Managing Our Nation's Fisheries 3

Advancing Sustainability

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Cover photo: Hawaiian bigeye (`äweoweo or *Priacanthus meeki) at Rapture Reef in the Northwestern Hawaiian Islands Marine National Monument. Photo: NOAA National Ocean Service.*

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PROCEEDINGS OF A CONFERENCE ON FISHERIES MANAGEMENT IN THE UNITED STATES HELD IN WASHINGTON, D.C.
MAY 6-9, 2013

EDITED BY JENNIFER D. GILDEN

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Donald McIsaac, Pacific Fishery Management Council

We hope this proceeding document will be useful in many ways. Useful to the Congressional staff who are drafting legislation to reauthorize the Magnuson-Stevens Act, and useful to the many people that will provide input into that important process; useful to the National Marine Fisheries Service as they prepare the first draft of National Standard 1 Guideline revisions for review by Regional Fishery Management Councils, stakeholders, and the public; useful to the Councils as they consider different ways of developing management approaches and regulations under current authorities; and useful to the National Marine Fisheries Service as they consider policy implementation decisions under the Secretarial approval process of the Magnuson-Stevens Act and other applicable law.

This proceedings document is voluminous, containing an impressive collection of information, perspectives, and conference results. However, it is not a complete record of all that occurred during the three-day conference. Additional information is available on the Managing Our Nation's Fisheries website, www.managingfisheries.org, including the slide presentations from the plenary sessions, the audio record of the Reactions Panel statements, and audio of the plenary sessions. If readers need further information about the conference, beyond what is available in these proceedings or on the website, please don't hesitate to contact us at the Pacific Council office (www.pcouncil.org.)

It has been a pleasure to be associated with all of the people who worked on this conference. I mentioned in my opening remarks that it is usually a winning formula when you bring together intelligent, conscientious, hard-working people in the "fish and fishing community" and present them with a particular challenge. In this case, the challenge was to develop ideas to advance fishery sustainability to a new level of success, and the 600 or so people participating at the conference certainly rose to the challenge. From the planners to the speakers, the staffers and the participants, it was exciting to see the positive chemistry of the contributions from all involved manifest itself in meaningful results.

In his introduction to the conference proceedings, Mike Burner extends thanks to the many deserving people involved in the success of the conference. I concur entirely, and would add even more. Mike deserves special recognition for his outstanding work in achieving the goals of the conference. While many saw him working tirelessly in his role as the concurrent and plenary session coordinator, I want to acknowledge his central accomplishments as the Chief of Staff in this endeavor. His pleasant, can-do attitude and always-on-deadline capabilities—from being an idea generator to a workhorse producer to an orchestrator with meticulous attention to detail—are a primary reason the conference went so smoothly. Decisively, he has strong ownership of the success of this conference.

Last but certainly not least, Jennifer Gilden deserves special recognition for her excellent work on this proceedings document. For those who have edited a large document of this type, you know how difficult this job is. However, Jennifer was also the designer, director and producer of this proceedings document, and deserves special appreciation for it being available to you as a resource.

Donald McIsaac
Executive Director
Pacific Fishery Management Council

Preface

Mike Burner, Pacific Fishery Management Council

The success of the Managing Our Nation's Fisheries 3 conference was the result of commitment and effort by many individuals. First and foremost, Dr. Don McIsaac, Executive Director of the Pacific Council, did a yeoman's job as chief conference organizer, architect, and emcee. Don's vision, perseverance, and positive approach kept the conference on course from start to finish.

I personally owe the chairs of the three concurrent sessions a huge debt of gratitude. Dave Witherell, John Henderschedt, and Mark Holliday contributed a tremendous amount of work over the better part of a full year to what was the core of the conference. The concurrent sessions were the focus spot where the speakers, panelists, and the public wrestled with the tough issues and important details with the difficult task of breaking it all down to a few key findings. These three gentlemen were critical from the very early planning stages to the post-banquet, late-night completion of the conference findings. They remained dedicated through every challenge and were simply invaluable me, and more importantly, to the success of the conference.

The concurrent sessions relied heavily on the wealth of information presented by the speakers and deliberated by the panelists and the public. The submitted papers, posters, and presentations represented a wide range of ideas and stimulated many dynamic discussions at the conference. The rapporteurs deserve generous credit for their long hours diligently capturing it all for posterity. The Reactions Panel professionally addressed 128 conference findings and summoned the leadership necessary to offer perspectives on ways to proceed. The conference poster session was a huge success and filled the East Room and the State Room with over 70 posters and booths under the leadership and watchful eye of Pacific Council Staff Officer Kerry Griffin.

The cornerstone of the conference was certainly the expert technical and logistical support of the Pacific Council's administrative staff, including assistance from Russell Porter and Theresa Fairchild of the Pacific States Marine Fisheries Commission and Craig Hess of Martin Enterprises. These folks performed flawlessly and covered far more responsibilities than there is room here to print. Specifically, I would like to thank Carolyn Porter and Renee Dorval for expertly handling the complicated hotel and banquet logistics, Patricia Crouse for her steadfast management of the conference registration website and fiscal matters, and Theresa Fairchild for plying her considerable knowledge and proficiency to the conference registration process. Sandra Krause and Kris Kleinschmidt spent considerable time planning for the numerous IT challenges, and together with Russell Porter and Craig Hess, provided seamless audio, visual, and technical support. Kimberly Ambert deserves special recognition for capturing the conference with her photographer's eye.

Public involvement was critical to the success of the conference, and the Communications Team (Jennifer Gilden, Darcie Honabarger, Kim Iverson, Kimberly Ambert, Laurel Bryant, Pat Fiorelli, and Sylvia Spalding) expertly handled public relations, media coordination, presentation of conference materials, and website development, making the conference easy to navigate.

The staff of the Pacific Council would also like to congratulate and thank the dedicated staff of the Mayflower Renaissance Hotel for their unbeatable service and support.

The proceedings were designed and edited by Jennifer Gilden, with further editing by Pacific Council staff, to represent a compendium of conference results. Papers and poster abstracts are included as submitted in advance of the conference. The keynote speeches were transcribed from the recorded conference record. Summaries of the focus topics and concurrent sessions were prepared by the session chairs and rapporteurs. Conference findings and the feedback from the Reactions Panel were summarized by Pacific Council staff.

It was a rewarding and enjoyable experience to be a part of this conference. It gave me pride to discover a reoccurring conference theme that, overall, U.S. fishery management is working well. It is my hope that the conference and these proceedings will serve as a vehicle to promote the strength and success of the Magnuson-Stevens Act while advancing new concepts toward the sustainability of our nation's fishery resources.

Mike Burner
Staff Officer, Pacific Fishery Management Council

Conference Design

The Managing Our Nation's Fisheries 3 conference was convened by the Regional Fishery Management Councils in their capacity as the Councils' Coordination Committee, as described in the Magnuson-Stevens Act, with the Pacific Fishery Management Council serving as primary host.

The conference was held May 6-9, 2013 at the Mayflower Hotel in Washington, D.C., beginning with registration and a reception on May 6. The conference opened the morning of May 7 in plenary session. This initial session included presentations from high-profile featured speakers and perspectives from the Regional Fishery Management Councils.

As conference partners, the National Oceanic and Atmospheric Administration, the Regional Fishery Management Councils, the Pacific States Marine Fisheries Commission, and the Fisheries Leadership and Sustainability Forum provided invaluable assistance in planning and conducting the conference. The conference was open to all and was attended by over 600 people representing a broad range of perspectives, including the U.S. Congress, recreational and commercial fishing interests, indigenous people, state and Federal fish and wildlife agencies, environmental nongovernmental organizations, academia, and the public.

The conference featured several keynote speakers. Representative Doc Hastings (R-Washington), Chairman of the House Natural Resources Committee, and Mr. Eric Schwaab, acting Assistant Secretary for Conservation and Management and former head of the National Marine Fisheries Service, spoke on legislative and administrative issues at the opening plenary session. Later that morning, Mr. Keith Colburn, skipper of the Wizard on the Deadliest Catch television show, and Mr. Barton Seaver, seafood chef and host of "In Search of Food," shared their perspectives on sustainable fisheries. Senator Mark Begich (D-Alaska), Chairman of the Senate Subcommittee on Oceans and Fisheries, gave an energetic speech to a full house at the conference banquet.

The conference was organized around three moderated sessions with the following themes and Chairs: Improving Fishery Management Essentials, chaired by Mr. David Witherell (Deputy Director, North Pacific Fishery Management Council); Advancing Ecosystem-based Decision-making, chaired by Mr. John Henderschedt (Executive Director, Fisheries Leadership & Sustainability Forum); and Providing for Fishing Community Sustainability, chaired by Dr. Mark Holliday (Director, Office of Policy, National Marine Fisheries Service). Each moderated session included three focus topics germane to the session theme.

Towards the purpose of identifying ways to advance the sustainability of United States marine fishery management, 27 invited speakers provided ideas for improvement, which were discussed in an audience interaction environment where additional ideas were brought forward. Nine panels considered the discussions from each focus area, and attempted to identify findings that have a high potential to advance fishery sustainability to a higher level.

Following the concurrent sessions, the conference reconvened in plenary session the morning of May 9. Session chairs and rapporteurs presented key findings from their focus topic sessions in the context of identifying improvements to national fishery practices, policies, and laws. The conference concluded with a panel of influential representatives from organizations with a role in implementing the recommended improvement, including both houses of Congress, heads of Federal and State fishery agencies, recreational and commercial fishing interests, tribal or subsistence communities, environmental advocacy organizations, and Regional Fishery Management Councils. This "Reactions Panel" was asked to provide their initial reactions to the conference conclusions, including input on the merits of the recommendations, the feasibility of their implementation, or ways to improve or clarify the conclusions. Finally, the Council Coordination Committee considered the findings and other results of the conference with regard to possible recommendations to relevant authorities.

Concurrent Sessions

The conference was organized around three moderated sessions with the following themes and Chairs: Improving Fishery Management Essentials, chaired by Mr. David Witherell (Deputy Director, North Pacific Fishery Management Council); Advancing Ecosystem-based Decision-Making, chaired by Mr. John Henderschedt (Executive Director, Fisheries Leadership & Sustainability Forum); and Providing for Fishing Community Sustainability, chaired by Dr. Mark Holliday (Director, Office of Policy, National Marine Fisheries Service).

Each moderated session included three focus topics. The first of the three focus topics began on the afternoon of May 7, with the other two scheduled for the morning and afternoon of May 8, each roughly 3.5 hours in length.

