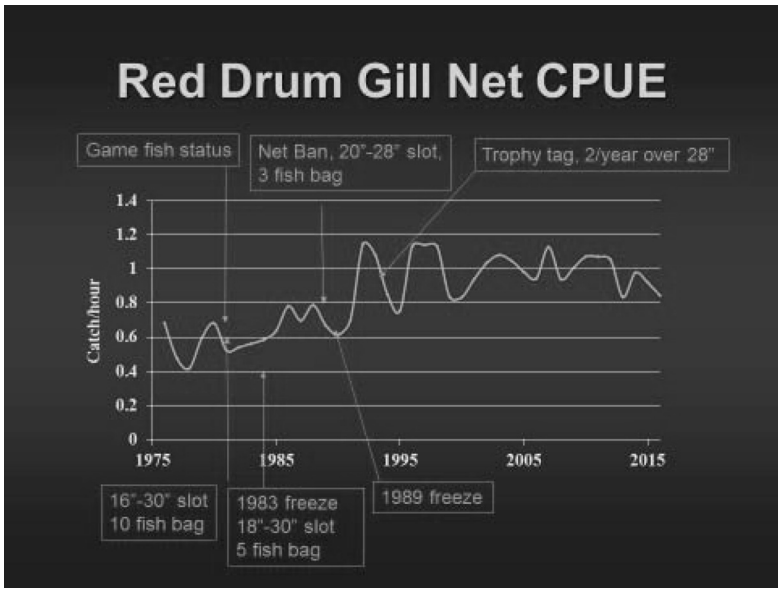

Figure 1. A brief graphic history of the management of red Drum in Texas. Figure courtesy of Coastal Fisheries Division—Texas Parks and Wildlife Department. The combination of legislative and regulatory actions were all predicated on a robust monitoring program, including both fisheries dependent and independent data

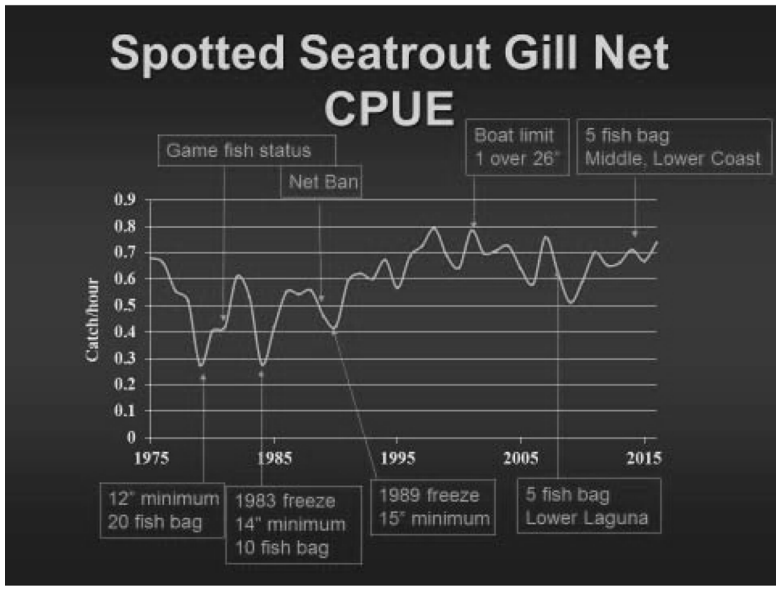

Figure 2. A brief graphic history of the management of Spotted Seatrout in Texas. Figure courtesy of Coastal Fisheries Division—Texas Parks and Wildlife Department. The combination of legislative and regulatory actions were all predicated on a robust monitoring program, including both fisheries dependent and independent data

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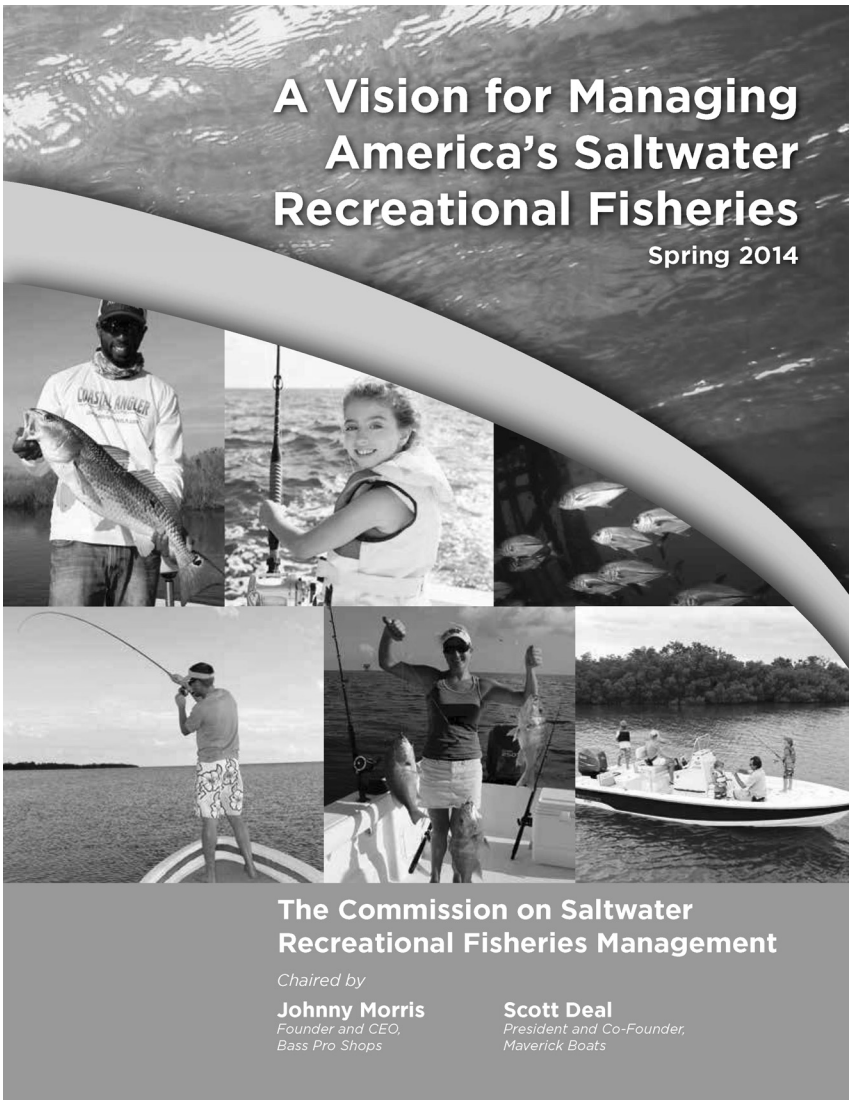
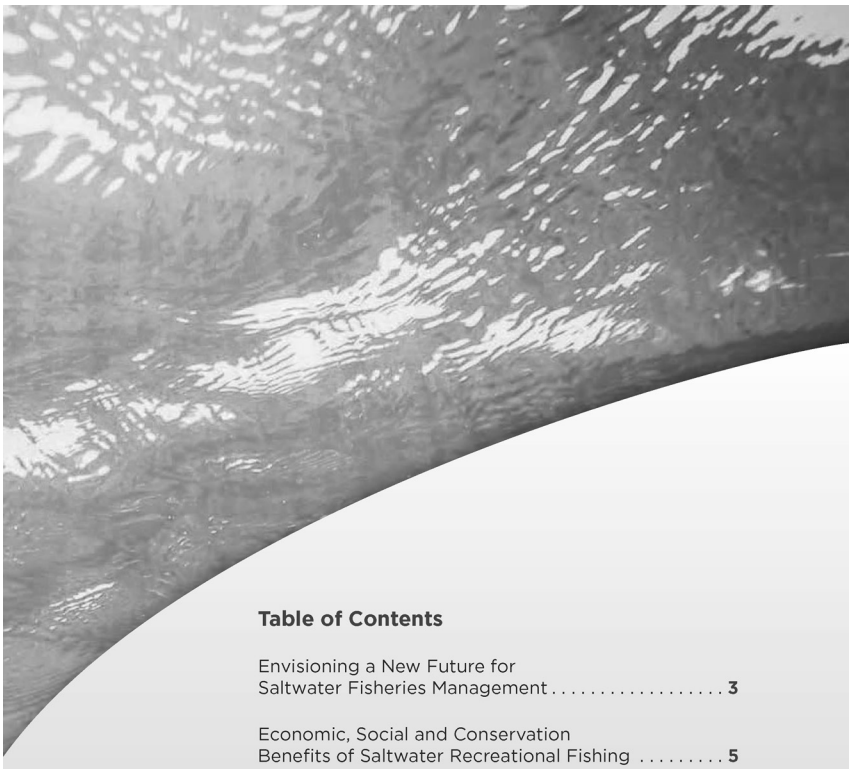

A Vision for Managing America's Saltwater Recreational Fisheries
Spring 2014
The Commission on Saltwater Recreational Fisheries Management
Chaired by
Johnny Morris
Founder and CEO,
Bass Pro Shops
Scott Deal
President and Co-Founder,
Maverick Boats



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Recreational Boating and Fishing Foundation (RBFF)

Envisioning a New Future for Saltwater Fisheries Management

America's sportsmen and women are the backbone of aquatic resource conservation. For the past several decades, anglers have played a leading role in helping rebuild marine fish stocks and prevent overfishing. This is a success story of which we should all be proud.

Through federal excise taxes on fishing equipment and motorboat fuel, fishing license fees and direct donations, anglers contribute nearly $1.5 billion annually to fund fisheries conservation and habitat restoration. Our community invests in aquatic resource conservation because we know that the future of recreational fishing directly depends on the health of fish populations and their habitat.

In the last half century, saltwater recreational fishing in the U.S. has experienced tremendous advances in the overall number of anglers, angling ethics, technology used and their overall economic impact to the nation.

The National Marine Fisheries Service[1] estimates that approximately 11 million Americans participated in saltwater fishing in 2011, spending $27 billion on fishing tackle, equipment, and trip-related goods and services. Spending by saltwater anglers generated more than $70 billion in economic output, supporting more than 450,000 jobs.

However, in the midst of our success in rebuilding marine fisheries and the growth in saltwater recreational fishing, the federal fisheries management system has not adapted to meet the needs of this economic and conservation powerhouse.

Recognizing that we now have an opportunity to establish a saltwater fisheries management system that incorporates the unique goals and needs of anglers, we invited a group of leaders and experts in the fisheries community to initiate a landmark process to develop a vision for saltwater recreational fishing. Throughout 2013, the Commission on Saltwater Recreational Fisheries Management met to deliberate and debate strategies to improve saltwater recreational fisheries management.

The Future of Saltwater Recreational Fisheries Management

The commission envisions a marine fisheries management system that conserves fishery resources, provides consistency in regulations, and produces the full range of saltwater recreational fishing's economic, social and conservation benefits for the nation.

1. National Marine Fisheries Service, 2012. Fisheries Economics of the United States, U.S. Dept. of Commerce, NOAA Tech. Memo. NMFS-F/SPO-118, 175p, 2011. **https://www.st.nmfs.noaa.gov/st5/publication/index.html.**

Additionally, a wide range of experts and other stakeholders were invited to meet with the commission to provide information and advice on a variety of fisheries management issues. These included economists, researchers, federal and state agency administrators, environmentalists, charter captains and individual recreational anglers.

After extensive discussion and deliberation, the commission established a vision for saltwater recreational fishing and identified steps to set the foundation for a management system that addresses the needs of anglers and industry and produces the full range of economic, social and conservation benefits provided by recreational fishing.

The recommendations in this report primarily focus on the reauthorization of the Magnuson-Stevens Fishery Conservation and Management Act in six key areas:

- **Establishing a national policy for recreational saltwater fishing**
- **Adopting a revised approach to saltwater recreational fisheries management**
- **Allocating marine fisheries for the greatest benefit to the nation**
- **Creating reasonable latitude in stock rebuilding timelines**
- **Codifying a process for cooperative management**
- **Managing for the forage base**

We are proud to play a role in advancing the long-standing traditions of recreational fishing and boating in this country. Each time Americans go fishing and boating, they make a positive contribution to our fish, our waters and the fabric of American society. We are committed to working together to ensure the conservation of our saltwater resources so their recreational benefits are available for future generations to enjoy.

Johnny Morris
Founder and CEO, Bass Pro Shops
Chairman

Johnny Morris (right) and his son John Paul

Scott Deal
President and Co-Founder, Maverick Boats
Chairman

Commission on Saltwater Recreational Fisheries Management

Chairman Larry McKinney, Ph.D., executive director, Harte Research Institute
Tundi Agardy, Ph.D., founder, Sound Seas
Lee Anderson, Ph.D., professor, University of Delaware
Rip Cunningham, former editor in chief, Salt Water Sportsman Magazine
Ricky Gease, executive director, Kenai River Sportfishing Association
Ken Haddad, former executive director, Florida Fish and Wildlife Conservation Commission
Rollie Schmitten, former director, National Marine Fisheries Service

Economic, Social and Conservation Benefits of Saltwater Recreational Fishing

Recreational fishing is one of America's most enduring pastimes: an activity in which people of all ages can participate, enjoying opportunities to spend time in the outdoors with family and friends. But recreational fishing in our nation's oceans is more than a chance to create memories and strengthen our connection with nature.

Recreational Boating and Fishing Foundation (RBFF)

Saltwater recreational fishing has a $70 billion impact on our nation's economy, supporting 454,000 jobs. Marinas, grocery stores, restaurants, motels, lodges, tackle shops, boat dealerships, clothing manufacturers, gas stations and a host of other businesses and entities benefit from the dollars spent by recreational anglers in pursuit of their sport. Coastal communities throughout the country depend – in some cases, exclusively – on recreational fishing for their livelihoods.

Whether they access the fishery in their own boat, fish from the shoreline, beach or pier, or hire a charter captain, America's 11 million saltwater anglers are looking for opportunities to have quality experiences on the water. For some, that means catching the fish of a lifetime only to release it for the next angler to catch. Others hope to bring home some of their catch to share with family and friends. For most, fishing represents an opportunity to strengthen relationships with family, friends and colleagues. For all anglers, fishing provides a chance to experience a special connection with our marine environment, gain a better appreciation for our country's natural resources, and practice the conservation ethic that is integral to the sporting community.

Economic Impact of Saltwater Recreational Fishing

State	Saltwater Anglers	Jobs	Sales (in thousands)
Alabama	907,000	8,867	819,340
Alaska	286,000	4,250	483,000
California	1,045,000	10,111	1,430,919
Connecticut	518,000	1,190	156,415
Delaware	318,000	1,403	132,223
Florida	4,878,000	98,355	11,826,000
Georgia	355,000	3,217	344,794
Hawaii	87,000	2,861	310,782
Louisiana	959,000	17,808	2,062,048
Maine	198,000	1,197	118,336
Maryland	836,000	6,466	724,394
Massachusetts	897,000	6,550	799,558
Mississippi	268,000	1,383	120,644
New Hampshire	96,000	441	47,999
New Jersey	1,067,000	12,818	1,841,343
New York	561,000	3,094	398,881
North Carolina	1,499,000	15,831	1,622,060
Oregon	217,000	2,799	308,602
Rhode Island	296,000	1,940	208,021
South Carolina	478,000	3,303	306,678
Texas	708,903*	13,332	1,644,672
Virginia	892,000	9,454	969,571
Washington	321,000	5,093	653,972

Source: Fisheries Economics of the United States, NOAA Fisheries, 2011.

*The Marine Recreational Information Program does not collect participation (number of anglers) data for Texas. Therefore, estimate for Texas is from Southwick Associates, "The 2011 Economic Benefits of Sportfishing in Texas," 2013.

Without recreational fishing, fisheries conservation would virtually cease to exist. Through federal excise taxes on fishing equipment and motorboat fuel, fishing license fees and direct donations, anglers contribute nearly $1.5 billion annually to fund fisheries conservation and habitat restoration. These contributions drive the most successful conservation and fisheries restoration program in the world.

Anglers not only pay for conservation through license fees and excise taxes, they also support conservation work by volunteering for habitat creation and restoration projects in all 50 states. As citizen scientists, they actively participate in fish tagging and tracking programs, monitor water quality, and collect other environmental data valuable to fisheries managers across the country. Anglers have spearheaded state and national programs that promote best practices among anglers to reduce fish mortality, including catch-and-release techniques and the use of circle hooks and barotrauma-reduction devices to reduce hook-and-release mortality.

Recreational fishing is founded on conservation, sustainability and opportunity. Saltwater anglers and the recreational fishing industry they support are critical to conservation and a healthy economic environment for all Americans.

License fees, taxes paid on fishing equipment and donations to conservation organizations made by anglers pay for a host of habitat restoration and creation projects throughout the U.S.

The Current State of Saltwater Recreational Fishing Management

Our ocean resources are used for many commercial and recreational purposes. Despite its large constituency and major economic impact, when critical regulatory or management decisions are made, the recreational saltwater fishing community often doesn't get due consideration. This is particularly true regarding federal marine waters, which, in most parts of the country, extend from three to 200 miles offshore.

The three factors contributing to the inadequate management of federal marine fisheries for recreational fishing are

- The laws that govern federal marine fisheries are primarily designed for and focused on commercial fishing.
- The federal agency tasked with managing marine fisheries has commercial fishing as its primary focus.
- We do not have a national policy for saltwater recreational fishing.

Federal law is focused primarily on commercial fishing

In the 1960s, foreign fishing fleets began fishing in waters off the U.S. coast for high market value fish and shellfish. Due to a desire to both conserve these valuable stocks from overfishing and promote and develop domestic commercial interests, Sen. Warren G. Magnuson of Washington State led the passage of the 1976 Fishery Conservation and Management Act. The act established a U.S. Exclusive Economic Zone, or EEZ, from three to 200 miles offshore and established eight regional fisheries management councils to develop management plans for marine fisheries in their individual regions. These actions were extraordinarily effective, and within a decade U.S. commercial interests had replaced foreign fishing fleets in the EEZ.

While the act was successful in keeping foreign fleets out of U.S. waters, many marine fish stocks were at low levels, prompting legislative changes to better ensure the fisheries' sustainability. Led by Sen. Ted Stevens of Alaska, in 1996 the act was amended with provisions to end overfishing and protect important fish habitats. This became the

Federal fisheries management and the law that governs it have been focused almost entirely on commercial fishing.

1996 Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act). The Magnuson-Stevens Act was again reauthorized in 2006, which added strict deadlines to end overfishing and called for annual catch limits to be put in place for all fisheries by a certain date.

While the Magnuson-Stevens Act has produced a demonstrable improvement in fish stocks, we now need to manage that success in a way that fully develops saltwater recreational fishing's economic, social and conservation benefits to our nation. Because it is a fundamentally different activity than commercial fishing, recreational fishing requires different management approaches.

From a management perspective, the Magnuson-Stevens Act relies on limited entry and catch share programs, along with fixed quotas that can be managed in real time. While these approaches

Saltwater anglers are fishing waters their fathers and grandfathers only dreamed about thanks to advances in boat designs, fuel-efficient engines and marine electronics.

work for the commercial sector where relatively few vessels are focused on maximum sustainable yield, recreational fisheries are enjoyed by millions of individuals with diverse goals. Some try to catch fish for food, while others simply want to have fun catching and releasing fish and enjoy their time outdoors. What recreational anglers want and need is wide-ranging, dependable access to healthy and abundant fish stocks.

In its defense, when the Fishery Conservation and Management Act was originally passed in 1976, saltwater recreational fishing was in its infancy. The ensuing decades have witnessed a significant growth in coastal communities and an interest in recreational saltwater fishing spurred on by tremendous changes in recreational boat designs, engines, electronics and other fishing gear technologies.

Current laws and policies governing saltwater recreational fishing have not kept pace with the evolution of recreational saltwater fishing, its growing popularity and its economic impact. This impact is equal to or greater than the commercial industry in terms of number of jobs provided and total economic benefits, while accounting for only a fraction of overall landings.

A federal agency focused primarily on commercial fishing

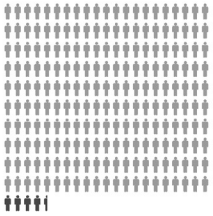
The National Marine Fisheries Service (NMFS), under the auspices of the National Oceanic and Atmospheric Administration and ultimately the Department of Commerce, is the federal agency responsible for fisheries management in federal waters. Given its mandated commercial focus, the fact that the NMFS has not embraced fisheries management practices that also meet the unique goals, needs and motivations of recreational anglers should come as no surprise. While the NMFS has made great strides in recent years in improving communication and interaction with the recreational fishing community, much work remains to be done to effectively integrate recreational fishing into its policies and procedures.

Marine fish such as red drum and snook are very successfully managed by state fisheries agencies.

Many state natural resource agencies, especially those in the South, recognize the benefits of a vibrant recreational fishing community and have managed to promote it while conserving their saltwater resources. Striped bass, red drum, black drum, summer flounder, sheepshead, snook, spotted seatrout and tarpon are examples of successfully managed state fisheries that sufficiently meet the needs of recreational anglers while providing extensive economic benefits to their state and the national economies.