Session Themes and Focus Topics

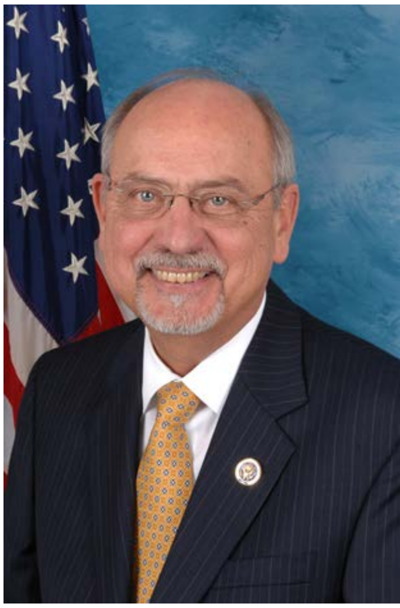
IMPROVING FISHERY MANAGEMENT ESSENTIALS	ADVANCING ECOSYSTEM-BASED DECISION-MAKING	PROVIDING FOR FISHING COMMUNITY SUSTAINABILITY
ACL Science and Implementation Issues, including Managing Data-Limited Stocks	Assessing Ecosystem Effects and Integrating Climate Change	Recreational and Subsistence Fishery Connections
Rebuilding Program Requirements and Timelines	Forage Species Management	Integrating Community Protection, Jobs Emphasis, and Domestic Seafood Quality Assurances
International Fisheries Management: Leveling the Playing Field	Integrating Habitat Considerations: Opportunities and Impediments	Assessment of Socio-Economic Tradeoffs

The session chairs opened and moderated each of the three focus topics sessions, which began with 20-minute presentations from each of three speakers, covering a range of ideas and perspectives on the topic. In their presentations, speakers summarized the ideas and perspectives contained in their papers, which were submitted for review before the conference, and included their ideas on ways to advance sustainability in the context of the particular focus topic. Presentations were followed by an audience interaction period of about an hour, where conference participants had the opportunity to support and challenge the ideas presented.

Following the audience interaction period, the three speakers were joined by four participants, chosen before the conference, to form a seven-member panel with broad representation. The panel was charged with condensing the ideas and perspectives from the session into findings via moderated discussion. These findings were later shared in plenary session.

Two rapporteurs were assigned to each of the focus topic sessions. The rapporteurs were charged with capturing summary minutes of the sessions, as well as major conclusions and recommendations. Working with the rapporteurs, the session chairs prepared a short presentation on their focus topic conclusions.

Remarks by Chairman Doc Hastings



Doc Hastings first joined the U.S. House of Representatives in 1995 to serve Washington's Fourth Congressional District. Before being elected to Congress, Doc served eight years in the Washington State Legislature. In 2011, at the start of the 112th Congress, Doc was selected by his colleagues to serve as the Chairman of the House Committee on Natural Resources. The Committee has jurisdiction over most Federal land use and water policies, including national forests, national parks and monuments, wilderness areas, national scenic areas, Indian reservations, and Bureau of Land Management lands. Under Doc's leadership, the Committee is dedicated to pursuing policies that both strengthen our economy and protect our nation's treasured lands, oceans, and wildlife. Specifically, Doc's priorities include increasing American energy production, ensuring U.S. offshore drilling is the safest in the world, guaranteeing access to public lands for recreation and job creation, effective management of our nation's oceans, and fighting for water rights in the West.

I want to thank Dr. McIsaac, the Regional Fishery Management Councils—in particular, the Pacific Council—and NOAA for hosting this conference. Pulling together a conference involving this many people who have an interest in fisheries management cannot be an easy task.

I would like to welcome all of you here to Washington, D.C. I know this is a commitment of time and energy, but I appreciate your willingness to participate and I look forward to reviewing the recommendations.

Balance/Flexibility

The title of this conference is "Managing Our Nation's Fisheries"—but it could just as easily be called Managing the Nation's Fishermen. As you've heard me say before, the Magnuson-Stevens Act is as much about managing fishermen as it is about managing fish.

Managing fish—and fishermen—is a challenge. It requires a balancing act in a number of areas: between a sustainable harvest level and the maximum economic value for the fisheries, between recreational and commercial users of the same resource, between different gear types in the same fisheries, and between the interests of different states. In addition, not only are the fisheries different, but the challenges are different in each region of the country. Because of these differences, a one-size-fits-all management structure is not the most efficient structure.

The Magnuson-Stevens Act provides the framework for sustainable fisheries management that allows for regional solutions to address regional challenges. The Act works, it is absolutely necessary to maintain this authority that allows regions to find unique solutions to their problems. Because of this framework, the United States has arguably the best managed fisheries in the world.

It's worth repeating that one of the keys to this is the ability of fishery managers to manage within their region, and this is primarily due to the flexibility that is provided in the Act. I know there will be some discussion of this issue at this week's conference and I look forward to hearing your recommendations.

In addition to managing the fish and the fishermen, the Act recognizes that there are coastal communities that rely on the fisheries for their economic livelihood. The Act again requires a balance between the need to maintain a sustainable fishery and the need to continue to provide an economic basis for these fishery-dependent coastal communities.

Fishermen and coastal communities that depend on healthy fisheries are certainly facing challenges. The Secretary of Commerce declared seven fisheries disasters in 2012 and several more have been requested.

New England is facing severe cuts in the quotas for important fisheries. The Gulf of Mexico is facing severely restrictive fishing seasons for recreational fishermen. The Pacific Northwest is seeing management and data collection costs growing with an ever-increasing burden falling on fishermen. All of these fisheries and all of these regions need economic stability and certainty.

Reauthorization Timing

The timing for this conference could not be better. It is Congress's responsibility to re-examine and reauthorize the laws that we create and the current authorization for the Magnuson-Stevens Act expires at the end of Fiscal Year 2013. The time for Congress to work on this reauthorization is now.

As Chairman of the Natural Resources Committee—the House Committee with jurisdiction over the Magnuson-Stevens Act—I have already begun the reauthorization process with several hearings in the last Congress and, in March, the first of several hearings we will hold this year.

It is my goal is to try and reauthorize this important statute this Congress.

At the first hearing in March. the major themes from witnesses were that:

- The Act is basically sound, but many of the challenges come from the implementation of the Act;
- The Act requires a balance between "preventing overfishing" and "achieving optimum yield." This balance has recently been shifted more toward preventing overfishing and underplays the needs for economic stability and needs of the fishery dependent communities;
- Data is limited. Technology is not being used effectively for data collection, and agency funding priorities do not seem to reflect the need for better data;
- Flexibility is needed for Councils when establishing rebuilding timeframes and when setting annual catch limits (ACLs);
- Rebuilding timeframes and ACLs must take economics and community needs into consideration;
- Data for management does not keep pace with what fishermen are seeing on the water. This leads to increased frustration when low harvest levels continue, but when fishermen are seeing recovery in real time and are not able to benefit from the recovery as it occurs; and
- The catch level recommendations and scientific guidance given by NOAA regional science centers to Councils and Council Scientific and Statistical Committees are not always developed or presented in a transparent manner.

While Congress has already begun the authorization process, the recommendations from this conference will certainly be important for us to consider.

We are in the process of scheduling our next hearing on the reauthorization and it will be formally announced soon. It will be on data collection issues and it will be held on May 21st, but there are other issues that need to be addressed at further future hearings.

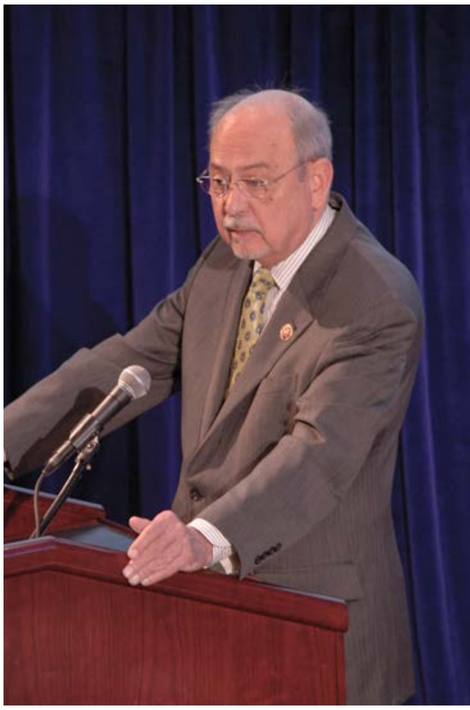
Science and Technology

One reason we will be focusing on data collection issues is that science underpins the entire management process. However, we often hear from fishermen that the science being used for management purposes is not "good" science. The Act requires fishery managers to use the "best scientific information available." The problem is that often the "best" information is not "available." This is a key factor for maintaining robust fisheries, and we plan on examining this issue further.

When fishermen lose confidence in the science that is being used to regulate their activities, they are less likely to support management changes—especially if those changes restrict their activities.

There has got to be a better way to get up-to-date, accurate data on fishery resources and on harvest levels—both for recreational and commercial fisheries. Congress started this process in 2006 by requiring an overhaul of the recreation data collection process. Unfortunately, that data collection process is still underway.

But this is not just an issue for the recreational fisheries. Increasing burdens are being placed on commercial fishermen in the Pacific and the North Pacific. In this digital age, the use of new technologies as it relates to your industry is not keeping pace with innovation.



Transparency

In addition to better science and better uses of technology, we need better transparency. Fishermen are less likely to participate in the process or adhere to the rules if they do not trust the managers or trust the science being used to regulate their livelihood. A recurring complaint from fishermen at our hearings is that many of the decisions that affect their ability to make a living are made behind closed doors.

The Regional Fishery Management Council system authorized in the Act is unlike any other natural resource management authority. This regional system was designed to allow those who are most affected by management decisions to have an active role in making those decisions.

The Act requires robust public participation and a very transparent process to be effective. The transparency aspect need to be further examined.

While some of you may not like some Councils' decisions, I suspect you would much prefer working through the Council system than having someone in Washington, D.C.—who may know little or nothing about your fishery—making decisions about your livelihood.

National Ocean Policy/Other Statutes that Affect Fisheries

While the Magnuson-Stevens Act allows for direct public involvement by the affected resource users, it is, unfortunately, not the only statute or regulation that affects fishing.

As many of you are aware, the Obama Administration released an executive order in 2010 that created a National Ocean Policy. The Administration decided to sidestep the legislative process despite the fact that four Congresses had considered legislation to create a very similar ocean policy, and created the National Ocean Policy by executive order and without statutory authority.

Not only does this Policy add new policy goals and requirements for Federal agencies to meet when permitting activities, it creates a new level of bureaucracy that will certainly add more hoops for all Americans to jump through.

And while the Magnuson-Stevens Act requires direct public participation, the National Ocean Policy envisions Regional Planning Bodies made up entirely of government officials. The Policy exempts these regional bodies from the Federal Advisory Committee Act (or FACA) which is the primary statute that requires transparency and public participation. As you are aware, the Regional Fishery Management Councils raised concerns with this arrangement. The Administration could not have created a more tortured way of including the Councils—done in an effort to maintain the FACA exemption. The result is that when the National Ocean Policy and the regional planning bodies are operational, no fishermen will be included. Does "I'm from the government and I'm here to help" sound familiar?

This is just one example of the lack of public involvement and lack of transparency that surrounds the National Ocean Policy. My committee has held six hearings related to this Policy and we have sent a number of letters to the co-chairs of the National Ocean Council and we still have not been able to get answers to simple questions. Questions about how this Policy is being funded and how many Federal employees or detailees are working on this policy should be easy to answer. But when we cannot get answers to these simple questions, it makes us wonder what they are hiding.

One of the other laws that is requiring a great deal of focus this Congress is the Endangered Species Act (ESA), which was last authorized by Congress nearly 25 years ago. This law has done more to keep environmental lawyers in business than it has to recover species or to balance the needs of average Americans.

Aside from the burdens created by the ESA, to most objective observers, the law is failing to achieve even its primary purpose of species recovery. Federal agencies charged with its implementation every year spend hundreds of millions of taxpayer dollars under the rubric of "endangered species recovery." Yet, the law over the past 40 years has only achieved, at best, a one or two percent recovery rate.

The Department of Interior and NOAA have signed closed-door settlement agreements with litigious environmental groups that require the Federal government to decide whether to list and designate habitat for over literally hundreds of species and sub-species within the next three years. These back-room deals will almost certainly have an effect on both commercial and recreational fisheries, and the lack of transparency in these deals is disturbing. In addition, the funding that will be required to implement these "deals" will further strain already tight agency budgets for things like fishery surveys and stock assessments.

The Administration's doubling-down on regulating through ESA-related litigation not only raises serious questions about the scope of their authority, but underscores the need for a serious examination of the ESA itself. This Committee intends to do just that this Congress.

I want to thank you all for being here and look forward to your suggestions for how Congress and the agency can make fisheries management better for the fish, the fishermen, and fishing communities.

This conference will certainly give us a lot of information to consider. In addition to the findings of this conference, there are a number of other efforts underway which will help us with the reauthorization—the General Accounting Office, the Department of Commerce's Inspector General, and the Ocean Studies Board of the National Academy of Sciences have or will be releasing reports that will add to our deliberations.

I look forward to working with you on this important reauthorization and look forward to reviewing the recommendations that will come from this conference.

I wish I could stay longer today, but the House is in session this week and unfortunately, I need to run back to Capitol Hill. Thank you again for the opportunity to speak to you today.

Remarks by Senator Mark Begich

Senator Mark Begich is in his fifth year representing Alaska in the U.S. Senate, where his primary focus is building a strong Alaska economy. Senator Begich was recently named to the Senate Appropriations Committee and the Senate Indian Affairs Committee for the 113th Congress. Senator Begich serves on the Veterans Affairs, Homeland Security, and Commerce committees, and is Chair of the Commerce Committee's Subcommittee on Oceans, Atmosphere, Fisheries and Coast Guard. Senator Begich was elected to the Senate in 2008 after serving as mayor of Anchorage for nearly six years. Born and raised in Anchorage, Senator Begich's other priorities include reducing the national deficit, tax reform, and building a national energy policy that emphasizes Alaska's oil and gas resources, an Alaska natural gas pipeline and the state's many renewable resources.

These comments were given during a banquet on May 8, 2013.

Thank you very much. This conference attracts so much attention. There's a reason: fishing. Commercial and recreational fishing is a huge industry in this country. It puts tasty, healthy, sustainable seafood on our dinner plates. It drives the economies of our coastal communities, and interior communities. It's a livelihood for almost two million Americans. Twelve million more just relish the opportunity to grab their rod and reel and wet the line.

I floated the Gulkana recently. My son—who at that point had just turned 10—was fishing and fishing and fishing, and we tried to explain that he had to come and set up the tent. He looked at me and said "Dad, I gotta fish! I gotta catch food for tonight." We also fish in catch and release fisheries. Sport fishing really is important.

Back in my state and elsewhere across the country, subsistence fishing is an ingrained and very important part of the culture of the Native American people. Americans love fish, and they love to fish. That's why we're here.

The challenge we face is preventing us from loving our fish to death. Since 1952, well within the lifetime of many of us here, the population of the United States has doubled. That's twice as many mouths to feed, twice as many weekend anglers. Technology has increased even more capability. Whether you're in the midwater trawlers or a bass master, the use of sonar, GPS, fish finders, has greatly increased our ability to kill and get fish. But overall, the amount of fish, wild fish, hasn't really changed. In the past, people thought the resources in the sea were inexhaustible. That is not true. To feed the growing appetite, now over 90% of the seafood Americans consume is imported. Aquaculture, both here at home and abroad, has helped fill the need. As much as I prefer my fish wild, half of the seafood Americans eat is farmed. A growing demand to meet our nutritional needs and recreational opportunities has put an unprecedented pressure on our wild fish stocks. It's led to fishery booms and busts, and increasing competition between the user groups. What do we do with all that?

When the late Senator Ted Stevens first ran for the U.S. Senate in 1968, he heard a lot about the problems of the fishing industry. Then it was foreign fleets operating right off our shores, right over the three-mile limit. This was happening around the nation, not just in Alaska, and Ted wanted to see it for himself. Once in Kodiak he asked the Navy to fly him out to the Pribilof islands. Out over the Bering Sea from the window of the Navy Albatross he saw dozens and dozens of foreign vessels, catcher boats and large processing ships, fishing just over the horizon without any regulation. He immediately started working on legislation to extend our boundary out to 200 miles. Other nations were making similar claims. It was causing havoc for the tuna fleets off of South America. Stevens didn't get very far at first, he was just a freshman senator, but he found a ready ally in Warren Magnuson, from Washington, and together they went to work. On the House side there were supporters like Rep. Don Young and Gary Studds from Massachusetts. I have to tell you to this day Don Young, still serving in Congress, complains that bill should have been called the Young-Studds Act. Only with Don Young can you say that.

When it finally passed as the Magnuson-Stevens Act (MSA), it went farther than boundary. It created a public process to manage our harvests. It created the eight regional Councils, guided by scientific committees and advisory panels for fishermen, processors, and the public to set rules and goals to protect the fish and our fishing economy. Well, just extending the boundary made a huge difference. Think about it. In 1976, when the Magnuson-Stevens Act was passed, the total commercial harvest nationwide was five billion pounds, worth about a billion dollars. In 2011, the catch was almost twice, 9.9 billion pounds, worth over five billion dollars to fishermen, and which generated 53 billion dollars in sales. The two million tons in the Bering sea Pollock, cod, and other groundfish previously harvested by foreign fleets, is now Americanized, thanks to the Magnuson-Stevens Act.

I thank you for serving Alaskan seafood here tonight. You'll forgive me for bragging about Alaskan seafood from time to time tonight, but that is only because Alaska produces 56% of the nation's commercial seafood catch, and it is well known the fact that Alaska has the best sports fishing in the world.

Recreational fishing supports almost half a million jobs around our nation. Anglers spend 4.5 billion dollars on 70 million fishing trips last year. And when you add up all the sinkers and bobbers and fishing lines and all those lures lost on snags and on outboard motors, the recreational fishing industry has about 70 billion dollar impact to the U.S. economy. The bottom line is, fishing, both recreational and commercial, is a big industry. And the question today is just how well the Magnuson-Stevens Act manages that. I know there are differences of opinion in this room; from Alaska's perspective things have worked pretty well. Not perfect, but most Alaskan stocks are in good shape. There are no overfished species of finfish, and major species like Pollock and cod and halibut and salmon are certified as sustainable. Our southern tanner crab was among six stocks recently certified as rebuilt. Yes, we have our problems. There are serious issues currently with halibut and king salmon stocks. Catches have been seriously reduced, and some fisheries completely closed as a result. We've lived with the hard quotas and catch shares, and yes, it can be tough. And there are fights over observers and small boats, the impact of bycatch, implementation of the Endangered Species Act, and allocation between commercial and charter fishermen. But by and large, Alaska enjoys a healthy enough resource to fight over.

Fishermen from New England will tell a different story, and I have to be frank with you, I've been to New England more than once, experiencing the debate and discussion of fisheries. There is no doubt the 70% cuts in the Gulf of Maine and Georges Bank will be devastating to individual fishermen and entire communities there. Some question the adequacy of science, the impact of catch limits, and the inflexibility of rebuilding goals. There remains opposition to catch shares. Elsewhere around the nation, most regions fall somewhere in between. As a member of the Senate Subcommittee on Oceans, and as the chair, my job is to look at these issues, find out what the answers are.

As Chairman of the Subcommittee, I understand there are important issues we need to move forward on, because now Magnuson-Stevens is up for reauthorization. It's time to take stock of our fisheries, our management system, and where we need to go from here. How do we meet the national standard of stopping overfishing and achieving optimum yield? What do we do regarding annual catch limits and rebuilding goals and timelines, especially when dealing with data-poor stocks, species we just don't have a lot of scientific information on? How can we take into account the broader ecosystems, forage fish and habitat loss and impacts of climate change? And perhaps the most challenging, while we're protecting fish, how do we protect the jobs, ensure stability for commercial fisheries and fishing communities, and opportunities for recreational and subsistence users? I know you spent yesterday talking about these issues, and truly I'm interested in your conclusions. I know there have been discussions on annual catch limits and rebuilding timelines, more collaboration, cooperative research, and improving Council outreach to recreational and subsistence users. The idea of MSA certification of sustainability has truly got my attention.

Let me tell you how my Oceans Subcommittee will be working on these issues as part of the reauthorization of the Magnuson-Stevens Act. First, we want to take the results of this activity, this conference, to be utilized as a base. Your work this week will be key to the issues we deal with. Next, my ranking member Senator Rubio from Florida, and I, are talking about a series of three initial oversight hearings to begin this summer. One covering New England and the mid-Atlantic, another for the South Atlantic and Gulf of Mexico, and a third for the Pacific and Alaska. After these initial inquiries, I want to hear directly from fishermen in the field hearings in affected regions, including Alaska.

Those of you who have been around for the last reauthorization of MSA know it took years to complete. I wish I could say here that it would be quick, but I anticipate it will take a little longer. I know on the House side, Chairman Hastings is working on a draft reauthorization bill, and I welcome his work to kick it off. I can tell you we are gearing up to bring our baseline bill forward also. It's important to bring these bills and start the discussion.

In the meantime, there is a lot of work in Congress that we can do on fisheries. We can deal a blow to the 20 billion dollar a year pirate fishing that's been occurring. These are people stealing our fish, and we need to get them under control. We can crack down on them by passing the Port State Measures Treaty to better enforce existing laws on seafood imports. We need to work with processors on practical ways to crack down on fraudulent imports and retail mislabeling so consumers know what they are buying at the fish counters. While talking about enforcement, we need to beef up the budget of the Coast Guard for fisheries patrols, search and rescue, and all their important work on behalf of American fishermen.