Many coastal states have adopted management models that are well tuned for their particular saltwater fisheries. These models conserve fishery resources, provide multi-year consistency in regulations and allow for ample public access. However, these approaches have not yet been embraced by the NMFS, which is a significant contributing factor to the current dilemma in saltwater recreational fisheries management.

Jobs per 100,000 pounds landed in the United States, 2011



All Recreation: 210 **All Commercial: 4.5**

For every 100,000 pounds of fish landed there were 210 recreational fishing jobs compared to 4.5 jobs in the commercial fishing industry.

Fisheries Economics of the United States, 2011. NOAA Fisheries.

Lack of a national policy for recreational fishing

For the past several decades, the recreational fishing community has helped lead the charge toward building a management system that controls commercial exploitation to effectively sustain healthy fisheries resources.

This was a natural focus of anglers, policymakers and resource managers because commercial fishing accounts for the vast majority of finfish harvest and

has been the primary contributor to over-exploitation. While the road to ending overfishing has been a challenge and many sacrifices have been made, Americans now have a solid foundation of healthy fisheries resources that benefit the entire nation.

However, the federal system to control commercial fisheries exploitation is largely inappropriate for managing recreational fishing. The solution is to develop a national policy for saltwater recreational fishing that builds upon our current fisheries management system but acknowledges that a new and distinctive path forward is needed for recreational fishing.

This report addresses the three primary contributing factors that have led to deficient federal saltwater fisheries management by identifying a clear vision for saltwater recreational fisheries management and recommending key policy changes to establish the foundation for a national saltwater recreational fishing policy.

The work to implement a national policy for recreational fishing will take a collective effort in which all segments of the recreational fishing community will need to come together and engage with fisheries managers, policymakers and other stakeholders to advance a unified vision.

Commission on Saltwater Recreational Fisheries Management Recommendations

The Commission on Saltwater Recreational Fisheries Management's recommendations are largely focused on the reauthorization of the Magnuson-Stevens Fishery Conservation and Management Act. The commission recognizes the need to extend these efforts beyond just the law's reauthorization to bring about a cultural shift within the National Marine Fisheries Service, which administers the law, to ensure that the values of recreational fishing are recognized throughout all relevant aspects of the agency's operations.

Strong fisheries conservation and management are the foundation for the recommendations in this report. Policy makers, resource managers, industry people and anglers must continue to advocate for a saltwater fisheries management system that conserves our fishery resources, provides consistency in regulations, and produces the full range of saltwater recreational fishing's economic, social and conservation benefits for the nation. Ensuring the health and sustainability of our fisheries resources is the primary concern of the recreational fishing community.

The following recommendations present a positive vision to build upon our recent fisheries management successes in a way that benefits conservation, the economy and the public.

Establishing a national policy for recreational fishing

Recreational fishing is currently addressed in an inconsistent fashion by NMFS. The only section of the Magnuson-Stevens Act that relates to promoting recreational fishing focuses specifically on catch and release practices, which, while an important component of many recreational fisheries, hardly encompass the entirety of the recreational fishing experience.

In the late 1980s, the U.S. Fish and Wildlife Service established a national recreational fisheries policy for the U.S. Department of Interior[2] that outlined the agency's goals and strategies for primarily freshwater recreational fishing on federal lands. The policy called for federal and partner resources

to be coordinated and organized to advance recreational fishing and fisheries conservation. Because the NMFS has no such policy, the impacts have not been felt within the saltwater recreational fishing community.

Recommendation

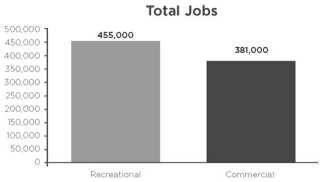
The Magnuson-Stevens Act should include a provision for the creation of a national saltwater recreational fishing policy that identifies goals and strategies for recreational fisheries management at the local, state and national levels. The NMFS has made progress in recent years in elevating the importance of recreational fishing within the agency, including hosting a national recreational fishing summit, establishing national and regional action agendas and creating new agency positions focused on recreational fishing policies. Future progress would be significantly advanced through the establishment of a comprehensive national policy defining and coordinating efforts throughout the federal government, focusing primarily on the NMFS, to advance saltwater recreational fishing.

2. U.S. Fish and Wildlife Service, Recreational Fisheries Policy of the U.S. Department of the Interior, 1989. http://www.fws.gov/policy/a1npi89_25.pdf.

Adopting a revised approach to saltwater recreational fisheries management

Recreational and commercial fishing are fundamentally different activities that require different management approaches. Currently, federal fisheries managers set catch limits for recreational and commercial fishing at or near maximum sustainable yield. While this may be an ideal management strategy for commercial fishing, where harvesting the maximum biomass is desired, it is not an effective management tool for saltwater recreational fishing. Recreational anglers are more focused on abundance and size, structure of the fisheries, and opportunities to get out on the water. Fulfilling these needs is an important economic contributor to coastal communities and the nation.

Total Jobs from Recreational and Commercial Fishing in the United States, 2011



In 2011, there were 455,000 jobs related to recreational fishing compared to 381,000 for commercial fishing.

Fisheries Economics of the United States, 2011. NOAA Fisheries.

Recommendation

The NMFS should manage recreational fisheries based on long-term harvest rates, not strictly on poundage-based quotas. This strategy has been successfully used by fisheries managers in the Atlantic striped bass fishery, which is the most sought-after saltwater recreational fishery in the nation. By managing the recreational sector based on harvest rate as opposed to a poundage-based quota, managers have been able to provide predictability in regulations while also sustaining a healthy population. While the Magnuson-Stevens Act does not prohibit such an approach, it should specifically direct the NMFS and regional councils to consider alternative strategies to commercial management for appropriate recreationally valuable fisheries.

Red snapper, like this one caught in the Gulf of Mexico, are being allocated to recreational and commercial fishermen based on outdated harvest data.

Allocating marine fisheries for the greatest benefit to the nation

For many mixed-sector fisheries, (i.e., those sought by both the commercial and recreational sectors), allocations of harvestable quota for each sector are based on decisions in fisheries management plans written decades ago.

In its current language, the Magnuson-Stevens Act[3] calls for allocations to be:

- Fair and equitable to all such fishermen
- Reasonably calculated to promote conservation
- Carried out in such a manner that no particular individual, corporation or other entity acquires an excessive share of such privileges

However, because no formalized process exists to prompt the regional fishery management councils toward reallocation, and because allocation discussions have been historically contentious, fisheries managers lack the necessary incentives to reexamine allocations regardless of how outdated and/or inequitable they may be.

Recommendation

The Magnuson-Stevens Act should require the NMFS, in conjunction with the National Academy of Sciences (NAS), to develop guidelines and criteria that the regional fishery management councils must consider for allocation of all mixed sector fisheries. The allocation decisions must consider conservation and socioeconomic output. To help provide necessary information for managers to consider, the NMFS must enhance its existing economic program for mixed sector fisheries. The Magnuson-Stevens Act also should require that the regional fishery management councils develop procedures for allocation reviews and adjustments based on those guidelines to occur at regular intervals.

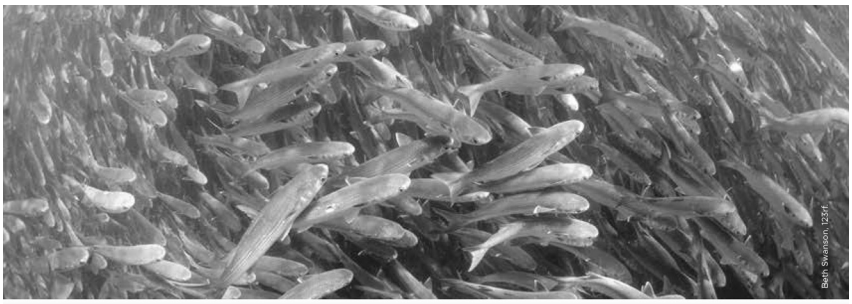
Creating reasonable latitude in stock rebuilding timelines

The Magnuson-Stevens Act currently states that the timeline for ending overfishing and rebuilding fisheries "be as short as possible" and "not exceed 10 years," with a few limited exceptions to allow for longer timeframes. While some stocks can be rebuilt in 10 years or less, others require longer generation times, or factors unrelated to fishing pressure may prohibit rebuilding in 10 years or less.

Echoing the concerns raised by stakeholders and many of the regional fishery management councils, a report by the prestigious and nonpartisan National Academy of Sciences concluded that the 10-year rebuilding provision should be revised to

3. 16USC1801 Sec. 301(a)(4)

4. National Research Council, Evaluating the Effectiveness of Fish Stock Rebuilding Plans in the United States, 2013. http://www.nap.edu/catalog.php?record_id=18488.



Healthy stocks of forage fish, like these mullet, are vital for healthy and sustainable recreational fishing.

provide greater flexibility than is currently allowed under the law.[4] Instead of having a fixed deadline for stocks to be rebuilt, the NAS recommended that the regional councils and fisheries managers set lower harvest rates that would allow fish stocks to recover gradually while diminishing socioeconomic impacts.

Recommendation

The commission supports the National Academy of Science's recommendations to provide the regional councils and fisheries managers greater latitude to rebuild fish stocks in a timely and reasonable manner.

Codifying a process for cooperative management

Cooperative management, where fisheries are managed jointly between the NMFS and individual states or interstate fisheries management commissions, is currently an option for fisheries management. By integrating research and management expertise, cooperative management can more successfully help meet fisheries management goals. However, the concept is not fully utilized because of a lack of guidance regarding options and processes to help determine if this is an appropriate management approach.

Recommendation

The regional councils should be required to develop a process to determine on a stock-by-stock basis which management entities are most appropriate and capable of successfully managing the stock. This requirement should provide guidance for determining the most appropriate management structure.

Managing for the forage base

The fisheries management system in the U.S. has historically concentrated on achieving maximum sustainable yield from individual fisheries and is slowly moving toward multispecies management or ecosystem-based fishery management. For the recreational fishing community, ecosystem-based fishery management includes conserving the forage base – the suite of fish that provide much of the food resource for important recreational fish species. Forage fish must be managed to provide enough food resources for healthy recreational fish species. Currently, very few forage fish are considered in fishery management plans, meaning that potential impacts on these critical components of the ecosystem are not considered or controlled.

Recommendation

Fisheries managers should better incorporate forage base management to provide optimal health, reproduction and growth in important predator fish stocks. The NMFS and regional councils should identify the most significant forage fish for every fish stock currently being managed and determine whether or not the identified forage fish should be managed.

Conclusion

The Commission on Saltwater Recreational Fisheries Management recommends that the reauthorization of the Magnuson-Stevens Fisheries Conservation and Management Act include the following elements:

- A national policy for recreational fishing
- A revised approach to saltwater recreational fisheries management that promotes both conservation and access
- Allocation of marine fisheries for the greatest benefit to the nation
- Reasonable latitude in stock rebuilding timelines
- A process for cooperative management
- Managing for the forage base

The commission strongly believes that now is the time to begin this important, critical work. The commission's recommendations provide the steps needed to improve the Magnuson-Stevens Fisheries Conservation and Management Act in a manner that finally addresses the needs of the saltwater recreational fishing community.

The commission recognizes the need for strengthening old and creating new partnerships to improve science, economic data and information sharing in fisheries management. The commission strongly advocates for the need to focus on habitat, water quality and environmental challenges that recreational anglers and all citizens will confront in the years ahead. In addition, federal and state fisheries management agencies should make it a priority to inform the public about anglers' contributions to conservation.

Finally, saltwater anglers must continue to support and advocate for a strong conservation ethic within our community. Anglers were among the first to set the example as stewards of the outdoors. Anglers need to continue that legacy to assure a future for anglers today and for generations to come.

The CHAIRMAN. Great. And thank you, Dr. McKinney, and for your work, your Morris-Deal work as well.

Mr. Haflinger, the floor is yours, sir.

STATEMENT OF KARL HAFLINGER, FOUNDER AND PRESIDENT, SEA STATE, INC.

Mr. HAFLINGER. Chairman Sullivan, Ranking Member Peters, and members of the Committee.

My name is Karl Haflinger and my company, Sea State, maintains a private fisheries information network for approximately 150 trawl and longline vessels that fish in the waters off Alaska, Washington, and Oregon.

Good science and data are critical in our fisheries management system. I hope my testimony today helps members of the Subcommittee understand the kind of management innovation that is possible under existing law and the importance of proceeding cautiously in any reauthorization process to ensure that we retain what is working.

I also want to address areas where continuing innovations by NOAA fisheries could be helpful in catalyzing further improvements in how fisheries' data is collected and utilized.

Shortly after passage of the original Act, limits were placed on foreign catch in Alaska and observers were placed on foreign processing vessels. As the growing domestic industry took over, the North Pacific Fishery Management Council retained full observer coverage on larger vessels and 30 percent coverage on smaller vessels.

The Council also retained strict catch limits, which requires tracking of both retained and discarded fish, and the Council also enacted limits on crab and halibut bycatch and started action on salmon bycatch as well.

By the mid 1990s, the problem for U.S. fishermen in our area became not one of catching their target species, but of keeping bycatch down to levels that would allow them to fish without being shutdown.

We responded to that challenge with innovations that harnessed cutting edge technology at the time; that is, fax machines and dial-up modems.

Because there had been a close relationship between the NOAA fisheries biologists, observers, and industry, members of the industry realized that they might be able to combine observer data from all vessels to aid in salmon bycatch reduction.

This is how Sea State began 25 years ago, by combining observer data from all vessels in the Pollock fleet and sending out maps showing areas that boats could avoid to reduce their salmon bycatch.

The approach spread to another sector that fished for sole and needed to avoid halibut and crab, and has continued since.

Our original efforts were only marginally successful since bycatch avoidance is not generally a win-win situation. It almost always results in slower fishing rates as vessels have to take time to relocate.

However, as catch share programs became the norm and the race for fish ended, vessels could take that extra time to relocate and the use of this information became more important.

As our fleets showed more ability to manage their bycatch, the councils have relaxed some of their rigid approaches to bycatch management in favor of flexible approaches that hence we can change closure areas on a much faster schedule than the Federal Government could and our enforcement is simpler because our vessels waive due process.

Our actions are audited by a third party to be sure that we are not acting as a fox guarding the henhouse.

We have built all these capabilities on data that we obtain from NOAA fisheries. But fisheries are no different from the rest of society, and we are constantly being challenged to incorporate new methods and technologies while not losing legacy data.

This offers opportunity. I believe that the same advantages that technology offers to society in general will also be extended to fisheries. Whatever you can do in the reauthorization process to encourage further innovation as well as continuing cooperation between industry and NMFS is important.

It is also important to realize that the demands on regions to live within catch limits makes accurate monitoring of catch even more important.

Thus, technologies like electronic monitoring will have to be used alongside human observers because we cannot afford to place observers on every boat, and fishermen will have to work together with NOAA fisheries to make this happen.

My written testimony references a document called "Improving Net Gains," that grew out of a data modernization workshop, and I would urge you to look at the report for suggestions in this arena. The report highlights how modernizing our data infrastructure could provide economic benefits to the fleet, make it easier for more vessels to stay on top of catch and bycatch, and allow both safety and efficiency gains.

Thank you again for the opportunity to testify and I welcome any questions.

[The prepared statement of Mr. Haflinger follows:]

PREPARED STATEMENT OF KARL HAFLINGER, FOUNDER AND PRESIDENT, SEA STATE, INC.

Introduction

Good afternoon, Chairman Sullivan, Ranking Member Peters, and members of the Subcommittee. Thank you for the opportunity to testify today. My name is Karl Haflinger and my company, Sea State, maintains a private fisheries information network for approximately 150 trawl and longline vessels that fish off the coasts of Alaska, Washington and Oregon.

I will be speaking today about the close partnership that Sea State has built with members of the fishing industry in the North Pacific and Pacific Northwest to dramatically improve business and conservation outcomes. Our work is, we believe, an illustration of "state of the art" cooperative management under the Magnuson-Stevens Act (MSA). It demonstrates how fishing industry participants are themselves investing in world-class science and data in ways that deliver healthier fisheries and more profitable fishing enterprises. First, I hope my testimony helps members of the Subcommittee understand the kind of management innovation that is possible under the existing law, and the importance of proceeding cautiously in any reauthorization process to ensure we retain what is working. Second, I want to address areas where continuing innovations by the National Marine Fisheries Service

(NMFS) could be helpful in catalyzing further improvements in how fisheries data is collected and utilized.

Meeting Business and Conservation Challenges

Data collection and analysis is an critical component of success for fishing businesses in the twenty-first century, and where Sea State focuses its work. Currently, approximately 150 commercial fishing vessels use our services, which could be loosely described as fisheries data analysis, in support of fishing activities governed under regulations developed by two of the eight regional fishery management councils established under the MSA, the North Pacific Fishery Management Council and the Pacific Fishery Management Council. All of these vessels are members of fishing cooperatives, whether these cooperatives are recognized in statute (as inshore cooperatives defined under the American Fisheries Act), or simply composed of all members of a closed class of vessels that receive a fixed percentage share of the annual harvest quota. Fish harvesting cooperatives are a form of catch share-style program.

With modern fishing gear, sophisticated electronics that identify fish schools, and fishing experience acquired over 40-plus years on the offshore grounds since the MSA extended U.S. jurisdiction out to 200 miles, locating target species is generally not a persistent problem for the fleets with whom we work. Reducing incidental catch of non-target species (bycatch), with an emphasis on certain species, is more often the focus of fishermen and fishery managers because fishery management regulations exist that can close fisheries before the target species quota is taken if fishermen reach an incidental catch allowance for certain non-target species.

In 1996, the MSA was amended to define bycatch as discarded fish. Fish can be discarded for economic reasons (*i.e.,* the fish are unmarketable), but there are also discards required by regulations, most often because fish incidentally caught by one fisherman are target species for another. Requiring such fish to be discarded is intended to eliminate any incentive to catch the non-target fish in the first place. The 1996 MSA amendments contained other provisions to reduce incidental catch of non-target species, including adding National Standard #9 to the Act, which requires Federal fishery managers to minimize bycatch.

Regulatory actions by the North Pacific Council on bycatch reduction predated MSA National Standard 9, due to the fact that major bycatch species like salmon, crab and halibut are at the center of subsistence and commercial livelihoods for many coastal residents throughout Alaska and the Pacific Northwest. The Council responded to concerns about bycatch (first raised in conjunction with foreign fishing) with a series of both input and output controls, such as time-and-area closures and outright limits on total allowed bycatch in the early 1990s. In the latter instance, target groundfish fisheries closed before the allowable catch was reached if the fleet reached caps on the incidental catch of certain non-target species, particularly halibut and crab.

In 1976 when the U.S. established its 200-mile Exclusive Economic Zone (EEZ), a number of foreign nations entered into fishing agreements to allow continued access to U.S. waters to harvest groundfish species. One condition of fishing was that NMFS's observers were placed on foreign vessels to ensure adherence to fishing quotas. Regulations requiring onboard observer coverage carried over to the domestic fleet in Alaska as U.S. fishing and fish processing developed through the 1980s.

The U.S. industry in the Northwest and Alaska is currently spending $15–20 million annually to cover Federal fishery observer costs. Observers are trained and managed by NMFS and the data they collect is protected under confidentiality rules covered in MSA. Confidentiality protections, while important to preserve in the Act, initially presented an obstacle to using this data to support industry bycatch reduction initiatives. The trawl industry realized that the solution was to authorize a 3rd party to receive and review observer data for all vessels in a fleet, and quickly create maps of bycatch trends that were returned in real-time to vessels. That is when Sea State began, and we have continued to create information products that captains themselves help design, that assist in bringing down bycatch rates. Original efforts were only marginally successful since bycatch avoidance is not a win-win solution—it almost always results in slower fishing rates as vessels must take time to relocate. However, once the fisheries I work with transitioned to catch share fisheries of some form fishermen could accept the cost of increased time that bycatch reduction almost always entails, because individual vessel allocations ensured no lost fishing opportunities from picking up gear and moving to areas with lower bycatch.

All of the major groundfish fisheries in the Bering Sea and the Pacific whiting, or hake, fishery off Washington and Oregon are now prosecuted under strong cooperative agreements. Input controls, like rigid time-and-area closures that often

proved to be at odds with actual trends on the grounds, have largely been abandoned by the Councils. The ocean environment is dynamic, and the distribution of fish stocks is in constant flux. Static lines on a map that require promulgation of a rule to change do not provide for the type of adaptive, real-time management that sound catch accounting methods and electronic reporting of catch can provide. Instead, the Councils have tasked the fleets with finding ways to reduce bycatch, at times adding performance standards for industry to meet. And industry is required to regularly demonstrate to the councils that their approaches are working.

To respond to these challenges placed on fleets by the Councils, we have had to step up our efforts to gather data from multiple sources and at times even automate our analysis and response to the fleets so that it is a round-the-clock process. Data-sharing among vessels in cooperatives is made mandatory by fishing cooperative contracts, and informal, cross-sector (that is, among target fisheries) sharing is common as well. Cooperative contracts are legally binding private sector agreements. Such agreements obligate cooperative members to fish according to whatever rules the coop in particular feels are necessary to put in an orderly harvest in accordance with Council guidelines. Sea State generates notices of high bycatch based on both observer data and landings information (whichever arrives first) and sends alerts to vessels on the grounds as text-based e-mails with links to live web maps.

Additionally, according to rules of some cooperatives, we evaluate actively fished areas on a weekly basis and close them to vessels exhibiting high bycatch rates, thus providing an incentive for individual vessels to figure out how to fish with less bycatch. All of these measures are prescribed in the cooperative contracts that all members sign, so that no behavior is simply voluntary. Substantial fines are levied for not following the rules (for example, fishing in a closed area, which is monitored via satellite), and in some cases Sea State's management actions are subject to 3rd party audits to be sure that we are performing according to contract in our oversight role.

Catalyzing Continued Innovation

We have been fortunate to work cooperatively with NMFS over the last 20 years to develop the most advanced private fishery information system on the planet. NMFS's Northwest Groundfish Observer Program office has been extremely cooperative from day 1, from a time when faxes and online bulletins boards were state-of-the-art tools. We have now progressed to the point where all vessels have at least text messaging systems, satellite monitoring of positions (VMS) and often full e-mail and Internet access. The e-Landing system in Alaska, which was created through a partnership with NOAA Fisheries, the State of Alaska and the International Pacific Halibut Commission followed in the early 2000s, allows us access to shoreside landings information for clients who authorize our access to their records.

Nonetheless, there is clearly more we can do to modernize data infrastructure, give additional tools to fishing businesses, and ensure the long-term sustainability of all U.S. fisheries. I was recently part of an expert panel that explored what more we could do to accelerate progress. Our "Fishing Data Innovation Taskforce" included a broad cross-section of fisheries stakeholders with an interest in harnessing technology to meet business and conservation goals. Our *Improving Net Gains* report reviews both areas of progress and remaining challenges and makes specific recommendations for reform, which I recommend to the Subcommittee.

I am encouraged by the reception our Taskforce report has received to date. The new Assistant Administrator for Fisheries, Chris Oliver, has confronted these issues before in his previous role as Executive Director of the North Pacific Fishery Management Council. Others in positions of leadership at the National Marine Fisheries Service are showing a willingness to explore new approaches where needed, which I applaud. We have been gratified by the interest of a number of congressional leaders. Chairman Sullivan, we're especially grateful for the spotlight you're shining on this issue. Progress in this area can be difficult. As in many fields today, fishery data systems that were developed ad hoc must be re-written to take advantage of newer information technologies, and doing so without losing critical "legacy" data requires almost inspired planning. However, it is critical that fisheries managers and fishermen find ways to navigate these challenges to secure the benefits that improved data systems can deliver. Modernizing our data infrastructure could provide economic benefits to the fleet, make it easier for more vessels to stay on top of catch and bycatch, and allow both safety and efficiency gains.

Maintaining what we have

One issue I haven't yet mentioned is the importance of maintaining NOAA Fisheries stock surveys and yearly stock assessments for both major and other constraining stocks (that is, minor or weaker stocks taken as bycatch in a mixed-stock

fishery). Maintenance of the surveys provides fishery independent data that is essential to the fisheries that span the West Coast and make up a substantial proportion of the Nation's groundfish landings. The industry "pitches in" on management costs paying for 100 percent observer coverage for catch share fisheries in the Bering Sea, often with 2 observers on larger vessels. Industry has also been involved in cooperative programs with NMFS, such as providing platforms for echo-sounding surveys while fishing, funding gear research, and genetic stock research for Alaskan salmon. However, the fisheries independent surveys and stock assessments are the basis for the most critical management decisions, and need to be carried forward to ensure that the large groundfish stocks off our coasts are fished sustainably.

Thank you again for the opportunity to testify, and I look forward to continuing to work with the Subcommittee to modernize fishery information systems and improve the performance of our fisheries.

The CHAIRMAN. Great. Thank you, Mr. Haflinger.

Dr. Jones.

STATEMENT OF MICHAEL JONES, PH.D., PROFESSOR, DEPARTMENT OF FISHERIES AND WILDLIFE, MICHIGAN STATE UNIVERSITY

Dr. JONES. Chairman Sullivan, Ranking Member Peters, and distinguished members of the Committee.

Thank you for inviting me to appear before you to discuss fishery science and its potential to better inform fishery management practices.

My name is Michael Jones. I am a Professor in the Department of Fisheries and Wildlife at Michigan State University. I received my Ph.D. from the University of British Columbia, and have experience as an environmental consultant, as a Government scientist, and since 1997, as an academic.

I come to fisheries honestly and my father worked, admittedly, as an accountant in the fishing industry in British Columbia. But my exposure through him to this world really set the course for my academic career.

As Senator Peters mentioned, I am the Founding Director of the Quantitative Fisheries Center at MSU. Our Center works with Government and stakeholders to foster better management of Great Lakes fisheries.

We marry analytics with management and decision making. We use our expertise to put computer models to work with stakeholders for real fishery benefits in real time. Our work is focused on the Great Lakes, but the science we use is just as relevant to other regions of the United States.

The Magnuson-Stevens Act has made a vital contribution to substantially improving the state of the country's federally managed fisheries. I hardly need to remind the Committee of this fact.

Via the Act, our country oversees over 4 million square miles of ocean, an area larger than that of our entire country. These waters range from the Caribbean to the Bering Sea. They include a huge variety of species.

Ecological science tells us that these species should not all be managed in the same way. There is merit in considering scientifically flexible, defensible flexibility in things like rebuilding plants, for example, related to species' life histories.

A one-size-fits-all approach to fisheries management does not work well and risks managing some fisheries overly conservatively, while others suffer from regulations that are too liberal.

All fisheries are managed in the face of great uncertainty, both about the current status and about future conditions. Good policy and decisionmaking frameworks should explicitly recognize this uncertainty, and frame action in the context of risks.

One implication of this is that there is not a bright line between stocks that are assessed as overfished versus those that are not. Accommodating this uncertainty about status by taking account of a range of possible assessments from, for example, slightly or possibly overfished to greatly or certainly overfished, will go a long way toward allowing for better decisions.

Around the world, fishery management is increasingly being informed by approaches widely referred to as Management Strategy Evaluations, which use computer simulation methods to evaluate how alternative fishery management strategies are likely to perform relative to predefined sets of management goals and that explicitly recognize our uncertainty.

While this approach is sometimes technically challenging, there is really no excuse for failing to use it. Increasingly, the National Marine Fishery Service is adopting this approach.

I would like to highlight two positive experiences with the application of these MSE methods to important fishery management issues in the Great Lakes: sea lamprey control and Lake Erie perch and fisheries.

Sea lamprey is a destructive, invasive species in the Great Lakes that require annual investments of millions of dollars on pest control to reduce their impact on valued species.

In collaboration with the Great Lakes Fishery Commission, we use MSE methods to guide critical decisions about allocation of resources between determining where we should apply control and actually implementing that control. These decisions have greatly helped the GLFC to achieve its management goals for sea lamprey in each of our Great Lakes.

Lake Erie walleye and yellow perch fisheries represent the most valuable commercial freshwater fishery in the world. Not unlike red snapper, for example, Lake Erie walleye and perch are highly valued by both recreational and commercial fishers.

These competing interests have led to considerable conflict and an erosion of trust in management by all stakeholders that peaked around 2009.

In the summer of 2010, Lake Erie fishery managers invited the QFC to lead an effort to create a more transparent, science-based process to help define harvest policies that were scientifically sound and balance the competing objectives of the different stakeholders.

We developed and used an MSE model in a process that involves stakeholders and managers to examine harvest policy options.

Largely as a result of the transparency and openness of this process, this work led to the adoption of harvest policies that are viewed by all stakeholders as suitable for these fisheries.

Our experience in the Great Lakes also highlights the importance of considering how ecosystem change can affect the future of fisheries in ways that are not evident from looking at the past.

Invasive species—including the sea lamprey, but also zebra, and quagga mussels, and possibly Asian carp in the future—can pro-

foundly alter the dynamics of native species that are economically and culturally important.

As well, land based activity, such as agricultural practices and storm water management, can have very large impacts on nutrient dynamics that drive so-called bottom up effects on the food web.

More than 50 years of experience studying the human driven ecosystem change in the Great Lakes should provide insight that can help us to develop robust management strategies for fisheries that are resilient to the uncertainties created by unanticipated changes in the ecosystem.

One of the great benefits to the U.S. fishery science, due to the Magnuson-Stevens Act, has been its impact on the development and deployment of cutting edge scientific technologies to inform us about fish stocks and their ecosystems. I would be remiss if I did not and were not to mention that this is a benefit that we, who do science in the Great Lakes, truly envy.

Senator Peters and others have recently introduced a bill known as the Great Lakes Fishery Research Authorization Act that seeks to provide comparable support for science for Great Lakes fisheries. I urge you to consider the merits of this bill for the betterment of fishery management on our north coast.

The Magnuson-Stevens Act has helped us to be able to claim that our country has some of the world's best managed fisheries, but our work cannot stop.

I am honored to have this opportunity to speak to you about the role of science and our investment in the future of America's fisheries.

I look forward to the opportunity to address your questions.

[The prepared statement of Dr. Jones follows:]

PREPARED STATEMENT OF MICHAEL JONES, PH.D., PROFESSOR, DEPARTMENT OF FISHERIES AND WILDLIFE, MICHIGAN STATE UNIVERSITY

Chairman Sullivan, Ranking Member Peters, and distinguished members of the Committee, thank you for inviting me to appear before you to discuss fisheries science and its potential to inform better fishery management practices.

My name is Michael Jones. I am a professor in the Department of Fisheries and Wildlife at Michigan State University. I received my B.Sc. and Ph.D. degrees from the University of British Columbia in Canada. I have worked in the private sector as an environmental consultant, in the public sector as a government scientist, and since 1997 as an academic. I come to fisheries "honestly"—my father worked in the fisheries industry in British Columbia, admittedly as an accountant, but my exposure through him to this world set the course of my academic career. My research focuses on fish population dynamics and ecology, resource management and simulation modeling.

Over the years, I have become more and more interested in how uncertainty and risk affect resource management decision-making. I have also seen how Structured Decision Making methods can lead to better management outcomes, especially when they involve stakeholder engagement. I have worked closely with fishery management agencies, particularly in the Great Lakes region and in Alaska, to apply my research findings and scientific expertise to current and emerging management issues.

I am a founding director of the Quantitative Fisheries Center (QFC) at MSU. Our Center works with agency partners and stakeholders to foster better management of fisheries, primarily in the Great Lakes Region. The QFC marries analytics with management and decision-making. We use our expertise to put statistical methods and models to work with stakeholders, to achieve real fishery benefits in real time.

We work to ensure that wise, fair decisions are made, based on the best science, and in partnership with many, sometimes disparate, stakeholder groups.

Although our work has focused on the Great Lakes, we tackle scientific issues that are just as important for other regions of the United States, where the Magnuson-Stevens Act applies, including:

- determination of sustainable and equitable harvest policies for exploited species;
- mitigation of the negative effects of invasive species;
- accommodation of the influence of ecosystem change on food webs that include economically valuable fish stocks.

The Magnuson-Stevens Fishery Management and Conservation Act has made vital contributions to substantially improve the state of our country's federally-managed fisheries. While I hardly need to remind this committee of this fact, we have seen since the early 2000s:

- 39 overfished stocks rebuilt.
- A 98 percent increase in fish stock sustainability.
- A Fish Stock Sustainability Index (FSSI), which gauges key stocks according to their overfishing status and biomass levels, has increased every year since the index was implemented.[1]

This is in stark contrast to reports of fishery performance in many other—although not all other—regions of the world.

The Marine Fish Conservation Network reports that as of 2013, two-thirds of overfished stocks placed in rebuilding plans due to the Magnuson-Stevens Act have been rebuilt or have made significant progress since 1996. They estimate that rebuilding *all* U.S. fish populations would lead to a $31 billion increase in annual sales and support for half a million new U.S. jobs.[2]

Via the Magnuson-Stevens Act, our country oversees 4.4 million square miles of ocean—an area larger than that of our entire country. These oceans and seas range from the Caribbean to the Bering Sea, and no two are the same. They include a huge variety of species that are the objects of exploitation: ranging from small, pelagic, short-lived fish like menhaden to large, extremely long-lived benthic fish like Pacific coast rockfishes, not to mention numerous important shellfish species.

Ecological science tells us that these species should not all be managed in the same way. There is merit—and evidence to support this—considering scientifically defensible flexibility in things like rebuilding plan expectations, for example related to species life histories. A 'one-size fits all' approach to fisheries management does not work well, and risks managing some fisheries overly conservatively while others suffer from regulations that are too liberal. Determining how to adapt management strategies to match the characteristics of diverse fisheries has been a focus of my work for the past 30 years.

All fisheries are managed in the face of great uncertainty, both about current status and about future conditions; good policy and decision-making frameworks should explicitly recognize this uncertainty and frame action in the context of risks.

One implication of this is that there is not a "bright line" between stocks that are assessed as overfished versus those that are not. Better decisions would result from some Accommodation for the uncertainty about status, taking account of a range of possible assessments from, for example, slightly/possibly overfished to certainly/greatly overfished, would go a long ways toward informing better decisions.

Around the world, fishery management is increasingly being informed by approaches widely referred to as Management Strategy Evaluations (MSEs), which use computer simulation methods to evaluate how alternative fishery management strategies are likely to perform relative to pre-defined sets of management goals, and that explicitly recognize the uncertainty I just mentioned. While sometimes technically challenging, particularly for data-poor fisheries, there is no excuse for failing to use this type of approach, especially for economically important fisheries. Increasingly, the National Marine Fisheries Service has begun to adopt this approach.

We have had positive experiences with the application of MSE methods to two key fishery management issues in the Great Lakes.

The first MSE application is sea lamprey control. Sea lamprey were one of the first aquatic invaders that entered the Great Lakes as a consequence of increased shipping and other commerce in the region in the early 20th century. When the sea

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[1] NOAA Fisheries Magnuson-Stevens Fishery and Conservation Act *http://www.nmfs.noaa.gov/sfa/laws_policies/msa/*

[2] Marine Fish Conservation Network *http://conservefish.org/healthy-oceans/magnuson-stevens-act-upholding-a-legacy-of-success/*

lamprey entered into the upper Great Lakes, they decimated native fish populations.

Sea lampreys have a very unique life cycle. Lampreys cause their damage to Great Lake fisheries during the adult parasitic phase of life, which lasts 12–18 months. During the spring, lamprey die, but not before they spawn in Michigan rivers to continue their destructive legacy. After the eggs hatch, they go through a nonparasitic larval stage that lasts for three to six years. When the larval stage is complete, they begin the adult parasitic phase where they enter the Great Lakes and feed on the fish population. However, during the larval stage sea lampreys are vulnerable to chemical control, and this has been the primary means by which this destructive invader has been controlled.[3]

Over the last decade we have used MSE methods to guide "million dollar" critical decisions about allocation of resources between assessment (that is, determining where we should apply control) and control (that is, how much habitat should we chemically treat) of this pest, and to evaluate trade-offs among competing management options. This science has been vital to the considerable success of the control program run by the bi-national Great Lakes Fishery Commission.

While sea lamprey control is a success story in the Great Lakes, the lessons learned from this program can reach far beyond the Great Lakes. Learning how to better manage invasive species ranks among the most important ecosystem-level issues we face today, and this is equally true for our marine ecosystems.

The second MSE application involves the most valuable freshwater commercial fishery in the world—the Lake Erie walleye and yellow perch fisheries. Not unlike red snapper in the Gulf of Mexico, and any number of other U.S. coastal marine fish stocks, Lake Erie walleye and perch are highly valued by recreational and commercial fishers alike.[4]

Since the late 1970s walleye and perch fishers, and the managers that determine who gets to catch what, have repeatedly fought over allocation of these prized fish stocks. By 2009 trust among stakeholders, and between many stakeholders and decision makers, was at an all-time low. In Ontario especially, managers and commercial fishery stakeholders were spending a lot of unproductive time in court.

In the summer of 2010, the Lake Erie fishery managers decided to change course. They invited the Quantitative Fisheries Center to lead a Structured Decision Making effort to help create a more transparent, science-based process—a process that would help define harvest policies that were scientifically sound and balanced the competing objectives of different stakeholders.

At the core of our effort was the development of an MSE model, using a process that involved active engagement of fishery stakeholders and managers, to both improve stock assessment methods and examine harvest policy options. Largely as a result of the transparency and openness of our process, this work has led to adoption of harvest policies that are viewed by all stakeholders as suitable for these fisheries.

My experience with using a stakeholder-engaged MSE process, both in Lake Erie and more recently in western Alaska for subsistence salmon fisheries, has convinced me that progress towards better management of fisheries, where a diversity of stakeholders have potentially conflicting objectives, depends on an open, transparent process where stakeholders feel empowered to influence management decisions, and are able to gain insight into the objectives of other stakeholders.

Experience with the management of fisheries in the Great Lakes over the past few decades also has taught me the importance of careful consideration of how ecosystem change can affect the future of fisheries in ways that are not always evident from looking at the past.

As I mentioned earlier, invasive species, including the sea lamprey but also zebra and quagga mussels, and possibly Asian carp in the future, can profoundly alter the dynamics of our native species that are economically and culturally important.

In addition, land-based activities such as agricultural practices and stormwater management can have large impacts on nutrient dynamics that drive so-called bottom up effects on the food web.

More than 50 years of experience with human-driven ecosystem change in the Great Lakes offers examples that can be applied to fishery management in marine

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[3] Jones, M.L., B. Irwin, G.J.A. Hansen, H.A. Dawson, A.J. Treble, W. Liu, W. Dai, and J.R. Bence. 2009. An operating model for Great Lakes sea lamprey integrated pest management. Open Fish Science Journal 2: 59–73.

[4] Jones, M.L., M.J. Catalano, L.K. Peterson, and A.M. Berger. 2016. Stakeholder-centered development of a harvest control rule for Lake Erie walleye *Sander vitreus.* pp. 163–183 in "Management Science in Fisheries", C.T.T. Edwards and D.J. Dankel, editors. Routledge, Oxford and New York.

coastal regions of the U.S. These can also help us to develop robust management strategies that are resilient to the uncertainties created by unanticipated changes to the ecosystem.

One of the great benefits to U.S. fisheries science and management that has come from the Magnuson-Stevens Act has been its impact on the development and deployment of cutting edge scientific technologies to inform us about fish stocks and their ecosystems. I would be remiss if I were not to mention at this hearing that this is a benefit that we who carry out science in the Great Lakes truly envy. Senator Peters and others recently introduced a bill known as the Great Lakes Fishery Research Authorization Act that seeks to provide comparable support for science for Great Lakes fisheries as we presently enjoy for marine systems thanks to the MSA. I urge you to consider the merits of this bill for the betterment of fishery management in the United States' "north coast."

The Magnuson-Stevens Act undoubtedly allows us to claim our country has the world's best managed fisheries, but our work cannot stop. I am honored to have the opportunity to speak to you about the role of science in our investment in the future of America's fisheries, and I look forward to addressing your questions.

The CHAIRMAN. Great.

Well, thanks again to all the witnesses for great opening statements. I think now we will proceed to questions.

I wanted to begin, Dr. Hilborn and Mr. Haflinger, you both mentioned the phrase "race to fish."

Can you describe that in a little bit more detail in what you mean? How data and sound science, that is really the focus of this hearing, can help us address some of the challenges that come out of the race to fish?

I will let either of you take it.

Mr. HAFLINGER. In the race to fish, I think typically refers to the way fisheries have most often been conducted in which whatever management agency is responsible would somehow set an allowable catch, and they would determine when a season would be for this fish fishery. The starting gun would go off and fleets would fish until the allowable catch had been achieved if they were fishing with an allowable, within the framework of an allowable catch.

In such an environment, anything that slows you down and takes you off the grounds, or makes you less efficient on the grounds, simply means you have lost revenue because you have lost fishing time to somebody else.

So that is the race for fish and removing the race for fish has been phenomenally important in fisheries in the U.S.

The CHAIRMAN. So are there safety elements to that?

Mr. HAFLINGER. There are certainly safety elements.

The CHAIRMAN. Can you unpack those a little bit as well?

Mr. HAFLINGER. I think the most striking example would be in the crab fisheries in Alaska where the seasons were compressed to just maybe a week or so. If it was blowing out of the north at 45 and it was heavy icing, you went out anyway.

A lot of boats were lost, a lot of lives were lost, and there was simply no choice because that is when the season started, and that is when you had to go and fish. I think it was true across the halibut fishery as well. I am sure it has been true in many fisheries. So safety was a large issue certainly.

The CHAIRMAN. Dr. Hilborn, do you want to comment on that at all?

Dr. HILBORN. Yes. The race to fish was destructive and it still exists in some fisheries, but it has safety consequences. It also

means that the incentives, for any individual fisherman, are to do anything that lets him catch fish at a faster rate.

As we have eliminated the race to fish in many fisheries, the incentive switched to getting the maximum value of the fish that you do catch. And this has led to much fuller product utilization, concentrating on trying to get higher value products, whether it is more fillets off of a pound of fish or whatever.

I think it has universally been recognized that stopping the race to fish is an essential element in most good fisheries management.

The CHAIRMAN. So management and safety?

Dr. HILBORN. But for economics, for management, and for safety, for all those reasons.

The CHAIRMAN. Great. Thank you.