I'm pleased the Administration is proposing modest increases to NOAA funding, but suggest even more is needed to meet our basic research needs, ensure enough ship time to do more stock assessments, meet management obligations with the states, and to develop workable options for observers and other critical management tools. Congress needs to support local fishermen and communities by funding declared fishery disasters in New England groundfish, Mississippi shellfish, and Alaska Chinook. We need more safety training and other common sense efforts to save lives and shake the reputation of being the deadliest catch. We can improve the fisheries finance program to facilitate the construction of new fishing vessels that are safer, and more efficient. We can fix the Capital Construction Fund to release standard capital to retired fishermen without penalizing them, and extend their tax advantages to improve shore-based facilities. We need to reform the immigration laws to ensure American processing plants have the seasonal workers they need to process the catch. We must improve our understanding of ocean acidification, which is already a problem in shellfish growing, but will likely have broader impacts; address marine debris and plastic garbage that is increasingly found in our fish habitat; and work out issues with the rigs-to-reefs concept to provide more opportunities for recreational users in the Gulf.

I know that's a big agenda, that's a lot of work that needs to be done, not only with the Act but all these other issues. But this conference is just the beginning. I know there is skepticism out there about the role of fisheries management. Fair enough; there is a lot of cynicism here in Washington. Let's counter that with open, honest discussion on these issues over the months ahead. Personally, I am a believer in applying science to address the biological issues we face, but never forget the human face. I know it means having to make tough choices for the long term; and short term, we have to mitigate the impacts on fishermen and fishing communities. This is not an easy task, and I guarantee you it will be controversial. Nothing around fishing is not controversial. But thank you for taking the first steps with this conference to help us kick off what we need to do in making sure that we do the right thing—and a special thanks to the Regional Fishery Management Council members and staff, including the SSC and the advisory panel members, for your hard work all year around on behalf of sustainable fisheries. Thanks to the fishermen and women, who work through the Council process to find answers on these very difficult decisions and questions. Thanks as well to the NOAA biologists and the boat drivers, the enforcement officers, and all the men and women of the Coast Guard, and everyone connected to our fisheries. It takes all of your work, your experience, your dedication, your commitment, and your active participation to save both the fish and the fishing industry, commercial and recreational, as a vibrant part of our national economy.

And again just a special thank you for all the work you are all doing here over the day and a half, two days. This is going to be important for us and our Committee work in stepping up and knowing where we need to go next, so thank you very much.

Remarks by Eric Schwaab, NOAA Assistant Administrator for Fisheries

Eric Schwaab served as NOAA's assistant administrator for fisheries from February 2010 until June 2013. While at NOAA, he led efforts to rebuild fisheries and the jobs and livelihoods that depend on them. His priorities included improving outreach and relationships with recreational and commercial fishermen, better aligning Federal and regional fisheries priorities, restoring confidence in fisheries law enforcement, and promoting management approaches to achieve sustainable fisheries and vibrant coastal communities. Eric spent the majority of his career at the Maryland Department of Natural Resources, where he began as a natural resources police law enforcement officer in 1983. Eric has also served as a member of the U.S. Department of Commerce Marine Fisheries Advisory Committee. During his career Eric has developed and implemented solutions to address challenges in regional habitat restoration, including Chesapeake Bay restoration issues, fish and wildlife conservation, public lands management, natural resources law enforcement, public agency administration, strategic planning and leadership development.

Thank you very much. Good morning everyone. I do want to thank Chairman Hastings for his remarks today. We work closely with Congress on many issues and depend upon their leadership, and I appreciate him taking the time to provide an important and valuable perspective on U.S. fisheries management. I must say, as an aside, that when Don offered me the opportunity to switch places with Mr. Hastings I jumped at it. It's very rare that I get the last word in when I'm in front of him.

So I also want to thank Don and all of the Pacific Council—Don and his staff, who brought us to this venue here with such a great agenda, and I really do want to very explicitly acknowledge the important work of the Council in pulling this thing together, because we all know that getting here is half the battle. And what a great venue. I also noted the balcony seating. I went one step further and noted that up here to my right is Sam Rauch, the current Acting Administrator for Fisheries, and Bill Hogarth—I'm sure it's only by chance that they're just up here looking down over us.

On behalf of NOAA, the NOAA team, and the entire administration, I must say in venues like this I am always very proud to stand and speak on behalf of the entire NOAA team. I want to welcome each of you here. Thank you for taking the time out of your busy lives to come here this week to talk, think, and problem solve with us about the future of our nation's fisheries and the communities that depend upon them. When we set about to plan this conference with the Councils, we really did see this as an important venue to bring together all of the great minds who are working around fisheries issues from all walks of life, from all parts of the country, and I think based upon the attendance in this room this morning we very much have accomplished our first objective in getting you here. By bringing together the very people who are both seeing the progress and dealing with the big challenges we can help to chart the most effective way forward. This morning I'm going to help frame things before us a bit, noting a bit about our progress, identifying some of our big challenges and then sharing from my perspective some initial thoughts regarding some areas for additional focus here over the next few days.

But before I do that, I do want to emphasize just one minute longer that all of the progress that we have made, all of the hard work yet in front of us, begins and ends with the people in this community.

I couldn't help but just be overwhelmed last night at the opening reception with the great diversity of old friends who are here in this meeting this week, and I think that the way this community has come together in recent years behind sustainable fisheries management has been noteworthy. But people like the Council members, NOAA scientists and managers, people in academic institutions advancing our understanding of the state of our fisheries, fishermen, advocacy organizations, our state partners, political and community leaders, many others—there are two such people who were tremendous influences on me personally over the course of my career, who are not with us this morning. Both passed away earlier this year. I know we've lost others, but these are people who have touched me again very importantly over the course of many years. Larry Simms, many of you know, was a fourth generation waterman from tiny Rock Hall, Maryland, and was best known as the first and only—until his passing—president of the Maryland Watermen's Association. It's hard to capture the essence of Larry in a few words; but I think the Bay Journal may have done it best in its tribute to him, describing him as a passionate defender of the Bay's watermen, known for building consensus with agencies in the mutual battle to save Chesapeake's degraded waters. Larry was a fisherman first but also a man who worked tirelessly to represent the interests of all of Maryland's watermen in ways that reflect the very foundation of this meeting: fisheries sustainability for both current and future generations of fishermen.

Many of you who know me also know me as a product of state management systems, and I have great respect for the role of our state partners in the fishery management process: Larry Simpson. For over 30 years Larry Simpson defined the very best of state engagement in fisheries management. As Executive Director of the Gulf States Fisheries Commission, he led the Commission's work to promote the conservation, development and full utilization of the fishery resources of the Gulf of Mexico to provide food, employment and recreation to the people of the United States. And he did so during some very challenging times for the Gulf and its fishermen. Both of these men demonstrate a great skill at carving out consensus and had innate abilities to see not only how things were, but also how they could be. Their example can be a model for us here this week, and going forward, as we continue working in partnership to sustain our nation's fisheries. So thank you for allowing me that indulgence.

This conference is designed to look forward. But to look to the future we need to know a little bit more about where we have been. Just last week we released our annual report to Congress on the Status of U.S. Fisheries. This report documents the strength of this country's science-based fisheries management process to prevent overfishing, rebuild depleted stocks, and ensure sustainable harvest for the long term. The report highlights the continued significant progress that collectively NOAA fisheries, the Councils, commercial and recreational fishermen and many others have made to end overfishing and rebuild stocks. Overfishing is at an all time low, and this year we report that 90% of the stocks with a known status are not subject to overfishing. Ninety percent. 2012 was the first full year that all Federal fisheries operated under annual catch limits to end and prevent overfishing. This marked a milestone in fisheries management, establishing a dynamic science-based process that both prevents overfishing and responds when it occurs. In fact, overfishing has ended for 58% of the domestic stocks that were subject to overfishing as recently as 2007, when the Magnuson-Stevens Act was last reauthorized. And we expect the number of stocks currently on the overfishing list to decrease further as a result of management under this innovative system.

There are of course long-term benefits to ending overfishing and rebuilding stocks; since 2000 we have rebuilt 32 fish stocks. But this isn't just about fish, as we all know very well. This is also about the economic success that follows once a stock is sustainable. Our commercial fleets can bring fish to the docks safely and consistently; and communities can depend upon good recreational fishing for tourism benefits and quality time on the water with friends and family. The results of well-managed fisheries yield great benefits to fishing communities and the United States economy. In 2011 the commercial and recreational fishing industry and the associated business played an enormous role in driving the U.S. economy, generating more than 199 billion dollars in sales, and supporting 1.7 million jobs. Based on the latest figures, U.S. commercial and recreational saltwater fisheries added 200,000 jobs to the economy between 2010 and 2011. I dare say there aren't very many industries during that period of time that can claim that kind of a job creation record.

Effective management of course requires good science. Over 100 stock assessments are successfully updated each year, and we are working hard to continue to improve stock assessments. In the future, improving technology for data collection, improving assessment models and methodologies and pursuing next generation stock assessments to better account for how ecosystem changes impact fish stocks, a solid understanding of the ecosystem foundation on which fishery resources depend, and productive habitats that support fisheries, are critical to our long-term success.

The best management, of course, can also take advantage of flexible tools that can be applied to meet the many different management objectives of fisheries around the country. Catch share programs are one such tool, and they are currently used in 15 fisheries managed by six Regional Fishery Management Councils. While not appropriate for all fisheries, and certainly even where appropriate, they are not one-size-fits-all solutions, well-designed catch share systems are better aligning long term sustainability goals with the immediate and long-term business interests of many fishermen. They are helping to eliminate overfishing and achieve annual catch limits, produce more fish at lower cost, improve fishermen's safety and profits, and provide much needed flexibility to fishing businesses. And in the international arena, through our nation's hard work to address illegal, unreported and unregulated fishing, we are helping fishermen who are complying with strict domestic standards to be more competitive, operating on a more level playing field.

I've mentioned this once already, but I must do it again. All of these successes can be credited to the hard work of the fishery management Councils, individuals in the process, our state and academic partners, fishermen, and many others. In fisheries, it's the hard work of individuals and the collective work of partnerships that lay the foundation for success.

Now, whenever we talk about the recent success, we are reminded quickly of the many places and the many ways where results have not been what we had all hoped for. And even where significant progress has been made, this progress has not come without cost. Fishermen, fishing communities and the Councils have had to make difficult decisions, and many areas of the country have had to absorb the cost of conservation and investment in long-term economic and biological sustainability. The start of the new groundfish season just last week in New England again brought these challenges into sharp focus. We've had to implement strict catch limits for the 2013 fishing year, for several key groundfish stocks, that despite the best efforts of all involved have not responded in the way that we had all expected. At the same time, red snapper in the Gulf present a different problem. While rebuilding is clearly underway, and even as catches increase annually, we are struggling to strike that balance between reaching an agreed-upon rebuilding target, long-term potential of that stock, and providing access to a rebuilding stock.

We have come far together, and although there are still many challenges to face, we are on the right course. Now is the time to focus on how to make the system and the processes work better. That's the primary purpose of our gathering here this week. We're here for an open and constructive dialogue about how to address these challenges and to identify the right steps to move forward in the future. So what are some of these challenges? I'm going to very quickly highlight eight.

First is how to manage for stability in the face of dynamic ecosystems. The marine environment and ecosystems are dynamic, and we don't have all the tools that we need to predict changes, understand their effects on stocks, and develop appropriate management responses. But if we fail to better address these issues, these fisheries will suffer despite our best efforts to manage fishing mortality rates.