Dr. McKinney, one of the Morris-Deal recommendations was, quote, "Adopting a revised approach to saltwater recreational fisheries management." This has also been termed "alternative management."

Can you elaborate on what is meant by alternative management? And do you have any experience from your work in Texas and in the Gulf on these management approaches?

Dr. MCKINNEY. Appreciate the question, Mr. Chairman.

I guess I would start that from the State's perspective and from a number of fisheries managements, we do not really call it "alternative fisheries management," but it is the fishing approach.

Because it is used in nearly every state, tribal groups, state compacts, even in wildlife type things which basically is looking at, not looking at [sic] quota based or maximum yield type of approach, but basically access.

And it is based on what was the old North American model of how we manage fisheries, and that is, that came about as we tried to move away from commercial fisheries for wildlife production particularly. I think that is the best management, best idea of management deal.

So it is looking at access based approaches where you use link limits, seasons, bag limits, those types of approaches and you combine that with a robust data collection process as you move along so that you can make adjustments as you move.

It is a very adaptive management approach rather than setting a targeted date, a time for restoration and a weight, a catch her by weight type of thing.

The CHAIRMAN. Thank you.

I might have some more questions on follow up, but I turn now to Senator Peters.

Senator PETERS. Thank you, Mr. Chairman.

Again, thank you to each of our witnesses for some very good testimony here today.

One thing that has come out through our hearings that we have had on this issue is that oftentimes we have difficulty reaching consensus. So when it comes to fisheries management, there are a lot of stakeholders that have very strong opinions, as you know.

Dr. Jones, your experience with the management strategy evaluations has certainly been a success in trying to bring some of these folks together.

If you could just elaborate more specifically as to how that works? How it enables us to bring divergent groups together and how that might be something for us to be thinking about going forward?

Dr. JONES. Sure. Thank you very much for the question.

I guess the main thing that I would emphasize about the MSE process is that it starts with a conversation about what you want to achieve. Dr. Hilborn made reference to this in his testimony, the importance of articulating what the goals of management are in order to, then, bring the science to bear on how best to achieve those goals.

And so, the process that we have used, the process that other groups have used also in the world with MSE, is to bring the diverse points of view into the room and articulate what the suite of objectives are.

Not necessarily resolve and try to define a common objective, but identify what the range of objectives are that different stakeholders have. And then proceed with an analysis that formally asks the question, "How will different management strategies succeed at meeting this diverse, and sometimes competing, set of objectives?"

What we have found is that if you do that in a transparent and explicit way, that stakeholders begin to have more of an opportunity to understand the need for compromise, the need for reconciling their goals with the goals of other stakeholders.

That was certainly our experience with the Lake Erie perch and fisheries that I referred to in my testimony.

Senator PETERS. Thank you.

Dr. Jones, also in your written testimony, you list some very important scientific issues to tackle that are actually shared between the Great Lakes fisheries, as well as fisheries under the Magnuson-Stevens Act including the influence of ecological changes on food webs.

The question is really, how can we go about improving fisheries management, whether under NOAA or in the Great Lakes, to accommodate ecological changes on food webs, as well as other environmental changes like invasive species, such as the Asian carp, which we hopefully do not have, in the Great Lakes? Hopefully, we will be able to prevent that. Or climate change, if you could elaborate a little bit on that, I would appreciate it.

Dr. JONES. Hard questions.

I think one observation that I would make is that I think we have been comparatively successful working in the Great Lakes to begin to tease apart and understand the role that ecosystem change—as invasive species' eutrophication and oligotrophication, the opposite of that—has played in influencing the productivity of fish populations that we are targeting.

I think that what we have essentially learned is that you cannot ignore those phenomena as you are asking questions about sustainable levels of harvest.

So you need to make accommodations in your targets of allowable harvests, or what have you, that account for your understanding of how those processes influence.

I would admit that the Great Lakes, despite the fact that you and I both see them as enormous bodies of water, they are kind

of puddles compared to the Gulf of Alaska or the North Atlantic Ocean.

The CHAIRMAN. Sorry, Senator Peters.

[Laughter.]

The CHAIRMAN. But I concur with your fellow Spartan.

Dr. JONES. The upside of them being puddles is that they are microcosms relative to the marine environment, where we can really understand these interactions in ways that are very, very elusive to understand in these large oceanic systems.

So I think that the science that we have over the last 50 years developed in the Great Lakes has a lot to say about informing questions that we should be asking in ecosystems.

Senator PETERS. Good. Thank you. My time is running down.

I have a vote coming up, so I will defer to make sure our other Committee members have questions.

The CHAIRMAN. Senator Cantwell.

STATEMENT OF HON. MARIA CANTWELL,
U.S. SENATOR FROM WASHINGTON

Senator CANTWELL. Thank you, Mr. Chairman.

I thank the panelists and thank you for your support of Magnuson-Stevens.

I think the verdict after decades is clear that good management of fisheries produces the greatest results. I think what we have to ask ourselves is, "What do we need to keep doing and what else can we do?" Clearly, using science is very, very important. Stock assessments would go a long way in making sure that we are measured in our approach.

I am glad to see that the management strategy that started in the Pacific Northwest has at least made it to the bottom of the continental United States to Texas. I hope that we can keep moving up the coast in the future.

I wanted to ask you about something, Dr. Hilborn. It is hard to think about the good aspects of Magnuson-Stevens and its management strategies when, at the same time, some people are proposing something as crazy as mining in Bristol Bay. This would affect the headwaters of a very large salmon stock and the most productive wild Pacific salmon fishery on Earth.

Do you have thoughts on the proposed Pebble Mine?

Dr. HILBORN. Yes. At the University of Washington, we have a program that has been researching the salmon populations of Bristol Bay since 1946 and I have been working there for the last 22 years.

It is the most productive salmon fishery in the world, in terms of value. You could not have designed a better habitat because it is essentially a giant gravel bed that is just perfect spawning habitat for salmon.

The idea that you can actually build reservoirs that contain highly toxic chemicals and hold them forever—forever—in a seismic and volcanic zone is just crazy.

We have one of the most valuable natural resources in the United States that has been sustained for a long time and is, in fact, at record abundance. A big goldmine, or a big mine, in the

middle of all of that is a serious threat to the sustainability of that resource.

Senator CANTWELL. Well, thank you for those comments.

I will note that our former Chairman from Alaska, the late Ted Stevens, also had doubts about this. I do not think that we can be too aggressive in saying that this is a very, very bad idea. It would basically devastate Magnuson-Stevens. Why do it if it will devastate the salmon runs?

Mr. Haflinger, what about our continued focus on science? How important do you think it is to maintain scientific investment in order to keep our maritime and seafood economy?

Washington has a $30 billion maritime economy; 60 percent of it is tied to the seafood industry. So we do not take this issue lightly when somebody says they want to cut any funding for science.

Mr. HAFLINGER. Mr. Chairman, Senator Cantwell, that one is just too easy.

All of my constituents or my clients that are involved in the North Pacific and the West Coast fisheries are very strong advocates of the process that the councils go through to establish catch limits. And we have had, we have gone through times where our TACs had been less than we had liked.

I mean, back in 2010, I believe, we had pollock TACs (Total Allowable Catch) that were under a million tons for the first time in 45 years and it was a wake up call. We have had Pacific whiting TACs that have been very low. We have had constraining species rockfish TACs that were low.

But I do not think anybody has ever questioned the need, I mean, ever even thought that what you would do is back off on science.

Senator CANTWELL. Well, apparently, there are some that think that way. I actually think we should be going in the opposite direction. I am so proud of what the North Pacific Fisheries Management Council has done. We have made progress.

When I first came here and started voicing those opinions, I would get little hate e-mails from various northeast parts of the country. They would say, "No, no."

But eventually, we are going to have a food shortage around the globe. We should be exporting our ideas on fisheries management instead of letting people into our fisheries to steal our fish. And we should be forcing those countries to implement better fishery management policies.

So anyway, I could not be more proud of what we have been able to accomplish and hopefully the next chapter will see even more investment in science and a stopping of bad ideas.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you, Senator Cantwell.

Senator Wicker.

STATEMENT OF HON. ROGER F. WICKER,
U.S. SENATOR FROM MISSISSIPPI

Senator WICKER. Dr. McKinney, you chaired the Working Group on Saltwater Recreational Fisheries Management of the Morris-Deal Commission. The working group came forward with a number of recommendations.

I have a little bill called the Modernizing Recreational Fisheries Management Act of 2017 and I have nine cosponsors in the Senate. Representative Gary Graves in the House, has introduced a similar bill with 23 cosponsors.

If enacted, the bill would allow for alternative management tools for recreational fisheries. It reexamines fisheries allocations, provides flexibility in rebuilding fish stocks, and improves recreational data collection.

How does this compare to the recommendations of your working group and what do you think of my bill?

Dr. MCKINNEY. Well, on behalf of my Commission, we would like to thank you for obviously taking a look at our recommendations in the Commission Report because they did include many, if not all of those. And so, we appreciate that.

It measures up quite well and I think it addresses those issues that we would hope to see addressed in Magnuson, so.

Senator WICKER. How would it help?

Dr. MCKINNEY. Well, as I tried to provide in my testimony, in every one of those areas of looking at timelines, cooperative management, and every one of the recommendations we made in that Commission Report, it addresses each one of those, essentially.

Senator WICKER. OK. I must say, we have had to come and go, and I did miss your testimony. So thank you for touching on that.

Dr. MCKINNEY. Yes, sir.

Senator WICKER. I will go back and be advised by your oral testimony.

Dr. Hilborn, let us talk about Gulf menhaden as an important forage fish down around where I come from.

They are embroiled in the debate over whether to enact one-size-fits-all restrictions on forage fishing or whether to go on a case-by-case basis.

Are you familiar with the menhaden issue with the forage fish issue? Can you help us decide where to come down on this issue?

Dr. HILBORN. Yes, I would be happy to.

I have been leading a study group looking at the impacts of fishing forage fish on their predators for the last about 2 years now, with a number of my colleagues, who were not working formally with us, but working on similar fisheries.

What we have really shown is that every system is different. That in some systems there is really very little impact to fishing forage fish on their predators. We suspect that in other systems, it is much stronger, but so far we have not gotten to those systems yet.

We have looked at the California current system. I have looked at the Atlantic menhaden. I have not looked specifically at Gulf menhaden, except insofar as we have looked if there is an empirical relationship between the abundance of the forage fish and the rates of change—that is, whether they increase or decrease—of the predators for pretty well all U.S. forage fish fisheries.

We found no empirical evidence to support the idea that abundance of forage fish affects their predators. Largely, we suspect, because most of the predators are reasonably generalists and if their forage fish species is in low abundance, they switch to something else.

Senator WICKER. So a one-size-fits-all rule of thumb on forage fish, we can do better than that. Is that your testimony?

Dr. HILBORN. Yes. That all you need to do is sit down, and take the biology of the forage fish and the predators, and put those into some reasonably simple population dynamics, or ecosystem dynamics models, that allow for the important biology, particularly the natural variability of forage fish.

You can do better than one-size-fits-all.

Senator WICKER. Dr. Jones, let me ask you briefly.

Are you familiar at all with our Mississippi Tails 'N' Scales electronic reporting system for red snapper? Would you comment about the accuracy of state by state reporting of this type coming from anglers?

Dr. JONES. I am afraid I am not familiar with that.

Senator WICKER. Let me tell you about the concept.

They have an application and they can provide fish data to the fisheries agencies. They have developed applications on their smart phones to provide information that would be helpful in creating policy.

And so, although we call it Tails 'N' Scales, perhaps you are familiar with it as a concept elsewhere.

Dr. JONES. Yes, thank you.

So what we are talking about is this, what do I want to say, exploding opportunity to use mobile, social networking types of technology to inform assessments, inform the assessment of catches, of exploitation rates, and so on, and so forth.

I guess my opinion on that, as a scientist, is that it is a wonderful thing, but it is going to take us a while to figure out how to do it, how to use that information in a way that is more informative than misleading because of the challenges of quality control on the data.

I see great promise in that. I think we should invest in learning how to use resource users to provide us with information on the fisheries they are exploiting in ways that we can use to then inform our assessments and our evaluation of status.

But I do not think it is a silver bullet right now.

Senator WICKER. Well, our people like it. There has to be a use for data supplied by the people who want to help and who are out there.

Thank you for thinking with me about that for a few moments.

Thank you, Mr. Chairman.

The CHAIRMAN. Senator Blumenthal.

STATEMENT OF HON. RICHARD BLUMENTHAL, U.S. SENATOR FROM CONNECTICUT

Senator BLUMENTHAL. Thank you, Mr. Chairman.

And thank you for having this hearing, the third in a series on a very, very important topic. Many of the issues that I have raised in previous hearings are still outstanding.

The United States still imports 90 percent of the fish we eat. That is absolutely astonishing and appalling.

The Seafood Import Monitoring Program is a Federal program overseen by NOAA that establishes reporting and recordkeeping re-

quirements for certain kinds of fish, but it applies only to 13 species.

I have raised these issues already with Secretary Wilbur Ross, but without any actionable response, as they say; without anything done about it.

They fly in the face of science and facts, which are your responsibility.

Human trafficking continues to be a problem in the seafood industry. I know it is not a matter of fish catches or fish population, but it afflicts the industry and it is a cancer on the humanitarian backbone of the industry.

Among other problems that I see—literally almost every day in Connecticut, either in the news or directly when I hear from fishermen—is the imbalance that has occurred in our fishing quotas; the imbalance and the distortions.

Say whatever you will about the cause of fish moving, as in many other parts of the country, certain of our species have moved away and others have moved into our waters, but the quotas remain the same.

This quota system is Byzantine, outdated. It has failed to adapt to the movement of fish stocks like black sea bass, summer flounder, and scup.

It effectively bars Connecticut fishermen from catching economically sustainable quantities of fish. Instead, it requires them to throw back fish. They go to waste. They are inedible. When they haul a larger catch than their permissible quota, which happens often, it is a waste of precious resources.

I have raised this issue at numerous, previous hearings. So have my colleagues.

The law governing the management of fisheries requires the Department of Commerce to ensure fishery management plans adhere to several national standards, and I am quoting, "the best scientific information available," in deciding catch limits.

So my question to you is, each of you, do you believe that the councils are using, quote, "the best scientific information," in determining the quotas and the system?

[No response.]

Senator BLUMENTHAL. I will take by your silence that you say, "No, they are not."

[Laughter.]

Senator BLUMENTHAL. I think that is fairly self-evident, but I would love to hear your explanation.

Mr. HAFLINGER. Mr. Chairman, Senator, my experience with the North Pacific and the West Coast council is that they do.

I think what you are talking about is a problem that is especially in the movement of fish and quotas, it is a big issue in other places in the world too. It is a huge problem throughout the EU. It is monstrous. It is very large.

But that is a symptom of a brittle management system rather than whether or not the Councils are using the best available science, in my view. I do not want to indict the Council in your region, because I do not go to their meetings at all.

But if you do have a system that is not flexible enough, then you have problems because fish do move.

Senator BLUMENTHAL. You have problems because they cannot take advantage of new data as quickly as the data is available.

Correct?

That is what you mean when you say it is not flexible enough.

Mr. HAFLINGER. Well, no. That is not really what I meant. I guess I was thinking that if allocations are relatively inflexible and cannot——

Senator BLUMENTHAL. I am not looking to blame anyone with my question right now. I am just asking whether these quotas—and maybe it is the system, maybe it is the councils—reflect the best scientific information available?

You are saying it is not flexible enough. That may be the reason that the system does not respond to new information.

Mr. HAFLINGER. I am saying that is a possibility. I mean, that is what we have seen in other places in the world that the systems need to be flexible.

Senator BLUMENTHAL. You have seen it in other parts of the world?

Mr. HAFLINGER. Yes, like I said, it is a huge problem.

Senator BLUMENTHAL. All over?

Mr. HAFLINGER. Throughout the EU.

Senator BLUMENTHAL. All over the world.

Mr. HAFLINGER. Well, I said other places in the world.

Senator BLUMENTHAL. Well, so it is likely to occur in the United States too?

Mr. HAFLINGER. I suspect it could. Sure.

Senator BLUMENTHAL. Does anyone want to be a little more unequivocal here?

Yes, sir.

Dr. HILBORN. I would be happy to talk on this.

The basic theory of fisheries population dynamics, that is more or less how our quotas are set, has traditionally been based on the assumption that things are not changing in time. That is, you have a long-term average productive relationship between the population and its productivity.

What many of us have identified over the last 20 years is that the natural systems fluctuate enormously and you do see systematic change in things like distributions.

Productivities of many of our stocks in New England appear to be going down. I know it is true in some Canadian stocks where as the temperatures have gotten warmer, the stocks have gotten less productive. The science community is struggling——

Well, first, it is often difficult to identify the changes as they are occurring. We can determine it in retrospect, but certainly within the U.S., we are short of scientific capacity to analyze those things and deal with it. The NOAA stock assessment scientists are struggling just to do the assessments.

What would really be required is a lot more time or resources of people to start really trying to do, as Mike Jones suggested, Management Strategy Evaluation for how you would manage resources that are changing; either changing in their distribution or changing in their productivity.

I would say that if there were more resources, we could do better science. But what I would say they are doing is the best science that they can do with the resources they have.

Senator BLUMENTHAL. Well, I appreciate that comment, which I will take as a plea for additional resources, which I wholeheartedly support.

In fact, as you know, the budget that has been sent to us by President Trump cuts resources for exactly this kind of research and, in fact, it slashes funding for programs like Sea Grant, and the Milford Lab in Milford, Connecticut for the University of Connecticut. These research efforts are essential to grow new forms of agriculture and keep track of fish populations.

At the last meeting of this Committee, we approved a bill that will help support driverless cars; a technology that many of us, who voted for the bill, find somewhat apprehensive, but certainly very much in the future.

If we can put a man on the Moon and put people into driverless cars, I respectfully submit, we can actually produce better scientific information.

It may not be the fault of the Councils. It may be the fault of the system, but it is destroying an American industry. We are complicit in destroying an American industry if we fail to fund the research that enables the law and the Councils to keep pace with the effects of climate change, which we know is there.

Thank you, Mr. Chairman.

The CHAIRMAN. Senator Markey.

STATEMENT OF HON. EDWARD MARKEY,
U.S. SENATOR FROM MASSACHUSETTS

Senator MARKEY. Thank you, Mr. Chairman, so much for having us here.

I heard the introduction of Senator Peters and it is good to have somebody here from MSU working on MSA, I thought.

[Laughter.]

Senator MARKEY. As I was listening to your opening statement and how we can actually use, complementing your other work in this Committee, autonomous monitoring, to accompany your autonomous vehicle legislation that you are moving as well.

The reality is that Massachusetts has been leading advances in fishery sciences at many of our prestigious institutions including the Northeast Fisheries Science Center at Woods Hole, the University of Massachusetts Dartmouth School for Marine Science and Technology funded, in part, by NOAA grants.

Professor Kevin Stokesbury, at the University of Massachusetts Dartmouth, has led very successful collaborative research doing sea scallop stock assessments using video surveys. This research is facilitated by a Fishermen Steering Committee made up of fishermen, owners, and processors that meets monthly to discuss management issues, the needs and concerns of the industry, and current research.

Mr. Haflinger, good science is fundamental to ensuring that sustainable fisheries can be managed under the Magnuson-Stevens Act.

How can we continue these collaborative research projects and the development of new technologies to keep getting better science?

Mr. HAFLINGER. Mr. Chairman, Senator, thank you for the question.

I wholeheartedly agree with you that collaborative, scientific work is tremendously important. There is a lot of it that has been done in the fisheries in Alaska that I am familiar with, especially in areas of development that is similar to what you are referencing in the scallop fishery off Massachusetts.

I am not exactly sure how to continue to expand this, but I feel like anything the Committee can do in MSA to encourage cooperative research between industry and NOAA fisheries is tremendously important and something that I am sure that all fishermen in the regions that I am familiar with would agree with.

Senator MARKEY. Great. Thank you.

When you live on the coast, and even reflecting upon what Dr. Hilborn said in his testimony, that we have never had more fish in the ocean at this particular point in time.

Is that correct, Dr. Hilborn?

Dr. HILBORN. No, I said, we have been increasing since the 1990s. We have more fish than 20 years ago.

Senator MARKEY. I misunderstood. I thought you said that we had more fish.

Dr. HILBORN. No, not more than ever. No.

Senator MARKEY. The United States, not withstanding how many we have, we do import over 80 percent of the seafood which we eat, and this seafood largely comes from countries that do not have laws like we do in the United States that create sustainably managed fisheries.

And while many Americans understand that they can support local sustainable fisheries by buying from American fishermen, it can sometimes be impossible for consumers to find out where their fish is caught and processed.

Senator Wicker and I worked with the previous Administration to address this issue by establishing the NOAA Seafood Import Monitoring Program. This program is laying the groundwork to ensure transparency and traceability for seafood products in the American marketplace, but this information is not yet accessible to consumers through any sort of labeling.

Dr. McKinney, based on your work as the Executive Director for the Harte Research Institute at Texas A&M, how can we expand upon this new monitoring program so that more Americans know where their fish is coming from and can enjoy wholesome, sustainable seafood from American waters?

Dr. MCKINNEY. Thank you for the question, Senator. I appreciate the opportunity to address it.