Second is how do we react to stocks when they do not respond as expected? Despite our efforts to manage using scientific guidance, for some stocks we don't see the response we had expected. We have to find better ways to minimize these occurrences, better explain them when they do happen, and put us on a course to identify corrective actions more expediently.

Third is the demand for information. Despite the best work of our scientists, it is hard to keep up with the information needs of our fisheries. More sophisticated stock assessments, information-intensive management systems, and changing conditions demand greater progress here.

Fourth, budget challenges. Current budgets are under significant downward pressure. Certainly that's a long term trend at the state level; it's something we are experiencing very acutely at the Federal level. It has impacts on Councils, it has impacts on scientists, it has impacts on many others. We have shown that fisheries investments yield dividends; how do we continue to meet the science and management needs more efficiently and continue to secure the resources needed for stock assessments to monitor fisheries and to understand more fully the socioeconomic needs of fishing communities against these downward budget pressures?

Fifth, and this is a big one, the need for more flexibility. Despite the best efforts of managers to be flexible, this is not a system that has traditionally supported quick reaction to changing circumstances. How do we improve our ability to react to changes responsibly but more quickly? And I might add, I think standing here today with the status of the stocks that we have now, an important part of our conversation will be how is it that we take advantage of the fact that for many stocks, we are operating from a healthier place, with perhaps a little bit more maneuverability with less downside risk.

Sixth, habitat. Habitat challenges are hindering the rebuilding of some stocks, impacting long term productivity in other places, and reducing the resiliency of ecosystems to respond to change. Every indication is that habitat challenges will become an even greater part of fishery management going forward.

Seventh, support for U.S. aquaculture. U.S. demand for seafood is ever increasing. Imports are higher than they have been, and over half of those imports are farmed in other countries. So while we have NOAA and the Department of Commerce aquaculture policies and are working with states to streamline some regulatory systems, we still do not have all the tools that we need to support a vibrant aquaculture industry in the U.S., to take advantage of those jobs for our coastal communities.

And finally, as it relates to challenges going forward, addressing the different and growing needs of recreational fisheries. Recreational fishing is an important social activity for individuals, families, and communities, and it is a critical economic driver of and contributor to many local and regional economies, as well as the national economy. We need to ensure that these opportunities continue to build while maintaining sustainable stock levels. We also need to better understand and manage for the unique needs of recreational fisheries, another focus of discussion here this week. So all of that, from my perspective, brings us here today, here this week.

Looking forward. As we have in advance of past reauthorizations, we've worked closely with the Councils to bring you here. The conference is organized around three key theme areas of this conference. You could say three challenge areas. First, fishery management essentials. These sessions are focused on the foundations of science, management and compliance that have gotten us to this point, yet it is clear that in each of these areas we need to continue to do better.

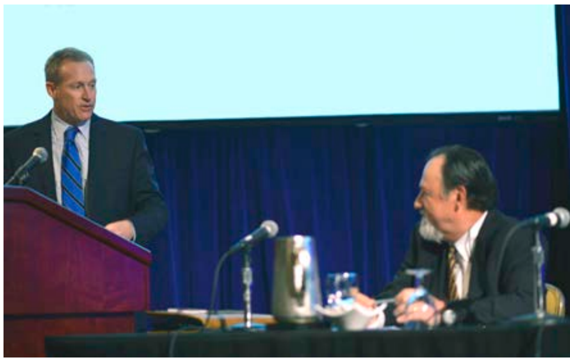
Second, ecosystem-based decision-making. There is no question that many of our big challenges going forward go well beyond catch limits and accountability measures. Warming and more acidic oceans, competition for forage species, and declining inshore and ocean habitat will be a big part of our future deliberations and challenges. We must prepare more effectively to anticipate and address them.

Third, the third major theme of the conference: fishing community stability. Social and economic tradeoffs. Allocation issues. Balancing the needs of commercial, recreational and subsistence uses. And most importantly, increasing community resiliency and stability are critical issues for our future. In each of these areas, there's opportunity: at NOAA, we have continued to seek ways to move forward, some apparent, some less so. Some yielding great benefit, others still works in progress. But I do want to spend just a few minutes on four key areas of focus that we think prominently hold promise.

First, we must continue to seek ways to improve the timely collection of data, develop more robust and frequent stock assessments, and translate those data and assessments into management actions. From MRIP [the Marine Recreational Information Program] to better use of alternative survey methodologies to increased use of electronic monitoring, opportunities exist to move forward even more aggressively than we have to date.

Second, even as we regularly increase the number of assessed stocks, we recognize the gap between what we have and the total number of stocks under Federal management. Councils and the agency have worked hard to find creative and effective ways to manage those stocks for which we lack current assessments. Some of those approaches have included effective use of ecosystem component stocks, or through developing effective proxies for stocks with long histories of relatively stable landings, but no stock assessments. We must continue to explore this area aggressively to ensure sustainable management for all Federally managed stocks.

Third, we must make more rapid progress in improving our understanding of those environmental factors I spoke of. Councils are making great progress in understanding and reacting to ecosystem changes, but more needs to be done, and it all starts, as so much of our work does, with a good foundation of scientific understanding.



And then, finally, we must find ways to do a better job of addressing fishing community stability. Action in many areas will help, but in the end we need to find ways to dampen the current volatility in catch limits, and the effects of accountability measures. Where significant decreases are necessary, we must work closely to mitigate economic impacts in ways that sustain fishing communities for better times ahead.

So in conclusion let me just say that looking back to 1976, when the Magnuson Act was initially passed, the legislation charted a groundbreaking course for sustainable fisheries. When the Act was reauthorized in 2007, it gave the eight Regional Fishery Management Councils and NOAA very clear charges, and some new tools to support improved science. It did mandate the use of science-based annual catch limits and accountability measures. It did provide for greater use of market based fishery management through limited access privilege systems. It did focus on collaborative research with the fishing industry, and bycatch reduction. It did address the need to improve science used to inform fishery management. And it did seek to end illegal fishing and bycatch problems around the globe so that foreign fishing fleets are held to the same standards as the U.S. fleets, and do not put us at an economic disadvantage.

With that in mind, let's remind ourselves that the purpose of this conference is to look to the future of U.S. fishing and the Magnuson Act, and learn where we can make improvements under current authorities. I do want to emphasize, there is a big part of this focus that is about the next reauthorization of Magnuson, but we don't want to limit our deliberations only to the next reauthorization. Many of us I think believe and are taking advantage of significant opportunities within the current legislation to achieve and address some of the topics that I mentioned. We need to also maintain over the course of the next few days those options as well.

I do not have any preconceived ideas about what would come out of the discussion we're going to have over the next two days; I suspect some of you share that view; others perhaps have much stronger opinions. I will be listening to what is said here to inform how NOAA Fisheries moves forward, and also how we might engage in upcoming discussions about Magnuson reauthorization. We are excited to hear from each and every one of you. I know that all of our speakers were charged with bringing one new idea to the discussion, and I hope that many of you are planning to engage actively and do the same. We have the people in the room who will constitute and provide the right leadership for the challenge in front of us. As participants in this conference I ask each of you to take that responsibility seriously and engage in the thoughtful dialogue about how to build on our successes and address the challenges that we face to advance sustainability of U.S. fisheries. To be successful we need to listen to each others' ideas, we need to build on each others' perspectives. Everyone has something important to say, and a reason why that idea is important to them. We are all here to hear those ideas as well as to share our own and consider the possibilities in them. Thank you all very much for being here this morning, and this week.

Remarks by Chef and Author Barton Seaver

Barton Seaver serves as Director of the Healthy and Sustainable Food Program at Harvard University. He is a chef, an author, and a National Geographic Fellow. Mr. Seaver believes food is a crucial way for us to connect with the ecosystems, people, and cultures of our world. As an executive chef, Mr. Seaver opened seven restaurants and gained numerous awards and acclaim for his food and for the environmentally conscious businesses he ran. His restaurant Hook was named by Bon Appetit magazine as one of the top ten eco-friendly restaurants in America. Mr. Seaver left the restaurant industry to pursue his interests in sustainable food systems and accepted a Fellowship with the Explorer Program at the National Geographic Society. For the past three years he has used this position to explore the confluence of human and ecological health. As part of this exploration, he has traveled the globe and gained deep insight into the human and economic systems that govern our relationship with nature. As the author of two books, Mr. Seaver continues to explore these themes with the home cook. His first book, For Cod & Country, showcases seasonal seafood, vibrant spices, and farm-fresh produce. His second cookbook, Where There's Smoke, was released in April of 2013. Mr. Seaver's work as the Director of the Healthy and Sustainable Food Program at the Center for Health and the Global Environment, Harvard School of Public Health will aim to highlight the important connection between environmental resiliency and human health while ensuring the profitability of local food producers. Complimentary to his role at Harvard, the New England Aquarium named Mr. Seaver their first Sustainability Fellow in Residence to help relate the Aquarium's conservation messages with our dinner plates.

Hi everyone, good morning. I can't tell you what a thrill and an honor it is to be standing here in front of you. This is absolutely not what I thought my trajectory would lead me to when I was washing dishes; but I am thrilled and happy to be here, and I want to take the opportunity first to thank Don, to thank Laurel Bryant, my good friend, for introducing me to this world here, and for allowing me the opportunity to speak to you today.

And also it's not very often that you get this many fishermen and fisherwomen in a room together, so I want to take an opportunity as a chef to say thank you to all of you who have enabled my career. You've provided the ingredients through which I have curated my career, and that means a lot to me. It is what has sustained me. It is what has sustained my family, and I really appreciate the effort you put forth in order to enable that to happen.

Now, I grew up here in Washington, D.C. I was the product of a family where family dinner was an event 363 nights a year. It was non-negotiable, and if I wanted to hang out with my friends, fabulous—they were invited over for dinner as well. And this was a good thing, because my parents were both very intrepid and good cooks. We didn't eat fancy food, we ate real food, whether that be Jolly Green Giant peas with just a little bit of salt and butter—this was real food, treated well, and we ate in ways that really reflected health, reflected community. It was at the dinner table that we really learned to become individuals, where we really learned the art of communication, of disagreement, of agreement, where to hate, where to love, where to argue, where to kick my brother in the shins under the table—I mean, all of these things that are so important to me now.

I was able to spend a good deal of my summers here in D.C. moving out of the city down to the Patuxent river, tributary of the Chesapeake Bay, and there I spent my entire day in the quest for food. I would wake up at the crack of dawn and run down the dock, pulling off the pilings giant male crabs, throwing back anything with a carapace size under six inches, throwing back all the females; every third cast of my line came back with a perch, a porgy, a croaker, a striped bass, a drum, a spot, a ray, a shark, a skeel, and—striped bass, bluefish, you name it. There was bounty in those waters, and I was fluent in that bounty. It became part of my baseline, how I see the world.