What we found, certainly, in the Gulf—and this is an important issue there about recognizing where our seafood comes from—and what we find, I think, is an informed consumer is a good one; the type that we are looking for. And anything you can give them of that information, they will make good decisions.

So certainly, any time we can provide information on the source of our seafood and its quality is going to be of benefit to some peo-

ple in the country, but also to our own commercial and recreational fisheries, but our commercial fisheries for sure.

Because, as Dr. Hilborn noted and other members did too, we have a very high standard of how we capture and manage those fisheries.

Senator MARKEY. Would you expand the Gulf Wild Program, which is a very successful program in the Gulf of Mexico?

Dr. MCKINNEY. Yes, sir. And I wish that I had some part of its origin, but I did not, but we certainly benefit from that, and that is exactly that type of program.

In that you see, it gives the opportunity for our citizens to identify seafood that is taken in the Gulf of Mexico, be it shrimp or whatever, and know that it was not farm-raised, but it is wild caught and have confidence in that, and then, it also supports the Gulf. And so from every aspect, it has been tremendously beneficial.

Senator MARKEY. Thank you.

May I ask one more question?

The CHAIRMAN. Sure.

Senator MARKEY. Thank you.

Fishery management councils understand the effects that climate change is having on their fisheries and are starting to include climate change considerations in their management plans.

Oceans are absorbing more than 90 percent of the excess heat trapped by greenhouse gas emissions. These rising temperatures change stock distribution, abundance, and catch.

For example, butterfish, which are caught off the coast of Massachusetts and the mid Atlantic region, are very temperature dependent and shift their distribution in response to changing bottom water temperatures.

By doing collaborative science with academics, fishermen, and regulators NOAA used water temperature data to set catch limits for butterfish in 2014.

Dr. Jones, how can increase the use of this sort of science that allows regulators to consider the impacts that climate change is having on our fish stocks?

Dr. JONES. Thank you for the question, Senator.

I think the most important thing to do is to begin by asking the question, framing the questions about management of a particular fishery or fish stock in terms of, if you will, hypotheses about how environmental change might alter your perspective on the productivity of that stock, or might alter, as a previous question alluded to, the distribution of the population.

If you ignore those factors, you are going to erroneously develop catch limits, or other management strategies, that are based on the state of those fisheries in the past, not the state of those fisheries in the future.

So I think there is a really important role for this sort of partnership between those of us, like myself and Dr. Hilborn, who do work on population dynamics and projecting fish dynamics into the future, and the scientists who have a better understanding of this sort of ecosystem processes that ultimately affect fish movement, and fish growth rates, and so on, and so forth.

I think that we could do a lot more using methods like the Management Strategy Evaluation modeling techniques that I referred to in my testimony to move the yardsticks on that a lot.

Senator MARKEY. Yes, I think that, obviously, the science is changing very rapidly in climate. I think probably the Arctic and the Gulf of Maine are the two fastest warming bodies of water on the planet.

So there are profound implications for the fishing stock because of that and because we are warming so rapidly in the Gulf of Maine that we just need the science to be there to help us to understand it.

So we thank you all for your wisdom.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you, Senator Markey.

We are going to wrap it up here in a minute, gentleman. Senator Peters has another follow-up. I have a few, if I can get them in. We have a vote that has already kicked in, so we might have to finish up a little bit early.

But again, thank you. Very, very informative testimony.

Senator PETERS. I will be brief because of the nature of this.

Dr. Jones, we have heard, I have already heard from all of you about the importance of science in using the best science. Currently, the Magnuson-Stevens Act requires that all of these decisions are based on best science.

But as has been alluded to by some of the other questioners, science is changing. There is emerging science and the guidelines under MSA ask that decisions use a standard encouraging both science from many sources, including both established and emerging science. Emerging science is emerging very rapidly.

What are some of the considerations that are important when we are using established science versus newer, emerging science?

Dr. Jones, a brief answer. I know it is a big question, but a brief answer would be helpful.

Dr. JONES. The brief answer would be it is hard.

A slightly less brief answer would be that it is all about the partnerships between the science that has very helpfully informed our management of fish stocks, both in the Great Lakes and in the oceans in the past with these emerging technologies.

An example that is very prominent in the Great Lakes right now is the acoustic telemetry network that we are establishing there called GLATOS, Great Lakes Acoustic Telemetry Observing System. There are similar infrastructures being put in place on the two coasts.

The potential for that science to improve our understanding of things like fish stock movements in ways that can make for better models to inform management in the future is really only constrained by being clever about how you think about the use of those technologies; to ask the right questions about fish dynamics and fish movement.

Senator PETERS. Great. Thank you.

The CHAIRMAN. I am going to ask one final question. I am going to combine two for Mr. Haflinger and Dr. McKinney.

One of the purposes of the hearing is looking at innovative programs, innovative technologies, and efficiencies. Both of you have

been involved with different programs. Dr. McKinney, the iSnapper application, which I think was something Senator Wicker was talking about; and Mr. Haflinger, the cooperative program that has been created in the Pacific Northwest, which you touched on during your opening statement.

Both of these look like they are innovative, that they have been helpful ways in which to better manage with regard to technology and data, and instill best management practices.

Can you just touch on these and maybe, if you think that there is a potential for broadening these kinds of innovations to other elements of the MSA? I would welcome your input or any of the other panelists on those kinds of innovations.

Dr. MCKINNEY. Thank you, Mr. Chairman.

I do appreciate the opportunity to comment on iSnapper. For full disclosure, it was my Institute that developed that originally as an app, but there are others very similar to it.

This gets back to your question, sir, about innovation and this type of thing. How can we make use of them?

We have been working with iSnapper for many years and actually testing it out in conjunction with Texas Parks and Wildlife comparing it to the type of normal type of surveys that they take in seeing how they match up, and the prospect is looking really good, that they will match up.

The way things move these days, we are always looking for these types of technologies. So anything we can do to get more information. Of course, it has to be as accurate as possible, because we are going to run it into the models and so forth that we use. So those things, I think, show great promise.

Not only can we get good information and timely information, we can get that information from these anglers and fishermen as soon as they catch the fish, basically, because they get into it. It is amazing how much they want to help once they get these apps and go with them. And the younger people nowadays, it is really good with them.

So they work wonderfully in that regard. Yes, sir.

The CHAIRMAN. Great. Thank you.

Mr. Haflinger.

Mr. HAFLINGER. Briefly, I think that the fisheries information that we make available to our stakeholders is done in such a way that I am sure there is no other private systems like this on the planet that are as advanced.

But we were able to do that really because we had the stakeholders who saw the need for it. And we had an agency that was willing to work with us to let us access the data that they were collecting from our stakeholders, so that we could turnaround and give them what they needed to do this.

So you need three things: you need the stakeholders who have some vision; you need an agency that is willing to work for you; and it is good to have a programmer like me around occasionally.

The CHAIRMAN. Good. That is a great way to wrap up this hearing.

Thank you again, gentlemen. I think the witnesses have all done an outstanding job.

The hearing record will remain open for two weeks. During this time, the Senators may submit additional questions for the record to all of you.

Upon receipt, we respectfully ask that the witnesses submit their written answers back to the Committee as soon as possible.

I, again, want to thank everybody for traveling here today and testifying; very, very helpful for all of us.

This hearing is now adjourned.

[Whereupon, at 3:50 p.m., the hearing was adjourned.]

A P P E N D I X

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. DAN SULLIVAN TO DR. RAY HILBORN

Question 1. Last month some researchers who purport to understand seafood sustainability published a paper concluding that up to 22 percent of Pollock caught in Alaska waters is caught illegally. Earlier this month, NOAA Fisheries called for the paper's full retraction because of the paper's flawed methodology and reliance on completely anonymous sources. As a scientist who has studied Alaska fisheries for decades, what do you make of this paper and its accusations?

Answer. I totally agree with NOAA and have investigated the methods used in detail. I along with 5 other well respected scientists have written the journal laying out a case that the paper is in fact fraudulent, not simply wrong, and suggest that this fraud meets the publishers standards for withdrawing of the paper. The key element in the fraud is the paper cites perhaps a dozen scientific papers as the source of information and none of these papers mentions IUU fishing, thus the authors try to make readers believe they have data on IUU from Alaskan fisheries when they have none, and the authors do not consider the enforcement system in Alaska in any way.

Question 2. During this current reauthorization process we've heard testimony from commercial fishing industry witnesses who indicated we are not achieving optimum yield, and in many instances we are actually under harvesting healthy stocks to protect minor ones. What is your perspective on these issues?

Answer. There is no question that this is true if the objective is to maximize yield. On average U.S. harvest rates are lower than would produce maximum biological yield. Now in some cases the "under harvesting" is due to markets, but in most cases is it precautionary management, either to protect smaller stocks that are at abundance below the target, or in cases like the 2 million ton cap in the Bering Sea, for a general form of "ecosystem" protection. We could certainly increase the yield from American fisheries. However, there are many interpretations of what "optimum yield" is and some of these that place considerable weight on maintaining high abundance of fish stocks can be considered a form of optimum yield.

Question 3. Some stakeholders engaged in the MSA reform process are calling for drastic management measures designed to curtail the harvest and use of forage fish species. What is your view on this from a natural resource management perspective?

Answer. There is a trade-off between the yield of forage fish, and the abundance of some of their predators in the ecosystem. The calls for drastically reducing forage fish harvest place great weight on the abundance or predators and have not looked in detail at the trade-offs. A recent paper by a large scientific team on the California Current showed there was very little impact of sardine and anchovy fishing on the predators of most concern, pelicans and sea lions. I have done analysis of the menhaden fishery in the Atlantic (this work as funded by the menhaden industry) and found very little impact.

My conclusion is that for each major forage fish fishery a study should be done of the trade-off between forage fish harvest and the abundance of their predators, and the decision making body should decide what trade-off they find most acceptable.

But environmental groups and decision makers must keep in mind that one of the benefits of forage fish harvest, is reduced reliance on crops and livestock, and it is very clear that the environmental costs of using forage fish as feed for aquaculture is much less than the environmental costs of growing additional crops, which comes primarily from destroying tropical rainforests.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. BILL NELSON TO
DR. RAY HILBORN

Question 1. Limitations to Stock Assessments: Can you outline some of the major barriers to conducting more frequent stock assessments that you see and your suggestions on how to address those concerns?

Answer. The major barrier is human resources—people trained in stock assessment. The key to this is increasing the pipeline of such training, and making the jobs within NOAA and other agencies less stressful to retain qualified staff. The NOAA/Seagrant program funding stock assessment training has been very successful at producing stock assessment scientists for NOAA but its scale is quite limited. A major expansion of this program would be the most significant step I can imagine.

Question 2. Do you have suggestions on how NOAA should prioritize allocating limited funding?

Answer. I suggest a triage system: We need to manage and assess our most important stocks, and importance can be measured by economic value, recreational value and conservation concern for ESA listed species. In all of our oceans we have hundreds of species, most of which make little contribution to benefits to the Nation and given limited resources, we are now, and must continue to largely ignore these species in our marine management. The inevitable consequence is that some will be overfished, but this will not have a major impact on the benefits the Nation receives from our oceans.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARIA CANTWELL TO
DR. RAY HILBORN

Question 1. Dr. Hilborn, I understand the University of Washington has a long standing research program studying Pacific salmon in Bristol Bay, Alaska. Bristol Bay is home to the most productive wild Pacific salmon fishery on earth. Bristol Bay salmon support 20,000 jobs in commercial and recreational fisheries, as well as support businesses like shipbuilders and restaurants. Despite the tremendous value of salmon fisheries in Bristol Bay, Administrator Pruitt is taking steps to undo commonsense Clean Water Act protections that were put in place to protect salmon from the proposed Pebble Mine.

Do you believe there is a way to move forward with the Pebble Mine without the risk of pollution, salmon die offs, and loss of fishing jobs?

Answer. Certainly there is no way to establish a large mine in the Bristol Bay watershed with the risk of all of those things happening. Although no specific proposals have been tabled, the idea that highly toxic waste can be stored forever without leaking is impossible—forever is a very long time.

Question 2. Dr. Hilborn, on October 23, numerous EPA scientists were prevented from presenting their research at an estuary conference in Rhode Island. Additionally, a CNN report two weeks ago found that EPA Administrator Scott Pruitt had not been briefed by scientists when he called for the removal of clean water protections in Bristol Bay. Instead, Administrator Pruitt made his decision based on a closed-door meeting with the CEO of a foreign mining company called the Pebble Limited Partnership, or the Pebble Mine. Putting a Canadian mine ahead of American fishing jobs and sound science is putting "America Second" not "America First" as our President has promised.

Dr. Hilborn, as a scientist, are you concerned about reports that Federal scientists are not being allowed to do their jobs?

Answer. Certainly this is a very serious concern.

Question 3. What can we do to protect the role of science in Federal agencies?

Answer. This is probably more a question for a lawyer than a scientist. We could have a "scientist freedom of information act that says that government scientists may be allowed to express their scientific opinion without censorship by their superiors.

Recently, the GAO released a study that found that climate change will cost American taxpayers more than a trillion dollars by 2039. The report reviewed Federal costs in response to extreme weather, decreased agricultural yields, and damage to public utilities and infrastructure. The report also identified the loss of habitat, fish and shellfish as a cost to taxpayers due to climate change. Oceans are on track to be 300 percent more corrosive by the end of this century. Numerous studies show that ocean acidification is likely to impact species such as Dungeness crab, salmon, and other species. This is a jobs issue. Washington state's maritime economy is worth 30 billion dollars, sixty percent of which is tied to the seafood industry.

Question 4. Dr. Hilborn, what is the state of the science on ocean acidification and its impact to seafood? While there is some research being done—is it enough to understand population level impacts?

Answer. With respect to prediction of ocean acidification I believe the science is very certain—the chemistry is quite simple. With respect to its impact on seafood things are almost totally unknown. We do know some specific examples of what has happened (shellfish in Washington) but we don't really know how resilient various taxa are to acidification.

Question 5. I introduced a bill with my colleague Senator Wicker that in part would address this issue. Our bill would require NOAA to determine which fisheries are most at risk from ocean acidification and direct NOAA to make targeted investments in research and monitoring for those at-risk fisheries. Would you support that approach?

Answer. Yes

Question 6. What more do we need to do to tackle this looming threat for our fishing industry?

Answer. Obviously reducing carbon emissions is #1. There is absolutely no scientific uncertainty about this. Other than that there is little we can do to change what will happen to the marine ecosystem, but we could have serious reconsideration of how we structure our fishing industry to be more adaptive to whatever changes may occur. For instance if it turns out that pollock are very badly affected by acidification, but some other species pops up to take their place in the food chain, should we transfer harvest rights from pollock to the new species?

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. GARY PETERS TO DR. RAY HILBORN

Question 1. Fisheries Management Priorities: In your testimony, you mentioned a need for Congress to decide the relative importance of various objectives for fisheries management.

What types of objectives do you envision Congress prioritizing? And what types of science and subsequently what types of management decisions would be necessary to make if those objectives were made into priorities?

Answer. For our commercial fisheries the overall structure works very well to achieve the current objective which is to stop overfishing. However, if we wanted to maximize jobs, profit or food production we would have quite different scientific advice. Any mixture of those three objectives would almost certainly lead to policies that would allow some stocks in our mixed stock fisheries to remain in what is classified as an overfished state. Small fish stocks that have low overall productivity would be below the levels that would maximize their production. The little lost yield from those stocks would be more than compensated by increasing the yield of stocks that are currently not fully exploited.

If Congress were to give guidance to the management councils on how to balance those objectives the science and management system would be able to respond and increase the production of jobs, food and profit. I suggest that Congress mandate an annual report to Congress on the potential for jobs, food and profit, and a score of how we are doing compared to the potential that we have from our marine resources.

Question 2. Changing Environmental Conditions: In your written testimony, you list several threats to U.S. fish stocks including climate change, degraded habitat, invasive species, and pollution.

In your opinion, what factors should management be considering and in what way should those factors be incorporated into fisheries management?

Answer. The major problem is that NOAA and the councils have almost no control over those factors. The major habitat and pollution concerns are outside their control, and climate change and invasive species are largely outside anyone's control. So essentially I don't see that our management system as it is now constructed can respond. The first step would be close integration of terrestrial and coastal zone management of habitat and land based pollution, with the fisheries management system.

Question 3. Bycatch: What could be done to resolve the issue of bycatch?

Answer. In the places I know best these issues are largely under control. The regulations put in place have led to some dramatic reductions in by-catch by the industry, often on their own initiative in responding to by-catch limits. By-catch avoidance is almost always a technical problem, and new technologies in gear design have made some impressive advances and will likely continue to do so. I would see

that within a decade or two, most trawl nets, for instance, would have cameras attached with real time detection of species and size that would allow ejection of non-targeted fish from the net.

At present there is little funding for this work, and government, university and industry partnerships could advance this rapidly.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. DAN SULLIVAN TO DR. LARRY MCKINNEY

Question 1. You discuss in your testimony that the conservation framework in MSA provides challenges for recreational fishing, but works well for the commercial industry. How do we balance the significant conservation gains achieved during the last reauthorization while allowing for responsible access to a fishery for multiple user groups?

Answer. What we now know as the Magnuson-Stevens Fishery Conservation and Management Act (MSA) had its origins in the1976 form, the Fishery Conservation and Management Act, drafted by Senator Warren Magnuson. It most notably established the 200-mile exclusive economic zone, eliminating the overfishing threats of foreign fleets and regularizing fisheries management and regulation through the establishment of eight regional management councils. The Magnuson-Stevens Fishery Conservation and Management Act of 1996 and reauthorization of 2006, secured the economic health and sustainability of our Nation's commercial fisheries.

I believe the history congressional actions regarding the MSA is a wonderful example of how the reauthorization process should work and I am confident that it will continue to work in such a manner. I would hope that Congress does nothing that would diminish the conservation gains achieved during the last reauthorization, nor anything that allow responsible access to the fishery for multiple user groups. I do think that it is necessary to address issues related to recreational fisheries. We developed the recommendations of the Morris-Deal Commission 2014 report, *A Vision for Managing America's Saltwater Recreational Fisheries,* with just that concern, in mind. The recommendations, if adopted, will most certainly expand access while providing significantly more economic benefits and jobs and will do so without harm to what has been gained through previous iterations of the MSA.

This reauthorization of Magnuson-Stevens must focus on recreational fisheries, the single largest component of our nations fisheries not yet addressed by our most important Federal fisheries management legislation. Securing the economic health and sustainability of the largest and most economically significant of all our fisheries sectors is achievable, if it provides for and encourages application of long established and successful science-based tools well known to fisheries managers and scientists. I would provide the following as an example of how Morris-Deal recommendations maintains that balance between conservation and access.

Magnuson-Stevens, in its current form, makes it almost impossible for Federal resource managers to use the very effective and well-established science-based tools that state fisheries managers have developed and successfully used to restore species like Red Drum and Spotted Seatrout, taking those species from overfished to economic powerhouses generating billions of dollars in economic benefit and thousands of jobs.

Restoration of these species and the economic benefits that were sustained during those recoveries would not be possible under the existing Magnuson-Stevens legislation. The MSA requires stock rebuilding within very specific timelines, regardless of circumstances, either science-or economic-based. In its 2014 report—Evaluating the Effectiveness of Fish Stock Rebuilding Plans in the United States—the National Research Council found rebuilding plans based on monitoring and controlling fishing levels, rather than on requiring that fish populations recover to a pre-specified target size within a certain time-frame would be less disruptive to the fisheries and less subject to uncertainty. This was just one of many recommendations that would greatly benefit recreational fisheries management, if the MSA allowed for it.

That Magnuson-Stevens must be modernized is illustrated by the current state of the red snapper fishery management in the Gulf of Mexico. While that iconic species has been the headline, similar management issues regarding Grey Triggerfish and Amberjack are no less problematic. That Federal managers have neither the tools, nor the basic information, to work effectively with state partners and provisions of the MSA are an often-cited impediment.

The angling public sees the failure every day they are on the water when they cannot get past swarming red snapper to catch other species, which they must because that season is closed most of the year. Charter captains cannot effectively

manage their business when the amberjack season closes by e-mail notification, on a seemingly random day with very little notice.

The solution is not rocket science; it is not even difficult fisheries science. We currently have the tools and knowledge to improve management for these species but are constrained by a Federal fisheries management act that was developed for commercial fisheries based on biomass extraction and not with a goal of providing access—what recreational fisheries need. This, of course, does not mean that for commercial species biomass extraction is not appropriate. Changes to the MSA to address this recreational issue would simply make it clear that a broader range of goals exists beyond biomass extraction and they are of equal value to the Nation.

Question 2. One of the greatest challenges facing recreational fishermen is inconsistent data and stock monitoring. How do we improve the real time stock data to ensure we have as good a picture as possible of the available fishery?

Answer. This question directly addresses a fundamental issue for successful management of recreational fisheries under Federal management. It is probably not a coincidence that the regions facing the most controversial fisheries management (*e.g.,* the Gulf and South Atlantic Regions) are also characterized by having the fewest and most infrequent stock assessments. The differences among production of the regions in terms of stock assessment is quite striking. The Fish Assessment Report—FY 2017 Quarter 1 Update, is instructive in this regard. The Southeastern Fisheries Science Centers do lag significantly behind other centers in almost every regard as to completing assessments. I make no judgement as to why. Every region is different and faces differing constraints. I do think it worthy of close review by NOAA leadership.

More frequent stock assessments, prioritized for high value species, is a critical need. An example being the iconic Red Snapper, but many others as well. The key is having timely and robust data. For Red Snapper, where the season has become progressively shorter to just a few days (3 days in 2017), our traditional data collection mechanisms, particularly in the recreational fishery, break down and become ineffective. There is wide consensus that the data collection program (*i.e.,* MRIP—Marine Recreational Information Program and its predecessor program) is not adequate to meet manager's need. Please refer to citations of National Research Council reports referred to in my written testimony before the Committee on this issue. Their finding makes this same point and that has not been lost on NOAA and NMFS, who are taking actions to address these issues but progress is slow. I know there is a desire for more rapid progress but budget and staffing issues are a real constraint. Regardless, it is clear our current approach is not as robust as needed to deliver the most pertinent management advice. Managers find themselves constantly lacking timely and accurate data and this is greatly hindering effective management.

There are solutions. Implementing these changes have been too slow, despite thoughtful guidance from the Councils in terms of approved amendments to the Secretary of Commerce and stakeholder desire (in most sectors) to change the management paradigm. One solution that could rapidly move toward reality is electronic real or near-real time data collection in the recreational sectors. The technology exists, such as iSnapper. As a point of full disclosure, iSnapper is an app developed by my institute's Center for Sportfish Science and Conservation. It would take a relatively short time to implement it, and similar technologies. Acting on these amendments and working toward more improved data collection methodologies are underway; however, the process is painfully slow with Federal bureaucracy a significant impediment. Because of those delays, I am concerned that we will see no real progress, for the next few years at least.

Finally, the lack of robust abundance data (in addition to harvest or catch rate) is driving much of the uncertainty. What anglers see on the water is simply not reconciling with assessments. This has led to a lack of confidence and distrust of the process when anglers see the ocean teaming with red snapper to the point they can catch nothing else, yet have to deal with the reduction of a six-month season down to three days. Anglers can accept such management actions when they trust the process. Within the states, there are many examples where they have done just that. I provided some in my previous written testimony. I cannot provide such examples as readily for Federal fisheries and must make changing that a priority.

Progress toward better abundance data is under way (*http://www.noaa.gov/media-release/scientific-team-selected-to-conduct-independent-abundance-estimate-of-red-snapper-in*). In an unprecedented study funded by Congress and implemented through NOAA Sea Grant College Program, a 2-yr study is now underway to generate an estimate of absolute abundance of Red Snapper in the Gulf of Mexico. We have currently been managing using indices of abundance, and having a true abundance estimate will not only inform management, but most importantly will open

up new opportunities to implement more effective management strategies. This would be the value of programs like iSnapper that can generate data quickly and involve anglers in a positive way.

One such strategy for private recreational anglers is moving toward a harvest rate management, and away from an Annual Catch Limit-based strategy (ACL) that is largely appropriate for allocation-based commercial fisheries, not recreational. An ACL system clearly does not work for access-based recreational fisheries. A management approach that targets a particular harvest rate (or mortality rate management) is much more appropriate and provides the access that recreational anglers need to promote the health and tremendous economic drivers these fisheries represent. It does take a robust and timely assessment process. We must make that a priority to make use of these more appropriate management tools. There is a history of conservation success across many management challenges using this approach. Joint Federal and state waterfowl management being the most prominent example.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. BILL NELSON TO DR. LARRY MCKINNEY

Question 1. Can you describe some successful strategies you've witnessed for engaging with the recreational angling community in order to build that trust and goodwill that you reference in your testimony in the case of Red Drum in Texas?

Answer. Building trust and a positive relationship with the recreational angling community is a sustained process towards which resources, staff and funding, must be allocated. It does start by focusing on sustaining an accessible and abundant resource. Because of reasonable harvest rate-based management, science-based conservation strategies, and angler support of management, Texas is blessed with robust fisheries that afford virtually unlimited access to that resource. Interestingly, under these liberal accessibility regimes, fisheries populations in Texas are at some of the highest abundance ever. As I noted in my written testimony, saltwater anglers may even come to turn down the possibility of increased bag limits. Anglers certainly benefit from this type of management, as do the environment and coastal economies. This desirable state of the fishery did not occur by accident.

While I was head of Coastal Fisheries at Texas Parks and Wildlife Department (TPWD) we established dedicated positions at key areas along the coast whose job was to be a liaison with the fisheries community, both commercial and recreational. Their primary focus was the latter because of the numbers of anglers and their economic impact to coastal Texas. These liaisons had many responsibilities. They held how-to clinics that always included conservation and management messaging. They always responded to any inquiry and were a ready source to explain new fishing techniques and new rules and regulations, with equal facility. They represented TPWD in community events so were a common and expected part of the community. Because they are part of a large and diverse agency they could call on expertise and assistance from game wardens, angler and boating education, wildlife experts, etc. They provide a direct conduit from anglers to management and the reverse.

One important annual activity for TPWD that has been key in building trust and goodwill is the annual regulatory process. Each Spring Coastal Fisheries Biologists meet to review the status of fish stocks and the fishery in general. Any biologist may propose new rules or revisions of existing rules, like size and bag limits, even new activities or programs. It is an intense, peer review-type process and it can be rough on egos. Once agreed upon these new proposals go through a statewide process of regional meetings for public input. The public may also propose new rules or changes in existing rules. Each August anyone may come before the Texas Parks and Wildlife Commission, the nine-member decision-making body appointed by the Governor, and comment on or make direct appeal to the Commission. Once through that process final rules are proposed by agency staff and are subject to one last round of public review and input before the Commission, in a formal multi-step process. Final action is taken at the Commission's spring meeting. No one can reasonably complain they did not have a chance to be heard at every level of decision-making.

Building trust and goodwill does not mean acquiescing to every public or angler demand. It is, in fact, just the opposite. TPWD's Coastal Fisheries Division dedicates significant resources to a robust data collection program. The potential impact of all regulatory proposals is evaluated against the data produced by the program. It is one of longest continual fisheries data collection programs still active. I summarized it in my written testimony:

This program covered four million acres of Texas bays and out to nine nautical miles offshore, with joint Federal management out to two hundred nautical miles. There are currently 900,000 recreational anglers and 1,700 commercial fishers in Texas. TPWD annually conducts 1,064 survey-days and interviews approximately 19,000 trips, of which about 12,000 are recreational in nature. Each year over 780 gill net sets, 1,680 bay trawls, 1,200 oyster dredges, 2,160 bag seines, 1,680 bay trawls and 960 Gulf trawls were used to gather the fisheries data. The forty-two years of continuous data collection is the longest record of its kind in the world. [these numbers are updated since written testimony, thanks to input from TPWD]

All regulatory changes proposed by the Division are evaluated and modeled using the data from this monitoring program to predict impacts on fish stocks, etc. It includes both fisheries independent and fisheries dependent data. Because the monitoring program and resulting data are so robust, predictive modeling has proven to be very reliable. This has fostered credibility with the public and decision-makers, alike.

It is the foundation of the regulatory process. Because it is a transparent process with the data widely and readily available, both the Commission and angling public have come to have confidence in predictions about impacts of proposed regulations. They may disagree with specific actions but because of the transparency of the process, they are more likely to accept the result, or if not, work in a cooperative fashion to revise those options. This detailed summary is important in fully understanding the two specific examples that follow.

Example One—Changing hearts and minds with data and hard facts. Yes, it is possible.

The TPWD biologist charged with management of the lower Texas coast presented data and analysis during the 2005 review process that spotted seatrout were moving towards an overfished status with both quality and numbers declining. His solution was to reduce bag limits in that region from ten fish daily to five. TPWD had never approved anything but statewide regulations and this would be the first regional regulation proposal—where the middle and upper coast would retain the ten-bag limit and lower coast a five-bag limit. The evidence was compelling and I agreed to send the proposal forward into the regulatory process I previously described. The proposal was strongly opposed by many anglers, including guide organizations and especially the Recreational Fishing Alliance (RFA). Others, like the Coastal Conservation Association (CCA) were supportive. The annual regulatory process was bitter. Political and personal threats abounded. TPWD biologists consistently presented the rationale for the proposal at every opportunity in the process. At the final decision-making meeting before the Commission, the state director of RFA stood before the Commission and stated that they were withdrawing their opposition because the TPWD biologist's arguments were compelling and they had nothing to counter them. Many guide organizations continued opposition. Regardless, the proposal was unanimously approved by the Commission. The modeled predictions proved to be accurate within the three years of predicted recovery.

The fishery has rebounded to once again produce an abundant and trophy quality fishery. In 2014 the five-fish bag limit was extended northward to encompass the entire middle coast because of the same compelling reasons and with little opposition. It was broadly supported, especially from guide organizations, many which were most bitter in their original opposition.

When you engage rather that dictate to recreational anglers, when you are transparent in process and open in information, recreational anglers will join you, putting conservation above maximizing fish extraction, every time.

Example Two—Why recreational anglers paid shrimpers and were happy to do it.

In my written testimony, I referred to a shrimp license buy-back program:

The program also allowed for the successful implementation of a [voluntary] commercial fishing license buy-back program. Through the 2014 license year, $14.2 million was spent to purchase and retire 2,145 commercial Bay and/or Bait Shrimp Boat licenses. This represents 66 percent of the original 3,231 licenses grandfathered into the fishery in 1995. Additionally, $1.8 million has been spent purchasing 63 Commercial Crab Fisherman's licenses and 241 Commercial Finfish Fisherman's licenses, retiring 22 percent and 44 percent of the licenses respectively.

The successful implementation of this program was possible only because of the support and trust of Texas recreational anglers. TPWD started the Shrimp License

Buy-back Program because the inshore shrimping industry was successful lobbying the Texas Legislature in limiting the TPWD Commission's ability to directly address that industry's debilitating impacts on recreational fishing within Texas bays and estuaries. Industry bycatch ranged from four to more than ten pounds of bycatch per pound of shrimp trawled from the bottom. That bycatch included the young of recreationally important species of red drum, spotted seatrout, flounder, etc. Trawling routinely also disturbed bay bottom habitat and the clams, worms and other benthic, or bottom dwelling organism, that is a basic food web within Texas bays.

Ecosystem impacts aside, the economic consequences of bay shrimping to the recreational fishery were severe. The simple arithmetic of comparing the economic impact of the inshore shrimp industry to the significantly more valuable recreational fishery was revealing and obvious. The inshore shrimp fishery was also detrimental to the larger and more sustainable offshore shrimping industry, so it was decided to propose a program to buy back inshore licenses to the point that the fishery could operate a much less impactful, yet for the fishery, a more sustainable level. A scenario, if properly executed would be a winner for all parties. The aspect of the program summarized above that is responsive to question about building trust and good will, is related to funding of the buy-back program.

For the program to be successful, the Texas legislature would have to act to limit the purchase of new shrimping licenses. You cannot have a successful buy-back program, if new licenses could be purchased. That political process was successful because of the agencies credibility with the Texas Legislature and support of Texas anglers. This was possible because of the history of a transparent regulatory process where all stakeholders felt they were heard and their views considered. Coastal Fisheries staff could work with all parties, commercial and recreational; to craft a buy-back process because all parties agreed the data and analysis were credible. This allowed a focus on solutions rather than a debate about science and data. This unified front was appreciated by the Legislature, providing much needed political support and a successful result in creating a limited access shrimp fishery.

It became obvious that the buy-back program after being underway for nearly two years, was working but was not adequately funded to meet either program goals or the demand by willing shrimpers to sell their license. The only viable option to generate the large sums of money needed to fuel the buy-back program at an accelerated pace was to ask our recreational anglers to pay for it. A seemingly counter-intuitive proposition, it was clearly the only path possible. Coastal Fisheries staff assembled the data, prepared analysis and developed the case to present to the Texas Parks and Wildlife Commission (TPWD's decision-making body) and Texas saltwater anglers. Full use of the regulatory process described earlier, along with special workshops, helped inform and win over stakeholders.

Many conservation organizations, led by the CCA, were joined by commercial organizations like the Texas Shrimp Association, in support of the proposal. A rare occasion of common cause. The result was that recreational anglers agreed to tax themselves an additional $3 per year to add to the existing $7 annual saltwater fishing stamp, if the addition was dedicated to the buyback program. They agreed because compelling evidence was presented and options were offered that included sunset review provisions and annual progress reporting.

The buy-back funding newly invigorated with funding from recreational anglers and supplemented by many and significant private donations, met all goals and expectations. The program was subject to sunset review and subsequently approved to continue two times while I was Costal Fisheries Director and continues to this day. It has expanded to the crab and finfish commercial fisheries, routinely reducing commercial fishing impacts to the benefit of coastal ecosystems, coastal economies and saltwater anglers.

Question 2. Can you outline some of the major barriers to conducting more frequent stock assessments that you see and your suggestions on how to address those concerns?

Answer. It is probably not a coincidence that the regions facing the most controversial fisheries management (*e.g.,* the Gulf and South Atlantic Regions) are also characterized by having the fewest and most infrequent stock assessments. The differences among production of the regions in terms of stock assessment is quite striking. *The Fish Assessment Report—FY 2017 Quarter 1 Update,* is instructive in this regard. The Southeastern Fisheries Science Centers do lag significantly behind other centers in almost every regard as to completing assessments. I make no judgement as to why. Every region is different and faces differing constraints. I do think it worthy of close review by NOAA leadership.

The lack of up-to-date information is greatly hindering decision makers in the regions noted. These issues of infrequent and too few assessments are not new to management nor to the leadership in the Federal science centers that are respon-

sible for producing them, but the problems persist and remain unresolved. The principal argument offered now is that Science Centers cannot retain enough qualified staff to carry out timely assessments and the stock assessments with which they are charged, are exceptionally difficult.

There have been vocal and repeated recommendations to subcontract the workload to qualified groups. While the councils have encouraged delegations, it has occurred only on a very limited basis, and there appears to reluctance by the agency to pursue this most obvious of solutions, for unexplained reasons.

In terms of complexities, one need to look no further than the Red Snapper assessment for the Gulf of Mexico. Most agree this assessment is the most complex document of its type for any federally managed species. There are many contributing factors that make this document overly cumbersome. It is over-parameterized (too many uncertain variables), making it insensitive for achieving its purpose of predicting outcomes. This forces managers to make decisions based on poor management advice. As such, assessments are not reflective of the actual population status nor responsive to regulatory changes. Thus, it is not surprising red snapper is seen by many as one of the most mismanaged of all Federal fisheries. Should the assessment workload and production situation be addressed, pressing problem like this might be solved.

While I directed fisheries management in Texas I initiated efforts to move from species management to ecosystem based approaches. Freshwater inflows to estuaries being a key issue and I had studied this resource extensively over the years. The situation with stock assessment and management of red snapper reminds me of a statement by Texas Supreme Court Judge, Will Wilson, in 1955, when describing the management of groundwater.

> *Because the existence, origin, movement and course of [groundwater] and the causes which govern and direct their movements, are so secret, occult and concealed that an attempt to administer and set any legal rules in respect to them would be involved in hopeless uncertainty, and would therefore be practically impossible.*

Texas groundwater remains today as big a mess as the management of red snapper. The secret, occult and concealed nature of red snapper stock assessment has led many constituents to lose confidence in the entire stock assessment and management process. This is particularly the case when the differences between the assessment and what is observed on the water by anglers are quite striking. It is baffling to these anglers as to why they are forced to a three day, derby-like season when for remaining 362 days a year they cannot get a bait or lure past the legions of red snapper between them and all other saltwater fish, that are legal to catch and retain.

My recommendations to address this issue would be:

- First, subcontract much of this work as rapidly as possible.
- Second, have independent experts evaluate the stock assessment process to determine why the production is so low.
- Third, I would recommend an evaluation by appropriate experts as to why the agency cannot attract enough qualified scientists or retain those currently in these positions and help develop strategies to remedy any problems.

I am particularly, sensitive the last issue about a shortage of trained biologists. In this, universities like my own share some responsibility. I chair an organization, the Gulf of Mexico University Research Collaborative (GOMURC). All the major Gulf universities with a fisheries interests is a member. A key concern for GOMURC is the declining number of students with this capability. We are actively exploring ways to work together to correct the problem. I am sure that GOMURC would work closely with both state and Federal fisheries managers in finding a solution.

Question 3. Do you have suggestions on how NOAA should prioritize allocating limited funding?

Answer. A key strategy to prioritizing limited funding would be to subcontract some of the scientific workload such as stock assessments and research. There are many programs within NOAA that have made great strides in this, such as the MARFIN, Saltonstall-Kennedy, and particularly the Cooperative Research Program. These programs have generated independent science of great use to the management process, fostering significant advances in managing our fisheries. These programs should remain at the top of the list for funding.

NOAA should prioritize data collection. Many of the issue that persist are a result of uncertainly in the data that could be improved by having better and much more responsive recreational fisheries data.

Funding work that reduces discard mortality (*e.g.,* NOAA BREP program) help anglers and commercial fisher become better stewards of the resource at the ground level and increase season length as mortality rates are reduced.

Better funding of Federal law enforcement and cooperative agreements with state counterparts could significantly reduce illegal take by Mexican fishermen, accelerating recovery and providing more management options. The amount of illegal and unreported catch by these fleets, particularly in South Texas, is astonishing and largely uncontrollable at the current level of significant illegal activity and minimal enforcement resources. An average of 32 illegal vessels are seized per year that retain over 700,000 lbs. of red snapper. Many other species are seized, as well. The U.S. Coast Guard estimates some 1,006 of these vessels go undetected and uncaptured. Interestingly, these major removals of biomass are "not detectable" in the current assessment, further questioning the reliability of Federal data.

Additionally, some of the funding for the Gulf-region could be directed toward the states, and this is particularly important for the controversial red snapper fishery. Regional management could a make significant and positive contribution. Gulf states are willing and have both the expertise and a positive track record, demonstrating their ability to take on such a challenge.

A recent and welcome action by Congress will significantly improve stock assessments of red snapper. The announcement was made after my oral and written testimony before the Committee on October 24, 2017, so I could not make note of it at that time but it is the most significant and positive development in the recent history of red snapper management.

In 2016, Congress directed the National Sea Grant College Program and NOAA Fisheries to fund independent red snapper data collections, surveys and assessments, including the use of tagging and advanced sampling technologies. Sea Grant and NOAA Fisheries worked collaboratively to transfer Federal funds to Mississippi-Alabama Sea Grant to administer the competitive research grant process and manage this independent abundance estimate. On November 17, 2017 That Sea Grant office announced that a team of university and government scientists, selected by an expert review panel convened by the Mississippi-Alabama Sea Grant Consortium, will conduct an independent study to estimate the number of red snapper in the U.S. waters of the Gulf of Mexico.

The research team, made up of 21 scientists from 12 institutions of higher learning, a state agency and a Federal agency, was awarded $9.5 million in Federal funds for the project through a competitive research grant process. With matching funds from the universities, the project will total $12 million. The project team will determine abundance and distribution of red snapper on artificial, natural and unknown bottom habitat across the northern Gulf of Mexico.

The project is led by Dr. Greg Stunz, Endowed Chair for Fisheries and Ocean Health at the Harte Research Institute for Gulf of Mexico Studies, Texas A&M University—Corpus Christi. Dr. Stunz also directs HRI's Center for Sportfish Science and Conservation.

Scientists on the team include:

- Greg Stunz, Harte Research Institute for Gulf of Mexico Studies, Texas A&M University—Corpus Christi
- Will Patterson, University of Florida
- Sean P. Powers, University of South Alabama, Dauphin Island Sea Lab
- James Cowan, Louisiana State University
- Jay R. Rooker, Texas A&M University at Galveston
- Robert Ahrens, University of Florida, Fisheries and Aquatic Sciences
- Kevin Boswell, Florida International University
- Matthew Campbell, NOAA Fisheries (non-compensated collaborator)
- Matthew Catalano, Auburn University
- Marcus Drymon, Mississippi State University
- Brett Falterman, Louisiana Department of Wildlife and Fisheries
- John Hoenig, College of William and Mary, Virginia Institute of Marine Science
- Matthew Lauretta, NOAA Fisheries (non-compensated collaborator)
- Robert Leaf, University of Southern Mississippi
- Vincent Lecours, University of Florida
- Steven Murawski, University of South Florida

- David Portnoy, Texas A&M University-Corpus Christi
- Eric Saillant, University of Southern Mississippi
- Lynne S. Stokes, Southern Methodist University
- John Walter, NOAA Fisheries (non-compensated collaborator)
- David Wells, Texas A&M University at Galveston

As noted by Dr. Stunz in the press release announcing the study

> "We've assembled some of the best red snapper scientists around for this study," said Greg Stunz, the project leader and a professor at the Harte Research Institute for Gulf of Mexico Studies at Texas A&M University—Corpus Christi. "The team members assembled through this process are ready to address this challenging research question. There are lots of constituents who want an independent abundance estimate that will be anxiously awaiting our findings."

Recreational anglers and commercial fishers will be invited to play a key role in collecting data by tagging fish, reporting tags and working directly with scientists onboard their vessels.

"The local knowledge fishermen bring to this process is very valuable and meaningfully informs our study," Stunz said.