When I was a young man, I first had the opportunity to step out onto my own as an executive chef in a restaurant here in D.C. I was tasked with creating a menu. Now, a menu is a very personal document. It is a narrative of what I want to communicate about my experiences to you, my guests. So I looked to my past. I looked to my own fluencies, and I got on the phone, called my fish guy, and said, "Hey, I want striped bass, I want blue fish. Send me oysters, send me blue crab. Oh my God, this is going to be delicious!" And the voice on the end of the line said, "Kid, what are you talking about? We ate all those. What else do you want?"

And it was quite a startling moment for me. I mean, right then, right there, I realized that the guiding hand of natural selection in our world is quite firmly holding a fork. The way that we eat largely describes how this world is used. So says Wendell Barry. I began looking for answers as to how and why we could have let something so silly happen. How could we let something so delicious, something so integrally linked to our own story, how could we let that go away? I began reading back through the canon of environmental literature. I began asking questions of my colleagues and friends in the NGOs. I began introducing myself to folks that were asking how. And the answers that I found were largely based on the idea of the tragedy of the commons – the seminal Garrett Hardin paper, 1968, which has largely come to represent how it is that we think about environment in this modern world. And that is the story of how we have impacted ecosystems, much to their detriment. Environmentalism often is a story of human bad. It reflects a growing anxiety over our lack of capacity to figure out what exactly it's going to take for us to thrive in our modern world, and whether the relationship between humans and nature is one that is based on scarcity or on abundance.

But in restaurants, tragedy is not what I sold. You don't come to a restaurant to be told everything you've done wrong. You come for joy, you come for gracious hospitality, you come for delicious nourishment, you come for community. The narrative of tragedy just simply did not work for me. It didn't fit my narrative.

You know, in the public's perception, environmentalism largely describes human beings simply as the bad actors. And even the term sustainable largely leaves us to believe that the best we can do is to maintain the status quo. So I had to look for a more positive narrative, one that described the opportunities of abundance that we have. And one that looked to celebrate the human role within the systems of nature. Because if, as I learned, we can destroy through the choices that we make for dinner, if I as a chef can choose to purposefully extirpate bluefin tuna, if we can bring seabass to the point of extinction, if we can diminish the capacity to feed ourselves from striped bass and bluefish, oysters and blue crab, here, in our own backyard, if we can then take those same decisions and make ourselves sick by them, with unprecedented levels of obesity, diabetes, and heart disease—fabulous. That's the best news I've heard all day. If we can destroy, then by the other side of that coin, we can heal. We can restore by the very same actions. We can restore the health of ecosystems, we can restore the health of economies, and we can restore the health of our own selves. Because if we are the problem, great. We're the solution.

I began to call this narrative the Communion of the Commons. The story about how humans are impacted by ecosystems, rather than just a metric of how we have impacted them. This is a more useful narrative for me; it was a more hopeful and it was a more human story. In our conversation, though, about sustaining environments and food systems, I think we often don't fully embrace the human side of this narrative. We often choose not to see the broader context of how our actions actually relate to our cause. I mean, take for example two environmental causes: organic foods, better for you, better for me, better for the planet, better for the community, right? OK, well what room does that create for cigarettes created with organic tobacco? Recycling? Largely considered to be the most successful environmental campaign of all time; reduce, reuse, recycle. Written into the legislation of municipalities all over this planet, and yet, recycling through all of our efforts has actually increased the amount of recyclable goods in our economy. We failed to recognize the first star, which was to refuse. Then, if we must, to reduce, reuse, and recycle.

In fisheries, we have fabulous science, we have the great work that NOAA does, we have the Marine Stewardship Council, the work that Monterey Bay Aquarium, my colleagues at New England Aquarium, are doing. We have the Sustainable Fisheries Partnership to tell us most of what we need to know about the what, where, and how of our interaction with the oceans. But what we need to do now is to take that knowledge and use it to consider exactly what it is about our oceans that we're trying to sustain. And I think the answer to that is that we're trying to sustain ourselves. We're trying to sustain our industry.

Now, the way in which we describe this to people is through good food movements. Just like organic. Now, I want to talk about two movements, the first one being Farm Aid. It started around the same time as the sustainable seafood movement, and I'll just lump in together for the ease of conversation under Farm Aid, local, seasonal, organic, all of these ideas that we have. Farmers' markets. The idea was that local, small family farms were going by the wayside, and we decided they were such an integral part of the social fabric of America that we had a moral imperative to save farmers. So we set out to do that. Now, around the same time, we had sustainable seafood come to the fore. As we began to realize how we had impacted systems and how those depleted systems were then impacting us. And we set out with a sustainable seafood campaign. Give swordfish a break campaign. Take a pass on Chilean seabass. Here in the D.C. area, Save the Bay. And while these campaigns have been affected by the courageous efforts of those involved fishermen, NGOs and government alike—none of these mention fishermen. They don't communicate the broader context by which those efforts actually succeeded, which was through the efforts of those who provide us access to those commons.

You know, we tend to think of fisheries as ecological models, but in fact they're not. They're economic models. We get this about farms. The settlers didn't set off from Plymouth Rock to cross the Missouri to find a perfectly manicured landscape ready for seed. We don't walk into a wood to find a hunt; we go there to hunt. So, too, do we pull away from safe harbor in order to find seafood. In order to create a fishery. In order to feed other people.

Now, the tragedy of the commons—I think it's a little bit misunderstood. Tragedy is not in an oil spill. That's not tragic. Tragedy is the preventable error which caused an oil spill through which we diminished our capacity as a community to clothe, feed, and house ourselves. It is through a preventable human error that we diminished our own security. Is in the diminished capacity of Gulf fishermen to continue on as they always have. Tragedy is not in the destruction of the commons; it is that we no longer have access to that which we so desperately need from the commons. So when we talk about sustainable seafood, I think it's important to note that we're not trying to stave the oceans. We're trying to save dinner.

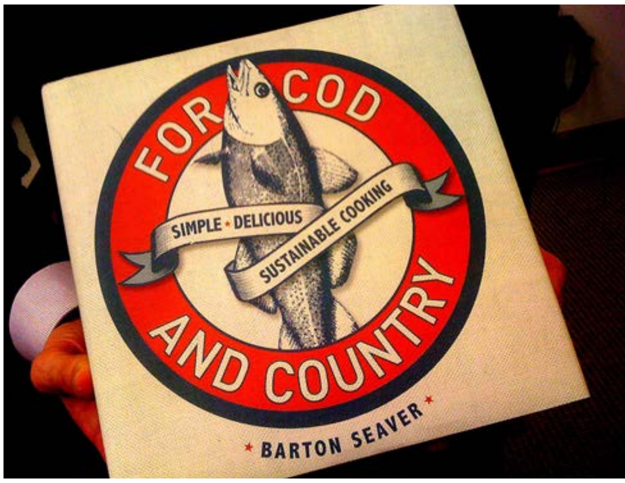
Sustainable seafood has largely neglected the position of the fishermen as part of the solution. When the public, my customers, were first presented with the idea of overfishing, well, what's the obvious solution? Underfishing. Right? Now, we all understand that the causations are not quite that easy. And the solutions are not that way. But unfortunately the public began to believe that overfishing's a problem, well, then, great, stop fishing. And thus the fishermen unfortunately became the pariah. But if we acknowledge that it is access to the commons that we are acting to restore and to save, then it becomes clear that we have an equal responsibility to save both fish and fishermen.

We understand that if there are no farmers, there will be no food. And yet our public struggles to understand that if there are no fishermen, there will be no seafood. Regardless of how many fish there are in the oceans. Furthermore, the public is unaware of the dangers that we face right now, and they lack clear understanding of how they can participate in the system to restore. And with 91 percent of the seafood we ate in this country last year being imported from foreign shores, they actually lack real capacity to do so. To participate in solutions.

But in order to talk about fishermen, I think we have to use a vernacular that actually describes what they do. Most people think of a fishery as an ecological system. But a fishery, as I said, is an economic system. It's a measure of human effort—the sum of millions of individual decisions that aggregate into what we call a fishery. Therefore, managing our nation's fisheries is actually managing our nation's behavior, in many aspects. Because it's not the environment that acts upon fishing communities, but rather it's the irrationally developed economies that we as consumers have created that act upon fisheries. One of the principle pillars of a sustainable relationship with our oceans, I believe, is a diversification of demand. We have hundreds of species that are commercially available in this country, and yet we only eat 10 of them [according to the] National Fisheries Institute—16 lbs per year, or so, we eat of seafood—and 8.8 lbs of that is only three species: shrimp, canned tuna, and salmon. Another seven species makes up over 90 percent of the full consumption of seafood, and yet we have hundreds and hundreds of [species] available.

Take for instance the cod fishery in New England. Somehow, we made cod king. And we've just left everything else to the side. Now what comes up in a cod net? Cod, haddock, pollock, cusk, Ling, wolf, monk, dog, skates, sea robins, I mean you name it—I could go on and on and on—all of those are basically flaky white-fleshed fish, right? And yet at the dock, cod commands a premium. And pollock is sometimes not even worth landing. How can that be? When each of those seafoods is actually equally profitable to the human body for the purposes of sustaining myself?

When we as a society ask fishermen to wet their gear on our behalf, we have a responsibility to then purchase at an equitable price all that they bring back. The system that we've created skews towards waste. It is a system that is based on demand. It is based on preference, rather than on supply. And this creates waste, it diminishes profitability. It also gets us asking the wrong questions. You know, instead of asking what the oceans can sustainably provide, we ask how we can make the oceans provide more sustainable cod. Instead of asking how we can get consumers to eat more forage fish at a higher price, we try and figure out how we can get forage fish to create more salmon for us. That's not the right question to be asking.



In my restaurant, I served in the first year we were open 78 different species of seafood. Seventy-eight. I had brotula and dentex and rainbow runner, blackfin tuna, sea robin, you name it. I mean, I had an incredible amount of diversity there. And all of those were sold by hand. The best story of this is, I didn't get my fish in time, I didn't know what was happening, I called up my fisherman and was working directly with him, and all of a sudden the box comes from FedEx, I open it up and go "what is that?" I had more Audubon guides than I had cookbooks! So I opened it up, and I had 200 lbs of flying fish. I called my fisherman—"What are you trying to do to me?" He said, "Well, the fishing was bad and I didn't want to leave you in the lurch, so I sent you the leftover bait." Fine! I mean, flying fish is already a pain in the butt, throw on some wings, ahh! Know what I did that night? Summer squash braised in Vidalia onion juniper-scented broth with a tarragon and Myer lemon zest marinated flying fish, threaded onto rosemary skewers, slowly smoldered over an oak wood fire. Whew! Served up for $27. I sold 130 orders by 8:00 that night before I was sold out. I told everybody the truth. My servers walked up to those tables, and said, "Oh my God, you'll never guess what happened today." Because we had the courage to actually sell a story. And that's what sustainability demands.

When we make demands of our ocean, we create the need for fraud. Because if it is cod, it is only cod that we will buy, guess what, it is cod that it will be, whether or not it's pollock or tilapia or whatever else it is, we'll be getting cod. We like to think that it's easier to change nature than it is for us to change our recipes, and that's based on hubris. In this way, we as consumers actually forfeit our ability to get the best products, and we forfeit our ability to use the system to our best benefit. To look broadly at the root causes of damaged ecosystems and economies is actually what sustainability demands we address, because ultimately there is no such thing as unsustainable seafood. There is only unsustainable demand.

Sustainability is not about the green list. It is about changing the fate of the species and the yellow and the red, and this is an opportunity for chefs to recouple seafood with its source. This is our chance to acknowledge that fishermen are the most charismatic species on the red list, and that we need to do something to change that. Sustainability is a chef's opportunity to diversify and participate broadly in an ecosystem, to take from the oceans what fisheries can provide. And for consumers, to reexamine what we expect to take from our oceans and to pay equitably for them.

We have all the tools of sustainability that we need: Magnuson-Stevens chief among them. It's time to use these tools to contextualize our actions and to shift our focus not just to the what, where, and how of the science of fisheries, but to the who and the why. Science and observation of fishermen can tell us much of what we need to know about the biology of fisheries. It's time we engaged in a conversation about the biography of fisheries. And what they tell us about ourselves. When we make seafood itself, and not the systems by which it comes to us, the mechanism of change, we actually allow ourselves to confirm our biases towards continuing in the same irrational behaviors.

So what does sustainability mean to me? It means we must restore the pride, the prudence, the profitability, and the permanence of those communities that provide us access to our dinner. It means that consumers must restore our expectations that seafood must be diverse – it must be identified with the person that produced it and we must use our purchases to sustain fishing communities. Sustainability is ultimately a social construct. Sustainability to me means using seafood for its highest and best purpose, and that is to sustain people. Thank you.

Remarks by Captain Keith Colburn, F/V Wizard

Captain Keith Colburn of Redmond, Washington, has served at the helm of the Wizard *for the last 14 years. Keith started his fishing career as a true greenhorn on the crabber* Alaska Trader. *He was instantly hooked by the fishing lifestyle and the camaraderie of being part of a crew working together against the elements. While initially looking only for adventure in Alaskan waters, Keith decided to make it a career. In 1988, three years after he arrived, he became a full-share deckhand on the* Wizard. *He earned his U. S. Coast Guard license in 1990 and moved from the deck to the pilothouse. Two years later, he received his masters (captain) license and has remained there as the skipper. In 2002, Keith purchased the crabber* Sirene *(pronounced Sea-Wren), but continued to operate the* Wizard. *In 2004, he sold the fishing rights for the* Sirene *in a government-run fleet reduction program. When this program led to a reduction of the crabbing fleet from 250 to 80 crabbers, Keith went ahead and purchased the* Wizard *to secure his stake in the crabbing industry. He and his wife Florence have shared a special bond as partners in both life and business for more than 25 years. She manages much of the business end of their boat's operations, and together they balance their time to raise their son Caelan and daughter Sienna. Keith stars on the Discovery Channel's* Deadliest Catch.

Well, hello, my name's Keith Colburn, and it's on honor to be speaking in front of the nation's leaders in fisheries. I'm a fisherman.

I started my career as a chef, believe it or not. In 1985 I decided I wasn't sure if I wanted to be a chef, so I convinced my best friend that Alaska might be a place to try something new. There'd be opportunity and, you know, the allure of the Wild West and everything that Alaska had to offer was sitting there, so we hopped on a plane, landed in Kodiak, Alaska with about fifty bucks, a backpack, and a tent, in March. After coming in on this little prop plane they used to let you fly in on, these little cargo planes, we landed, and there's a little shack there for the airport, and first thing we saw when we walked out of there in the snow was this big statue of this Kodiak brown bear. We looked at each other with our backpacks and said "We're screwed." But we weren't daunted by that. So we thumbed a ride into town, got to the harbormaster's office, put our backpacks in there, and he said "What are you boys looking for?" We said "We're here to get work. We wanna be fishermen." And he looked at us and he said, "Look at the harbor. The lights are all off. You guys are about a month early. There's no jobs right now." So Kurt and myself both looked at each other and said "Wow. We're really screwed."

So we pounded the dock for a day, and of course, being the optimistic souls that we were, we'd be heading down the dock saying "Wow, that boat looks good. Yeah, I'd work on that one." It's got a foot of snow on it, of course—nobody's been on it for a month. That one—ah, that one's an old derelict. We're not gonna work on there. So day one, we weren't doing too well. Day two, we set our sights a little lower and just figured if we could get something, that would be good. And that occurred. An old derelict crab boat had just come back into the fishery, had been bought on the [U.S.] Marshal's sale [of forfeited property]. It was one of the boats that had failed during the King crab crash of the early 80s, and they needed a couple of real stupid kids to do every possible ugly job in the book. So I started my career working for room and board, mucking out diesel tanks, cleaning the bilges, standing in a foot of fish gurry, and that's how I got started. I didn't have any idea why I was there; just that it seemed like the thing to do.

I get the question all the time, did you ever think you'd be a TV celebrity? The answer to that was, "Yeah, when I was standing in a foot of gurry I was probably thinking all the time 'aw yeah, one of these days they're gonna be watching me on TV doing this!'" But the show Deadliest Catch has had an impact, and it's been a positive impact. Cable

TV has allowed more content to reach people around the U.S. and around the world, so people have a better idea in America now what fishermen do to bring that fish—whether it's crab or shrimp from the Gulf, or scallops coming off the East Coast—and they can relate to it a little bit better. That is a plus.

But Americans as a whole kind of lose track right there. They think that once we get to the dock, that's where it ends. Eric Schwaab brought up earlier the commerce that's being generated in America based on what fishermen do. The general public doesn't understand that it's the longshoremen, the rail services, the truck drivers—it's the chefs and the store clerks that are putting that fish or crab out there. The secondary producers that are producing products throughout the entire fabric of America. Fisheries are touching everybody.

I'm proud to hear that our fisheries are a positive impact on employment in the U.S. over the course of the last decade, when that can't be said about most industries. I'm excited by that, and excited by the fact that as fishermen we're trying to continue to maintain that. Your job here is this week and in the coming months and years is to try and find a way to help us at the dock continue to generate income to the economy through commerce throughout all of the U.S.

In 1985 when I first started, that was 28 years ago. We were working with the hot new technology which was Loran. We were using paper charts to plot where we would fish. Our plotters in effect were a version of Pong. I mean, there was not a lot there. Subsequently, now today we have AIS, VMS, we have ARPA radar, we have digital tracking, we have bottom imaging, we have weather programs that'll help us find fish and find fish in a very efficient way.

One of the problems that fisheries managers have today is that technology has allowed us as fishermen the opportunity to become more and more efficient, and in some ways lethal. You give a fisherman a chance to catch something, he's going to find a way to catch it as quickly as possible. Even though this new technology has allowed fisheries managers the opportunity to manage fisheries at a better level as well, at times it's hard to keep up with fishermen. It's hard to keep up with what we're doing out there on the grounds. So at times managers have to literally act on the fly in order to maintain or to predict or even to keep a resource viable for us at the dock.

Another thing... you'll always hear fishermen say, "Well, there's lots of fish out there. They don't know what they're talking about. How come we didn't get that much to catch?" On the flip side you'll also probably hear that fisherman say, "You know what, I couldn't find anything out there. Where did they all go?" So another task that we have here is to try to find a way so that at the end of the day, when myself and my crew, or the crew of a guy working on the East Coast hits the dock, he can say "Wow, you know what? Fishing was good. There were a lot of fish out there." How are we going to do that? Through the word you're looking at right there. Sustainability.

Sustainability to me means maintaining our resource to the level where we can continue to fish, our kids can fish, and our great grandkids can fish. That in itself is a huge objective—and, based on the people in this room, something that touches all of America. Another problem is, because I reach all kinds of people across the United States, I get this comment all the time—the guy that says "Hey, I was watchin' the show and there was all kinds of ice on the boat. Y'know, global warming, yeah! Huh huh huh." Right? And I think, "Oh, man, I don't have time to explain to this guy what's going on here," but, unfortunately that perception still exists.

One of the biggest hurdles we have right now is climate change. Working at the extreme northern latitudes that we do in Alaska, we are seeing a more extreme example of what climate change represents. In the last decade alone, we have seen three of the warmest years on record and three of the coldest years on record. So it's not necessarily that everything is warming up, it's that it's becoming more extreme in the cycles. Those extreme cycles are having an impact on our fishing, and on our fisheries, and on the ecosystems out there in the oceans. Basically, survival rates one year can be off the charts, the next year predation can be off the charts—we don't know what to expect. This is creating a huge hurdle for managers and scientists, to try and predict this and gain some kind of baseline to be able to continue to keep these fisheries sustainable. So what I would like to see is more data collection. With all the advent of computer modeling and everything else that we're using these days, to me the best form of data collection starts right on the boat. What we're catching. Data collection. Landing reports. That itself is a great opportunity for managers to utilize real-time information from year to year and see what we're using, and what we're catching out there.

Based in Alaska, I've been fortunate. Alaska has, in essence, a very fledgling fishing industry. You know, the Alaska fisheries, because of their remote location, are relatively new. About 30 years, 35 years at most, since the industrial fleet really started to get involved in fishing in Alaskan waters. Because it was a new resource, and it was a pristine environment, and because there were so many mistakes made around the globe managing other fisheries, the fishermen and the managers have been able to work together to try and utilize a great resource and keep it sustainable, and keep it manageable. That in itself is a long-term difficult task. We're working at it do the best we can.

One [area where] we've been fortunate in the North Pacific is that we have a quota-based system for a lot of our fisheries now. I know in some areas of the country that's like a skull and crossbones—don't even think about it. But just like the managers using computer modeling as a tool in your toolbox, quota-based systems are a tool that you should at least consider in your toolbox. It's not something to just throw out. Because in the North Pacific, in the crab fisheries specifically, we've had great success over the course of the last decade, and our program, the crab program, was built on three pillars: conservation, decapitalization, and safety. We have seen a positive on all three of those things. Our fisheries are more sustainable; it's easier to manage a 60-boat fleet than it was a 200-boat fleet, so conservation has been a huge plus for our industry; safety has improved, but safety was already improving in the North Pacific prior to our program. Being diligent to make sure that it's not just about catching fish, but keeping the guys on deck safe, and keeping the guys who are working on the shore safe, is another goal that has to come out of this.