Some stakeholder groups have expressed concerns that there are more red snapper in the Gulf than currently accounted for in the stock assessment. The team of scientists on this project will spend two years studying the issue.

In addition to excerpts above, I included both the link and the actual press release in my response to questions. The release came almost two months after the issuance of the award letter; it was released on a Friday, November 17, 2017; and, on submission of this response to questions has not appeared on any NOAA website, other than that of Mississippi-Alabama Sea Grant, that I can discover. I thought it might be of interest to the Committee.

The full press release is included as an attachment and may be found online at: *http://masgc.org/news/article/scientific-team-selected-to-conduct-independent-abundance-estimate-of-red-s*

Scientific team selected to conduct independent abundance estimate of red snapper in Gulf of Mexico

A team of university and government scientists, selected by an expert review panel convened by the Mississippi-Alabama Sea Grant Consortium, will conduct an independent study to estimate the number of red snapper in the U.S. waters of the Gulf of Mexico.

"American communities across the Gulf of Mexico depend on their access to, as well as the long term sustainability of, red snapper," said Secretary of Commerce Wilbur Ross. "I look forward to the insights this project will provide as we study and manage this valuable resource."

The research team, made up of 21 scientists from 12 institutions of higher learning, a state agency and a Federal agency, was awarded $9.5 million in Federal funds for the project through a competitive research grant process. With matching funds from the universities, the project will total $12 million.

"We've assembled some of the best red snapper scientists around for this study," said Greg Stunz, the project leader and a professor at the Harte Research Institute for Gulf of Mexico Studies at Texas A&M University—Corpus Christi. "The team members assembled through this process are ready to address this challenging research question. There are lots of constituents who want an independent abundance estimate that will be anxiously awaiting our findings."

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In 2016, Congress directed the National Sea Grant College Program and NOAA Fisheries to fund independent red snapper data collections, surveys and assessments, including the use of tagging and advanced sampling technologies. Sea Grant and NOAA Fisheries worked collaboratively to transfer Federal funds to *Mississippi-Alabama Sea Grant* to administer the competitive research grant process and manage this independent abundance estimate.

"Today's announcement is welcome news for all red snapper anglers in the Gulf of Mexico," said Sen. Richard Shelby of Alabama. "As Chairman of the U.S. Senate

Appropriations Subcommittee on Commerce, Justice, Science, and Related Agencies, I was proud to author and secure Federal funding to address the need for better data, which is a fundamental issue plaguing the fishery. The management of red snapper must be grounded in sound science if we want to provide fair access and more days on the water for our anglers. It is my hope that these independent scientists will be able to accurately determine the abundance of red snapper in the Gulf of Mexico once and for all."

"This research will be driven largely by university-based scientists with partners from state and Federal agencies." Stunz said. "This funding will allow us to do an abundance estimate using multiple sampling methods with a focus on advanced technologies and tagging for various habitat types."

"I'm pleased to see that the independent estimate is moving forward and including the expertise of recreational fishermen," said Rep. John Culberson of Texas. "I will continue to work with Texas fishermen and NOAA to address the inadequate access to red snapper."

The project team will determine abundance and distribution of red snapper on artificial, natural and unknown bottom habitat across the northern Gulf of Mexico.

Scientists on the team include:

- Greg Stunz, Harte Research Institute for Gulf of Mexico Studies, Texas A&M University—Corpus Christi
- Will Patterson, University of Florida
- Sean P. Powers, University of South Alabama, Dauphin Island Sea Lab
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- Lynne S. Stokes, Southern Methodist University
- John Walter, NOAA Fisheries (non-compensated collaborator)
- David Wells, Texas A&M University at Galveston

Response to Written Questions Submitted by Hon. Gary Peters to Dr. Larry McKinney

Question 1. Dr. McKinney, at the hearing, you were asked about legislative efforts to actualize the Morris-Deal Report. One area of the Report that may warrant additional attention from Congress is improved management of forage fish fisheries that occur under the jurisdiction of the Magnuson-Stevens Act (*i.e.,* in Federal waters).

How do abundant forage fish populations contribute to healthy fisheries, both recreational or otherwise?

Answer. Forage fish are lower trophic level species that at some life stage and most often at all life stages, is a significant food source for other fish, marine mammals and birds. Forage species are of importance to ecosystem function because they transfer energy through the system from lower trophic levels to higher levels. Forage fish most often feed near the base of the food web, often they are filter feeders, like menhaden. Other common and well-known forage species include sardines, shad and anchovies. When environmental conditions are favorable, they can be prolific spawners, reproducing quickly in huge numbers and rapidly growing to sexual maturity. Under such conditions, they may gather in very large schools, hence the attraction to predatory fish as an abundant and easily located food source.

Forage fish are valuable, both in ecosystem function and as a food source for highly valued sportfish. The very traits that allow them to reproduce in huge numbers

by quickly responding to favorable conditions can work against them, especially in temperate ecosystems such as most waters of the United States. Populations of these species also respond to unfavorable conditions like diminished or excessive freshwater inflows, hypoxia and shifting temperature regimes. These are examples of population drivers that can suppress population numbers. This is an evolved response common in ecosystems where widely changing conditions occur naturally. These ecosystems can be pushed beyond natural limits by man-made events like habitat loss, pollution, oil spills and water management. Forage species may respond accordingly. These often widely fluctuating population levels can, in turn, drive ecosystem stability and productivity because of their significant ecological role. Where anthropogenic actions add to extremes in natural cycles they can so stress the system that resilience is diminished or lost.

Forage species are also subject to intense overfishing if they have a commercial value, because they concentrate in such large schools. Menhaden are an example. Spotting aircraft, high-speed net boats and immense purse seines can quickly and easily deplete these species over wide areas. When commercially over exploited this critical trophic driver can upset ecosystem function and significantly and negatively affect higher trophic levels, often species of great value to both recreational and commercial fisheries. Natural perturbations and overfishing, especially both in combination, can have cascading effects on higher trophic level species like valuable sportfish, the impact of which can echo through many years, with significant economic impact.

Having healthy robust populations of forage fish is essential for production of more ecologically and economically desirable finfish populations, as well as, contributing to ecosystem stability and productivity. Science is just uncovering the full extent and dynamic role forage species play in the broader ecosystem. It is these types of linkages that we now recognize as fundamental to ecosystem health and productivity. It will require development of management frameworks focusing on ecosystem-based approaches, rather than a singles species management, to assure these species are not overexploited generating unintended and detrimental consequences on the ecosystem of which they are a part.

Question 2. The Morris Deal Report urged that "forage fish must be managed to provide enough food resources for healthy recreational fish species." Although some regional fishery management councils have taken significant steps toward this, as the Report indicates, "very few forage fish are considered in fishery management plans, meaning that potential impacts on these critical components of the ecosystem are not considered or controlled."

In the context of changes to or a reauthorization of the Magnuson-Stevens Act, what improvements should Congress consider helping move the ball forward on more comprehensive consideration of forage in management decisions?

Answer. Forage species must be considered in fisheries management plans, either as individual species or in aggregate where several species are present, with the goal of preserving their role in ecosystem function and support of valuable higher trophic level fish, marine mammals and birds. Reauthorization of Magnuson Stevens should address this issue in a systematic and science-based approach. The first and fundamental requirement is to identify these species, their geographic range, condition and contribution to ecosystem health and productivity. During this assessment, no new direct fishery for any potential forage species should be permitted until their ecological functions are well understood. In the event of a proposal to develop a fishery for one of these forage species, subsequent to the review noted above and a regional fisheries council determination that it is allowable, an important determination must be made—what portion of the annual maximum sustained yield will be set aside in support of ecosystem function and maintaining valuable sportfish and other commercial fisheries. If a fishery is approved, there should be an annual evaluation to determine if that set aside is adequate to minimize ecosystem harm. An economic assessment should be part of this evaluation. Additionally, a mechanism to make those adjustments in a timely fashion should be required. There are models on which to construct this adaptive regulatory approach that recognize the practical difficulties of managing these species for both commercial exploitation and ecosystem function protection.

In 2009, while Director of Coastal Fisheries for Texas Parks and Wildlife I oversaw creation of a process much as described above for menhaden in state waters. The result was a determination by the Texas Parks and Wildlife Commission that the harvest of menhaden in state waters should be capped to protect the remainder as a forage base, securing their contribution to sustaining economically important sportfish [Texas Administrative Code. Title 31. Part 2. Chapter 57. Section 995]. To minimize economic disruption for the existing commercial fishery the initial cap number was based on a ten-year average of annual harvest. Several adaptive

regulatory methodologies allowed for accommodation of over and underfishing during each year.

Question 3. The Commission on Saltwater Recreational Fisheries Management, which you chaired, published the "Vision for Managing America's Saltwater Recreational Fisheries". This document talks about the importance of abundance and stipulates that recreational anglers need a "wide-ranging, dependable access to healthy and abundant fisheries." The Magnuson Stevens Act has been successful at creating more abundant fisheries, as 84 percent of stocks are no longer overfished and over 43 previously depleted stocks have been rebuilt. This is largely due to requirements to end overfishing immediately, rebuild depleted fish stocks within certain time parameters, and use of annual catch limits.

If Congress loosens conservation requirements to allow overfishing, weaken rebuilding, and reduce fish abundance, how would that help recreational fishermen when abundance is so important to the angling experience?

Answer. The Magnuson Stevens Act provided the necessary Federal framework to curb industrialized commercial fisheries from rampant overexploitation and protect our country from intrusions by foreign fishing fleets. The Act's history is a notable example of an adaptive legislative process that has focused on the key issue of the time, while being responsive to developing needs during subsequent reauthorization. It is my hope that the adaptive process continues during consideration of this reauthorization and that an important focus is given to the recreational fishery. As it stands now the Act is an impediment, rather than a benefit in establishing a workable Federal framework for recreational fisheries management in Federal waters. This is not a criticism of the Act, which has served our country well, as noted earlier. It is a request to continue the exemplary adaptive legislative process that has so far characterized the Magnuson-Stevens Act and move forward to appropriately address recreational fisheries.

Recreational fisheries, the most economically important of all fisheries in our country, should not be confused with commercial fisheries in either structure or the legislative framework needed to sustain it. The needs of this fishing sector are quite different from that of commercial fisheries. For example, recreational fisheries can have much less of a negative "footprint" on the ecosystem than other fisheries focused on industrialized extraction of the resource. Recreational fisheries are more focused on access and quality rather than extracting the maximum yield allowed by regulation. Abundance has a much different meaning for recreational anglers than for commercial fishers.

I do not agree that the Morris-Deal Commission recommendation to consider reasonable stock rebuilding timelines constitutes a "loosening of conservation requirements" as suggested in the first question. As I summarized in my written testimony, neither does the National Academy of Science panel that closely reviewed this current requirement of the Act:

> *The National Research Council, a part of the National Academy of Sciences, Engineering and Medicine, reached the same conclusion in their report—Evaluating the Effectiveness of Fish Stock Rebuilding Plans in the United States. They found that rebuilding plans based on monitoring and controlling fishing levels, rather than requiring fish populations to recover to a pre-specified target size within a certain timeframe, would be less disruptive to the fisheries and less subject to uncertainty.*

This sentiment is echoed by many well qualified fisheries scientists and especially managers who have successfully recovered fish stocks, especially for recreational fisheries. Overfishing, weakened rebuilding and reduced fish abundance is a relative term defined by whatever time-frame is selected, whether science-based or arbitrary. That timeframe, as defined in the Act, was not based on science. It was based on the need of the time. Please do not misunderstand, I do appreciate the difficulties in dealing with this issue during an era when overfishing and delaying tactics to avoid imposing any reasonable management structure reached so frustrating a point that a line had to be drawn. That was then, not now. We have abundant examples where successful recovery of recreational fisheries have happened. Those examples are primarily in state managed fisheries. I graphically provided two examples in my written testimony—red drum and spotted seatrout. Recovery timelines in those examples were relative to both the species biological needs and the economic needs of the fishery. What I illustrated in those examples was an adaptive management process.

The existing Federal management structure generally, is not. The "one-size-fits-all" approach is cumbersome and does not allow for adaptations for differing management strategies across a species range, nor does it recognize differing economic realities of fisheries dependent coastal communities across that same geographic

range. Federal management strategies, in part due to restrictions of the Act, attempt to manage recreational fisheries and mixed fisheries (ones with both recreational and commercial components) with approaches more suited to commercial fisheries. Abundance, for example, calculated as quota-based annual catch limits focused on maximum sustained yields by weight. This is not an appropriate strategy for recreational fisheries.

The metrics of the current Federal management process, as summarized in the preamble to the two questions shows that biological recovery is possible under such management and it has happened in many cases, especially for commercial species. It is a commendable achievement, realized in sustained, difficult struggles to those positive ends. Federal fisheries managers and regional management councils deserve credit and recognition of achievement. The primary focus, however, was commercial fisheries. Today it should be recreational fisheries, a very different ball game. Biological and economic factors must be considered in tandem. In this endeavor, mixed fisheries do represent the greatest challenge to a stabilized future. There, flexibility and cooperative management is key. As noted, state fish managers have navigated this difficult terrain successfully and have much to offer, if allowed and encouraged.

In the case of red snapper, Federal management is succeeding on the biological level, but at what cost? What value in economic stability and jobs is being lost in this $63 billion-dollar industry? What value is a recovered and abundant fishery, if no one is left to enjoy it? It does not have to be an either-or choice. State managers have proven this repeatedly. The ability to expand recovery timelines is fundamental to solving this puzzle as it minimizes negative economic impacts, protects and even grows jobs and produces fish in abundance. The evidence is clear and incontrovertible.

Question 4. Do you think it is fair to say that abundant fisheries create more opportunities to fish, which is key to the recreational angling experience?

Answer. I was asked if it was fair to say that abundant fisheries create more opportunities to fish, which is key to the recreational angling experience. In part, but the real key to such an experience is threefold: access, quality and abundance. If the process to achieve those ends precludes or unnecessarily curtails, any one of those objectives, then it fails. Current Federal management, under the restrictions of the existing Magnuson Stevens Act all but precludes this possibility and thus fails.

I am a strong proponent of the North American Model of wildlife conservation, a model that was much inspired by our greatest conservation president, Theodore Roosevelt, and codified by Aldo Leopold. Its core principles should be instructive to any reauthorization of the Magnuson Stevens Act. The most basic tenet is that wildlife is a public trust resource, equally available to all. It appears to me that some of our fisheries managers have forgotten, ignored or worst of all, never heard of this most basic tenet of the American experience.

The most successful demonstration of the model, informing fisheries management, is the way in which Federal and state wildlife agencies and managers cooperate in assuring waterfowl conservation across international borders and within the United State, across state borders. All the issues faced by fisheries managers have been common to waterfowl managers—commercial versus recreational species, managing for access, quality and abundance, rebuilding timelines, etc. The solution there is as instructive as it has been successful. Why have waterfowl managers succeeded where fisheries managers have not?

I do believe all parties in the current red snapper debate and likely, other fisheries issues as well, share a common and positive end goal. Fisheries managers have much to learn from waterfowl managers and could so worse than adopt such a model.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. DAN SULLIVAN TO KARL HAFLINGER

Question. In your testimony you refer to the Improving Net Gains report that resulted from a multi-stakeholder process you were involved in that included representatives from many regions of the country. Please expand on that report and on the recommendations that resulted from that process and how they could help move us forward with fisheries data innovation.

Answer. The basic recommendations could be summarized as:

(1) Prioritize modernization of national fishery information systems

(2) Perform a cross-regional assessment of status and needs

(3) Develop and disseminate a policy based on the above.

(4) Develop and fund a budget for modernization

(5) Review confidentiality issues and prioritize access to participants

(6) Ensure that key stakeholders understand the capabilities and use of these systems

It is perhaps important to note that members of the task force were not current NMFS employees, but were mostly drawn from industry, NGOs, and state and former NMFS employees. Key areas that had proven frustrating to those attending were multiple levels of reporting for some fishermen (apparently multiple agencies needed the same information but didn't communicate), delays in stock assessments that led to harvest recommendations at odds with what fishermen saw in the environment, and difficulty for those outside NOAA Fisheries in accessing data that had been submitted by participants.

It seems clear that EM and ER (electronic monitoring and electronic reporting) are making inroads into fisheries management. The iSnapper app was mentioned in the Committee hearing and is an example of an approach that would seem to any outsider as a no-brainer for small-boat fisheries (basically a smartphone is used for recording catch and location, and reporting then occurs when vessels are in cell range). Participants in trial use of the software reportedly were pleased with it but were unable to take the time to estimate discards, which is an essential part of fisheries management. I suspect some refinement of the screens that are routinely seen on the smartphones (as suggested by participants) could make entry of essential data simple enough to allow the time to enter discard estimates. I wouldn't be surprised if they were fairly accurate when averaged over the whole fleet. A similar issue, that of estimating overall effort, could be attempted by asking participants to estimate the number of boats of their class that could be seen fishing at various "stops" along the way. I think a "citizen science" approach in this type could yield more timely and likely more accurate estimates of effort than shoreside surveys.

The Holy Grail in electronic monitoring for commercial vessels is the ability to make species-level identifications of fish, to document discards, and make some attempt at reporting the size of fish being discarded. We are a long way from realizing this but it's going to occur at some point and it's important to continue funding the necessary research and concurrently introducing the incremental advances in this field as they appear.

As someone who is involved with day-to-day fisheries data use, I have been surprised by the speed at which cloud services and "big data" analytics have become available to small concerns. I think that fisheries data modernization inevitably means moving fisheries data into the cloud, perhaps on a national level (a national landings database), so that the wheel is not being re-invented time and again at each regional science center, and for individual fleets spread throughout the country. There seems to be a critical mass of people from diverse science and technical backgrounds worldwide who are working on approaches to understanding complex problems and modeling solutions, but these are often difficult to actually program into machines, so a common, modernized data infrastructure could help immensely with the spread of these tools. These developments will help us with bycatch reduction by better understanding the problems and solutions through "spatiotemporal" modeling (looking at fish distributions changes both through space and over the course of many years). Combined with remote sensing we should be able to better understand the variability of species over time, and in response to climate variations, and this will affect stock assessments as well as industry response.

Retooling the Nation's fisheries data infrastructure was viewed as essential to furthering partnerships with industry. My own personal belief is that this won't be possible without expert help from outside NOAA Fisheries. I think it would be necessary to form a relatively small task force that included members of the agency and stakeholders (including from the academic community), and some outside expertise on data management. I think at some point it would be necessary to decide which legacy data you have to leave behind (perhaps temporarily) to allow you to move forward with storing and allowing better access to current incoming data. Finally, design documents should be open to the public and source code should be in open source repositories to enable both shared access and increased scrutiny for debugging purposes. This would obviously be an expensive undertaking so certainly support from this committee outside the framework of MSA reauthorization would be essential.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. BILL NELSON TO KARL HAFLINGER

Question 1. Bycatch Mitigation Strategies: Can you discuss some of the main bycatch mitigation strategies that the fleets you work with employ and what your company is doing to help fleets decrease bycatch within vessel cooperatives?

Answer. The bycatch mitigation toolbox for the West Coast and Alaska trawl and cod longline fisheries has 3 components: gear designs to reduce the rates of bycatch, handling procedures to reduce the mortality of fish returned to sea alive (this works for Pacific halibut only), and avoidance programs designed to help vessels operate in areas of the lowest bycatch rates possible for that fishery in the first place. Gear modification is an ongoing process that involves regular trips to a flume tank in Newfoundland to study how half-scale models of trawl sections actually behave when deployed. Recapture devices or cameras placed on nets serve to document the effectiveness of designs. Deck sorting of halibut is used on large-volume catcher processors and smaller trawl catcher vessels to radically reduce the amount of time that halibut spend on deck (they are very tough animals and up to 50 percent can be returned alive even when caught in a trawl net), thus increasing the survival rate. Quickly releasing halibut caught by large longiners increased survival rates for discards for this fleet to the 90 percent range.

My company (Sea State, Inc) is largely involved with helping fleets avoid bycatch in the first place. We look at observer data from catcher/processors, landings information from vessels that deliver shoreside, and satellite vessel positions records from VMS (vessel monitoring systems) to determine the locations of high-bycatch events, and relay this information to the fleet. Thus, we are working to get something as close to the raw data as possible, but still understandable, in front of those working on the water, as quickly as possible. We do not try to predict the next bycatch event but to let all fishermen in the various fisheries that employ us know as quickly as possible where bycatch events are occurring. We also implement bycatch reduction programs for 8 different cooperatives that fish in Alaska and the Pacific Northwest using trawl and longline gear. Each cooperative has different rules that they have decided their members must follow as a part of cooperative membership, and we process the catch information, get it back in front of the fishermen, and continue with any special reporting or activity that a given coop desires. This extended action ranges from simply publishing bycatch rates of the member vessels to actively monitoring bycatch on a daily basis and running "rolling closure" programs, wherein we decide which areas of the ocean should be temporarily closed to a cooperative or to individual vessels in a fishery based on criteria set forth in cooperative agreements. The closures generally last for a week, although at times they are extended for several weeks. Compliance with these closures is monitored using vessel VMS-reported positions, with substantial fines levied for infractions.

Question 2. Data: What are some of the challenges your company and partners face in terms of modernizing data management and data collection?

Answer. Whenever we add a new fleet or fishery we work with NOAA Fisheries to identify mechanisms that we can use to receive data from fleets via some form of bulk download. Oftentimes this has meant asking the agency to develop those methods for us, since it's their database that we need to pull information from. We always have to figure out how we are going to deal with confidentiality since different regions interpret the confidentiality rules in MSA somewhat differently. If we are trying to develop detailed views of fishing behavior we have to work with each vessel's VMS provider so that we can get a copy of the vessel's VMS information in near-real-time. Each company that sells the equipment and satellite time to these vessels provides for the vessel a website that allows the owner see his own data. We work with these vendors to allow us to download this data in bulk, given the owners' authorizations, much the same as we work with NMFS to develop new data pathways when necessary. All of these steps are challenging because there's no directive from NOAA Fisheries that the various regions cooperate with us. That is not to say that they haven't cooperated, because in most cases they have, ungrudgingly. In many instances the Councils have adopted management goals that only the member cooperatives could carry out, and the observer and landings data is required by the cooperatives, so it has been imperative that the agency work with the fleets to meet Council objectives. However, it has taken nearly 25 years of working with the fleets and NOAA Fisheries to get to this point. The idea that fishing vessel owners and operators are clients and need to be worked with cooperatively by NOAA Fisheries, especially as regards developing mechanisms to return data to the boats on which it was generate, would be a welcome addition to the re-authorization process. As part of a modernization effort, NOAA Fisheries could develop software to provide critical data to both individual users and those like myself, who need data in large

batches for users that authorize access. It would be very helpful if an amended MSA would make clear that individual fishermen (and their cooperatives) be considered as users of NOAA Fisheries data and that consideration be given to developing the software infrastructure needed to interact with them.

Question 3. Limitations to Stock Assessments: Can you outline some of the major barriers to conducting more frequent stock assessments that you see and your suggestions on how to address those concerns?

Answer. The stock-assessment process from start to finish is lengthy. Development of a new "benchmark" stock assessment can take upwards of 3–5 years to assemble data, iteratively go through and address comments from plan team and SSC to have a final model accepted and then used for setting Annual Catch Limits through the Council process. A previously approved stock assessment model is reassessed approximately every 5 years by an independent review panel. Modifications based on these reviews can then take another year or more to be implemented and be approved by the Councils' SSC.

Impediments to developing new assessments and updating old certainly include lack of regular survey data (data that are independent of fisheries), and also lack of fishery information (data from fisheries, including landings, discards, areas fished, lengths and ages of fish taken, etc). For some fisheries these data are hard to collect or don't exist, but in other cases the science centers depend on regional offices that manage fisheries to provide harvest information. My understanding is that outdated information processing systems and lack of communication within NOAA Fisheries often leads to delays in the transfer of fishery data to stock assessment scientists.

Ironically, based on my experience, about 1/2 of the new hires in the last decade will stay in a particular position for 3–5 years before moving on to either a different-species, or a different science branch altogether. As an individual gains more experience, they are more likely to be assigned higher profile species. The process of promotion leaves the more difficult stocks to assess (those with less data and less fishery value due to scarcity) with less attention than we would desire.

As far as improvements and making this process more efficient. I'm not an expert on this, but what I have seen with respect to developing tools such as Stock-Synthesis has had a significant impact on the efficiency of constructing new "benchmark" assessments. I don't think developing these tools has shortened the necessary length of the review process; however, these tools have allowed for competent reviews of very sophisticated models. Such model complexity would not be possible without the co-evolution of university training, model-development, and timely hiring within NOAA, that Stock-Synthesis has enjoyed.

Another major barrier is a shortage of highly qualified and experienced personnel. Explosive growth in the tech industries has attracted a lot of young talent with high paying jobs. I can think of three potential solutions with respect to conducting more frequent stock assessments: (1) increase intellectual capacity, (2) industry collaboration, and 3) contract the work out. NOAA has a number of incentive programs in place for increasing intellectual capacity (*e.g.,* John A. Knauss Marine Policy Fellowship Program), and these are great programs. Incentives for industry to collaborate in research programs (*i.e.,* tax-credits for research and development might be effective tools (I have seen these operating at the state level, in Alaska). A number of other countries around the world have had success with bid contracts for software development, or annual stock assessments conducted in collaboration with industry (*e.g.,* New Zealand rock lobster).

Finally, a thorough, high-quality stock assessment obviously takes significant resources to develop and maintain. The current legislation makes it difficult to use other forms of management that are less reliant on stock assessments and estimates of absolute abundance. There are a number of other "input" controls that could also be used to effectively manage data poor commercial and recreational fisheries (*e.g.,* time-area closures, season restrictions, lotteries, to name a few).

Question 4. Do you have suggestions on how NOAA should prioritize allocating limited funding?

Answer. I am not familiar enough with the competing priorities within NOAA and NMFS to answer this question.

Response to Written Questions Submitted by Hon. Maria Cantwell to Karl Haflinger

Question 1. Mr. Haflinger, your company, Sea State, has been involved in helping to improve bycatch avoidance in the Pacific Northwest and Alaska. If a bycatch limit is reached, a fishery may be shutdown, which could lead to a loss in revenue and

jobs. In order to develop bycatch reduction devices, exempted fishing permits, or EFPs, are often used to test new devices and techniques to determine if they are successful at improving fisheries management and reducing bycatch.

Do you think that EFPs are helpful in developing new management techniques and testing new fishing gear to improve fisheries management?

Answer. Exempted Fishing Permits (EFPs) have been essential to the process of developing both salmon and halibut excluders used in the trawl fisheries in Alaska. Using prototype models under real fishing conditions facilitates evaluating the success of those devices through scientific trials. Without objective evaluations of these devices, their efficacy is mostly guesswork, and fishermen are reluctant to adopt them. Experimental trials also often require that vessels seek higher bycatch circumstance (*i.e.,* areas of higher bycatch rates) than fishermen would operate in under normal fishing circumstances. If a fisherman has a quota for halibut or salmon, then he is looking to avoid instance of high salmon or halibut abundance, but it is in precisely those conditions that we need to test the devices. You cannot ask a fisherman to deliberately sacrifice his quota and jeopardize his fishing season to test the device, so you need extra quota of constraining species that can be utilized under an EFP. Without it, the excluders would never be tested in the environments that matter most.

It's also clear that EFPs are the most direct method available to evaluate new tools in catch estimation and bycatch reduction that are not gear modifications; for example, Electronic Monitoring (EM) and deck-sorting catches to reduce mortality on discards. Councils and NOAA Fisheries alike must figure out how these programs should work and it is impossible to anticipate the problems and workarounds without trying these programs in real fishing conditions. For both these examples, the benefits to fishermen and conservation were obvious and unambiguous, but these were new approaches that everyone had to become familiar with putting rules in place. Thus, the adoption of these new methods would take much more time if Federal rules had to be promulgated for each new program before such methods could even be seen in action on deck. The resulting rules would have to be modified because you're never "right" the first time, and the ensuing delays (associated with the rule-making cycle) would be absurd.

Question 2. Would your company and others like it be able to test new bycatch reduction mechanisms if EFPs became more difficult to obtain?

Answer. Sea State has not been involved in field testing any devices although we often handle the data produced in these experiments, or advise field testers on bycatch conditions in the areas they seek to test (*i.e.,* helping to find the optimal bycatch rates for the device test under consideration) Without the EFPs the only method we have to rate success in devices are comparative bycatch rates (between vessels) but in general we don't know the exact configuration of nets that vessels are using, and in real-world fishing you would never see enough paired tows (between boats that have reduction devices and those that don't) to make statistically valid comparisons. In other words, I don't think it's possible to effectively evaluate these devices and techniques without EFPs, and that is why I consider them to be essential.

Question 3. From an economic perspective, EFPs are critical to keeping fishermen fishing while conservation issues are being addressed. What would happen to fishing jobs if EFPs were no longer a management tool?

Answer. EFPs are just one of many issues surrounding bycatch that can allow fisheries to proceed or result in their closure, so I would first clarify that my remarks that follow include more than the effects of EFPs alone. Fishery-related employment occurs both on vessels and at shoreside plants, and further on down the supply chain to the point of sale. The most immediate effects of premature closures are probably felt by captains and crews, but almost as immediate are effects for employees at processing plants and later handlers of fish. In more remote coastal areas where jobs may be less available, plant closures may be difficult to recover from, so that once closed, they may not re-open, and fishing jobs can be lost for good. The situation may or may not be the same for vessels, which can possibly move to different areas, depending on the management regime they fish under. In both cases, reestablishing fishing operations after prolonged closures is difficult, especially if key personnel are lost.

Events that have played out over the last 20 years along the Pacific NW coast has shown the difficulty of retaining fisheries for healthy bottomfish species (for example, Petrale or Dover sole) when bycatch problems with overfished species of rockfish led to reduced fishing opportunities for non-rockfish species as well. For many years the fleets dealt with reductions in fishing areas due to rockfish bycatch regulations. With severe reductions in catch, many of these bycatch species have re-

bounded faster than stock assessments can keep up, so they remain problematic because allowed rockfish catch levels are still unrealistically low. Also, area-based rockfish conservation closures still remain in place, despite rebounding populations. Bottomfish catches are thus still affected unnecessarily by concerns on rockfish bycatch, and as a demonstration of the complexity of the problem, the rockfish that are quite legitimately harvested as bycatch in increasing amounts is difficult to sell. The markets are now unfamiliar with these fish, or where there is familiarity, the market share has been lost to foreign competition. It will likely take many years of persistent marketing efforts before these fish occupy the place they once did in markets on the West coast. This state is clearly the result of earlier overfishing, but it demonstrates the problems we see when fisheries in an area are closed for extended periods, and the continuing need for bycatch reduction of constraining species even when their populations have recovered.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. GARY PETERS TO KARL HAFLINGER

Question 1. Improving Net Gains report: In your testimony you refer to the Improving Net Gains report that resulted from a multi-stakeholder process you were involved in that included representatives from many regions of the country.

Could you provide a little more information on the recommendations that resulted from that process and how they could help move us forward with fisheries data innovation?

Answer. The basic recommendations could be summarized as:

(1) Prioritize modernization of national fishery information systems
(2) Perform a cross-regional assessment of status and needs
(3) Develop and disseminate a policy based on the above.
(4) Develop and fund a budget for modernization
(5) Review confidentiality issues and prioritize access to participants
(6) Ensure that key stakeholders understand the capabilities and use of these systems

It is perhaps important to note that members of the task force were not current NMFS employees, but were mostly drawn from industry, NGOs, and state and former NMFS employees. Key areas that had proven frustrating to those attending were multiple levels of reporting for some fishermen (apparently multiple agencies needed the same information but didn't communicate), delays in stock assessments that led to harvest recommendations at odds with what fishermen saw in the environment, and difficulty for those outside NOAA Fisheries in accessing data that had been submitted by participants.

Question 2. Improving Net Gains report: How can we make it easier for NOAA and the Regional Fisheries Management Councils to implement emerging technologies to reduce bycatch and improve data collection?

Answer. Fishery issues involving multiple stakeholders are surprisingly complex and it simply takes a long time to figure out how management changes will affect all stakeholders, and also how to implement in ways that are cost-effective yet still meeting management goals. The simplest way to assist the process has been to utilize Exempted Fishing Permits (EFPs) to allow the industry, NOAA Fisheries, and councils experiment with altered and improved management approaches before deciding on every detail of the rules that will be necessary to implement new approaches. Cooperative research involving industry and agency can also be useful in developing expertise and familiarity with new techniques on both sides (agency and industry).

Question 3. Improved Technologies: Data and data collection for fisheries, especially recreational fisheries, needs to be brought into the 21st Century, and there are so many technologies now available that were not in the past and additional technologies coming up on the horizon.

What technologies are on the horizon that NOAA and NMFS should be taking a closer look at to improve data collection and meet both economic and conservation goals?

Answer. It seems clear that EM and ER (electronic monitoring and electronic reporting) are making inroads into fisheries management. The iSnapper app was mentioned in the Committee hearing and is an example of an approach that would seem to any outsider as a no-brainer for small-boat fisheries (basically a smartphone is used for recording catch and location, and reporting then occurs when vessels are

in cell range). Participants in trial use of the software reportedly were pleased with it but were unable to take the time to estimate discards, which is an essential part of fisheries management. I suspect some refinement of the screens that are routinely seen on the smartphones (as suggested by participants) could make entry of essential data simple enough to allow the time to enter discard estimates. I wouldn't be surprised if they were fairly accurate when averaged over the whole fleet. A similar issue, that of estimating overall effort, could be attempted by asking participants to estimate the number of boats of their class that could be seen fishing at various "stops" along the way. I think a "citizen science" approach in this type could yield more timely and likely more accurate estimates of effort than shoreside surveys.

The Holy Grail in electronic monitoring for commercial vessels is the ability to make species-level identifications of fish, to document discards, and make some attempt at reporting the size of fish being discarded. We are a long way from realizing this but it's going to occur at some point and it's important to continue funding the necessary research and concurrently introducing the incremental advances in this field as they appear.

As someone who is involved with day-to-day fisheries data use, I have been surprised by the speed at which cloud services and "big data" analytics have become available to small concerns. I think that fisheries data modernization inevitably means moving fisheries data into the cloud, perhaps on a national level (a national landings database), so that the wheel is not being re-invented time and again at each regional science center, and for individual fleets spread throughout the country. There seems to be a critical mass of people from diverse science and technical backgrounds worldwide who are working on approaches to understanding complex problems and modeling solutions, but these are often difficult to actually program into machines, so a common, modernized data infrastructure could help immensely with the spread of these tools. These developments will help us with bycatch reduction by better understanding the problems and solutions through "spatiotemporal" modeling (looking at fish distributions changes both through space and over the course of many years). Combined with remote sensing we should be able to better understand the variability of species over time, and in response to climate variations, and this will affect stock assessments as well as industry response.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. GARY PETERS TO DR. MICHAEL JONES

Question 1. Management Strategy Evaluation: You have extensive experience with Management Strategy Evaluations that has led to a great deal of success in the Great Lakes.

What could employing MSE approaches mean for U.S. fisheries especially in areas with tense relationships between different groups of stakeholders?

Answer. As I mentioned in my earlier testimony, the National Marine Fisheries Service (NMFS) has begun to show strong interest in using Management Strategy Evaluations (MSE) to address challenging fishery management issues, including Atlantic Menhaden and Gulf of Maine Herring. I have been invited to speak about our experience with MSE in the Great Lakes at a NMFS workshop planned for late January 2018 in San Diego. MSE methods are being applied to important fisheries elsewhere in the world as well—most notably Australia, South Africa, and the European Union.

The great advantage of an MSE process is its transparency. The simulation methods are intended to model the entire management process, from stock assessments to population dynamics to the harvest rule that determines how much fishing takes place, and to generate outputs that represent the consequences of different harvest policy options for a variety of performance measures representing different objectives. This means decision makers and stakeholders are able to see how alternative management strategies will lead to trade-offs among competing objectives that represent the divergent interests of different stakeholder groups, fostering a greater appreciation for how there has to be some give and take to balance these competing objectives and that there is often a middle ground that stakeholder groups with competing interests are all willing to live with.

Vitally important to an MSE process that attempts to tackle a contentious issue is engagement. While the MSE simulation process can be highly technical, and thus beyond the capacity of many stakeholders to critically evaluate, engaging the competing stakeholder groups in the process of an MSE, especially the early stages where the problem is defined and objectives identified and acknowledged, fosters an environment of "ownership" of the problem—and the possible solution. Doing this right will be very challenging, especially when the level of conflict is already very

high, but our experience has suggested that even (perhaps especially) in high-conflict situations and engaged MSE process can be extremely helpful.

Question 2. Changing Environmental Conditions: We see changing environmental conditions everywhere with increased temperature, changes in water chemistry, and subsequent impacts to fish and other wildlife.

What do you see as the emerging management issues for U.S. fisheries? And what can we do to detect these issues and ameliorate the situation before things get worse?

Answer. I'm not sure it would be accurate to describe either of these as "emerging" issues—we have known about them for a long time—but there's not much doubt that global environmental change (dare I say climate change), and the spread of invasive species will be two of the most challenging issues facing the future management of U.S. fisheries.

Needless to say, we have an awful lot of experience with aquatic invasive species in the Great Lakes. Management of sea lampreys has been a central element of fishery management in the Great Lakes for over fifty years, and emerging evidence suggests that zebra and quagga mussels may ultimately have an even greater impact on our lakes than sea lampreys did. Marine invasive species has received a great deal less attention than freshwater invaders, but I believe they will become a much more important issue for managers to grapple with in the future—in no small part because of the other issue I cited above. As the environmental conditions in coastal regions change (warmer, more acidic, stormier) the ecosystem is likely to become less favorable for currently important species and more favorable for new invaders.

Another really important aspect of global change, which was discussed at the hearing, is that the range and distribution of economically valuable fish stocks will change, creating challenges for spatial management: location-specific quotas will become mis-aligned with where the fish are. Harvest policies in the future will likely need to be more adaptable to these changing conditions.

Not only will global change affect species distributions, it will affect productivity of fish populations. It seems likely that productivity of some stocks will increase, while for others it will decrease. This means that management strategies which are informed by analyses of past data—which is nearly always how we do things—will be poorly tuned to the managed populations in the future. This reality will need to be accommodated as new harvest policies are established for species affected by global change.

Question 3. Emerging science: You mention in your written testimony that in order to ensure that "wise, fair decisions are made," you must ensure decisions are "based on the best science." Currently, the Magnuson-Stevens Act requires that all "measures shall be based upon the best scientific information available." The guidelines to implement that standard encourage using science from many sources and including both established and emerging science.

Can you explain why maintaining this standard is important, and how progress in fisheries management might be harmed if this standard was eliminated or weakened?

What considerations are important when using established science versus newer, emerging science in management decisions?

Answer. Using scientific knowledge to inform fishery management is a "no brainer". Sometimes arguments are made that "we got it wrong" even when decisions were arguably science-based. Mostly this happens because we were either unlucky—an unpredictable event led to an outcome we weren't able to anticipate—or because the science was not used as well as it could have been. An example of the latter is that historically, science-based decisions often relied on the best scientific judgement of an expected outcome (for example setting fishing rates at levels expected to yield maximum sustained yield) without properly considering the risks of such policies; risks that arise due to inevitable uncertainties in our knowledge and information. But to conclude from this experience that using the best science is not necessary for wise management does not make sense. We need to use the best available science, and we need to use it wisely, which includes thoughtful consideration of both what we know and what we are uncertain about.

New, emerging science promises to greatly improve our knowledge base to inform wise decision-making. In the Great Lakes, acoustic telemetry is a great example of emerging science that could transform our understanding of fish movement and thereby improve our ability to manage individual fish populations which inter-mix. Advances in molecular methods (DNA fingerprinting, genomics, etc) are also having an enormous impact on our understanding of fish populations. All scientific knowledge—established and emerging—needs to be subjected to rigorous standards of peer review and confirmation before we rely too heavily on exciting and sometimes

controversial new knowledge. It is just as important that we apply this rigor to knowledge and information provided through so-called citizen science as it is for more traditional science led by academics and government scientists.

Question 4. Forage Fish: Forage fish are crucial part of the food web that supports many of the fish we strive to eat. Menhaden were one species of forage fish brought up during the hearing, but forage fish are important from the Great Lakes to the Gulf of Mexico to the Gulf of Alaska.

Can you share with us the importance of forage fish and provide guidance on managing forage fish such as menhaden and others across different regions?

Answer. Management of forage species requires us to take a multi-species, or even ecosystem view of fisheries management. Forage species, as the name implies, can be an important food source for economically valuable predator species, but in the case of species like Atlantic Menhaden or Gulf of Maine Herring they also have value as commercially exploited species. This implies a management trade-off between maintaining an abundant population of forage for predators to consume versus harvesting more forage in a fishery. This trade-off needs to be confronted by using sound ecosystem science to assess the relationship between (a) fishing rates and forage species abundance and (b) predator growth and survival and forage species abundance. We have a reasonably good understanding of (a) from forage species stock assessments, but empirical information to inform (b) is surprisingly limited for marine systems.

We have experience with a predator-forage issue in the Great Lakes that is different from the scenario I described above but that nevertheless can illustrate how science can inform the marine forage species issue. In my Great Lakes example the predators are the salmonine species (trout and salmon) that are the basis our billion dollar recreational fisheries in Lakes Michigan, Ontario, and to a lesser degree, Huron. The primary forage species is alewife. The difference between our Great Lakes issue and the marine situation is that alewife is not the object of a commercial fishery in the Great Lakes so there is not a tension between commercial and recreational fishing interests in this case. However, alewife—an exotic species in the Great Lakes—are believed to have negative effects on numerous native species when they are abundant, which provides an incentive to reduce their abundance below levels that might be ideal for their predators. We have used decades of fishery assessment data for alewife and their predators to develop an understanding of salmonine-alewife predator-prey interactions, and then used this information in computer models that inform decisions about what levels of alewife abundance we should aim for to balance these competing interests. Our history of supporting ecosystem science in the Great Lakes has enabled us to develop a substantially better understanding of predator-prey interactions involving economically important species that is typical for most marine predator-forage systems.