Lastly, I'd just like to say I was asked to tell a story about danger. People think that what they show on TV is sensationalized, and in all reality it's not, because when the weather really gets abysmal and at its absolute worst, that's when the cameras are covered in ice or water or the weather gets so bad that they can't film, or they have to film from a location where they really can't capture what they're trying to get. A few years back we were fishing about 150 miles from the rest of the fleet. We were quite a ways up north, about halfway between the Russian border and St. Paul, and a good distance from the rest of the guys fishing crab. We happened to be unfortunately right in the storm track, and so we got hit about four times in a row back to back to back with the leading northeast quadrant of these storms. So whereas the rest of the fleet was working in 40- and 50-mile an hour winds, the *Wizard* was up there working in anywhere from 50- to 75-, sometimes as much as 80-, 90-mile an hour winds. We sat there and toward the end of our trip, after trying to work our way through this stuff, we got hit with a particularly vicious storm that came out of the southeast, and it spun around to the southwest so quickly that we were still seeing these 30- to 40-foot seas and swell that was generated coming out of the southeast. At the same time we had this southwesterly swell from the storm itself that was pushing in, so in effect what was happening as we were trying to travel to deliver, we were seeing these 40-foot seas compounding into massive waves… You don't see this out on the open ocean because the wind will literally blow any froth off the seas pretty much instantaneously, but just seeing these mountains of water spouting up everywhere and we're still driving in 30-, 40-footers. We went through about a half mile of just pure white foam. I can't even begin to imagine how much force was generated in that particular wave that had collided and built up. I got a call from the processor as I was heading into town, and I'm heading straight southwest; St. Paul is southeast. He asks me, "When are you gonna be here? We really want the crab." I'm saying, "Well, with my current course, I'll probably be in Japan in about three weeks. But there's no way on this planet that I'm turning and putting this boat in the ditch right now to head to St. Paul." So at any rate, we managed to get through that particular storm, get delivered, and finish up the season. Everybody was healthy and happy when we got to the dock, and that ultimately is our goal, getting guys back to the dock safe.

I think that storm in particular was another sign that climate change is our biggest obstacle in trying to manage these fisheries and sustain these fisheries. I hope that before we leave this week that we remember there's a lot at stake here, and opening up the Magnuson Act is like opening up the tax code. Beware!

Thank you so much.

Council Perspectives

Prior to the conference, each Council was asked to provide three examples of what was working well in regard to the Magnuson-Stevens Act (MSA), and what should be changed when the Act is reauthorized. These brief summaries were presented during the plenary session at the start of the conference.

Gulf of Mexico, Caribbean, and South Atlantic Fishery Management Councils

Presented by David Cupka, Chair, South Atlantic Fishery Management Council

GULF OF MEXICO FISHERY MANAGEMENT COUNCIL

THINGS THAT ARE WORKING WELL UNDER THE CURRENT MSA

- *Interdisciplinary Planning Teams composed of Council and National Marine Fisheries Service (NMFS) staff have helped streamline the National Environmental Policy Act (NEPA) process*
- *Increased emphasis on outreach has improved stakeholder understanding—but more needs to be done*

PRIORITIES FOR IMPROVEMENT IN THE NEXT MSA

- *Improved NMFS/Council interactions*
- *Further regional definition of ecosystem-based fishery management, including international and interjurisdictional cooperation*
- *Improve and increase the number of stock assessments*

CARIBBEAN FISHERY MANAGEMENT COUNCIL

THINGS THAT ARE WORKING WELL UNDER THE CURRENT MSA

- *The established channels of communication between the Caribbean Fishery Management Council and the NMFS Southeast Regional Office and Science Center*
- *The orderly MSA process for development of fishery management plans and regulations*
- *The process to engage fishermen and the general public in open and effective discussion using internet communication tools, including webinars, streaming of Council meetings, smartphones and social networks*

PRIORITIES FOR IMPROVEMENT IN THE NEXT MSA

- *The need to harmonize NEPA and MSA process in a more open and effective manner*
- *Better guidelines for data collection and analyzes in data-poor regions*
- *Better definition on Council involvement in international fishery matters*

SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL

THINGS THAT ARE WORKING WELL UNDER THE CURRENT MSA

- *Emphasis on outreach and communication*

PRIORITIES FOR IMPROVEMENT IN THE NEXT MSA

- F_{MSY} *is a good target but a bad limit*
- *Flexibility in ending overfishing*
- *Change the 10-year rebuilding period limit*
- *Maximum sustainable yield specified for stock complexes*

Mid-Atlantic and New England Fishery Management Councils

Presented by Rip Cunningham, Chair, New England Fishery Management Council

MID-ATLANTIC FISHERY MANAGEMENT COUNCIL

THINGS THAT ARE WORKING WELL UNDER THE CURRENT MSA

- *Enhanced Scientfic and Statistical Committee role allowing for development of Acceptable Biological Catch Control Rule and Council Risk Policy (especially in moderate to high data quality situations)*

PRIORITIES FOR IMPROVEMENT IN THE NEXT MSA

- *Provide NMFS with authority to establish a sustainability certification program*
- *Scope and specificity of National Standards should be strengthened*
- *Governance structures and representation should be evaluated in light of changing environmental conditions and representation needs*

NEW ENGLAND FISHERY MANAGEMENT COUNCIL

THINGS THAT ARE WORKING WELL UNDER THE CURRENT MSA

- *Adoption of annual catch limits and expanded role of catch share systems*

PRIORITIES FOR IMPROVEMENT IN THE NEXT MSA

- *Modify fixed rebuilding period requirements and focus on ending overfishing*
- *Increase flexibility to respond to unusual events*
- *Provide NMFS with authority to establish a sustainability certification program*

North Pacific, Western Pacific, and Pacific Councils

Presented by Dorothy Lowman, Chair, Pacific Fishery Management Council

NORTH PACIFIC FISHERY MANAGEMENT COUNCIL

THINGS THAT ARE WORKING WELL UNDER THE CURRENT MSA

- *Catch share programs*
- *Annual catch limits*

PRIORITIES FOR IMPROVEMENT IN THE NEXT MSA

- *Great flexibility in rebuilding plans*
- *Streamlining NEPA and MSA Statutes*
- *Avoid unrealistic and expensive analytical mandates and management constraints that limit Council responses to changing climates and shifting ecosystems*

WESTERN PACIFIC FISHERY MANAGEMENT COUNCIL

PRIORITIES FOR IMPROVEMENT IN THE NEXT MSA

- *Provide greater flexibility in annual catch limits*
- *Authorize greater Council role in protected species actions*
- *Support and strengthen trade sanctions for non-compliance in Regional Fisheries Management Organizations*
- *Strengthen provisions to support domestic fisheries*

PACIFIC FISHERY MANAGEMENT COUNCIL

THINGS THAT ARE WORKING WELL UNDER THE CURRENT MSA

- *Transparent Council process*
- *Pacific Council's Scientific and Statistical Committee's peer review process*
- *Catch share program for the groundfish trawl fishery*

PRIORITIES FOR IMPROVEMENT IN THE NEXT MSA

- *Better align and streamline NEPA with MSA processes*
- *Improve balance between speedy rebuilding requirements and fishing community needs*
- *Provide flexibility in addressing scientific uncertainty and best scientific information available*

SHRIMP BOAT. PHOTO: NOLA.AGENT (FLICKR CREATIVE COMMONS)

INTRODUCTION

Session 1
Improving Fishery Management Essentials

TOPIC 1 ANNUAL CATCH LIMIT SCIENCE AND IMPLEMENTATION ISSUES, INCLUDING MANAGING "DATA-LIMITED" STOCKS

TOPIC 2 REBUILDING PROGRAM REQUIREMENTS AND TIMELINES

TOPIC 3 INTERNATIONAL FISHERIES MANAGEMENT: LEVELING THE PLAYING FIELD

SESSION CHAIR: DAVE WITHERELL
DEPUTY DIRECTOR, NORTH PACIFIC FISHERY MANAGEMENT COUNCIL

After 35 years of evolution under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), marine fishery management in the United States now involves an impressive set of principles, practices, and tools that are essential to our current success in achieving long-term sustainability. Such elements include the recently-implemented system of setting annual catch limits (ACLs) for each fish stock or stock complex, including accountability measures to ensure their achievement; efforts to rebuild depleted stocks; and the promotion of the U.S. model of science-based, precautionary management in international arenas. However, recent experience has shown that there is still room for improvement in how these elements are approached and implemented. Finding ways to refine current practices will improve fishery management sustainability and the attendant benefits to the nation.

All Federally-managed fisheries are now required to have ACLs and accountability measures (AMs) to ensure their effectiveness at ending and preventing overfishing. Unlike season approaches or effort controls, total catch limits have consistently proven effective for sustainably managing fisheries, preventing overfishing, and addressing overfishing when it occurs. Nevertheless, the transition to ACLs has posed challenges in many commercial and recreational fisheries. Some say this change has led to overly precautionary restrictions, while others say ACLs do not sufficiently account for scientific and management uncertainties, and should be more precautionary. One area of concern is how to best set ACLs on data-limited stocks—stocks with inadequate scientific information for sophisticated management.

Rebuilding plans for depleted (overfished) stocks also affect the amount of fish available to a fishery. The MSA requires that rebuilding take as short a time as possible, after due consideration of the effect on fishing communities, with a maximum rebuilding time of 10 years if possible. Alternatively, for long-lived stocks that cannot rebuild in 10 years, rebuilding must occur in the time to rebuild if there were no fishing, plus one generation time. This requirement often leads to large reductions in catch of directed fishery stocks that are being rebuilt, and can restrict mixed-stock fisheries when the rebuilding stock coexists with healthy stocks. However, it is important to note that rebuilding programs are designed to increase stock sizes to provide for biological stability and the attendant future economic benefits.

Some believe that the current focus on rebuilding in a certain amount of time results in overly restrictive fishery management that is unnecessarily harmful to fishermen and fishing communities, and that more flexibility is needed to optimize multiple goals. Others believe current rebuilding policies are too lenient towards short-term economic urgencies, and that they insufficiently consider the long-term benefits of fully rebuilt stocks.

Advancing the U.S. model for science-based, precautionary management in international arenas has been done towards the goal of providing long-term fishery and seafood production sustainability and to "level the playing field" in terms of conservation burden equity. The 2006 reauthorization provided some impetus to accomplish this, and mechanisms to assess compliance of foreign countries and their vessels with international conservation measures with potential impact on U.S. seafood markets. While there have been improvements in international fishery management, some say that more should be done to achieve conservation objectives and help the U.S. fishing industry remain competitive. As an example, U.S. fishing restrictions that limit incidental take of protected species can result in a domestic fishery being unable to harvest its quota of a particular stock, only to see the market demand filled by imports of the same species from international fisheries that are not subject to similar restrictions.

The purpose of this session is to examine the challenges of using ACLs, implementing rebuilding programs, and participating in international fishery management, towards a meaningful discussion of potential ways to improve sustainable management practices that maintain vibrant fisheries.

Session 1, Topic 1

Annual Catch Limit Science and Implementation Issues, Including Managing Data-Limited Stocks

The 2006 reauthorization of the MSA included requirements for ACLs and AMs to be put in place by 2011 in order to end and prevent overfishing. However, the MSA did not specify how ACLs would be developed and implemented. To assist the Regional Fishery Management Councils in meeting these requirements, the National Marine Fisheries Service (NMFS) developed extensive guidance on ACLs and AMs through a process that revised National Standard 1 guidelines in 2009.

The MSA and National Standard 1 guidance defines an ACL to be no greater than the biologically-permitted safe catch level. The National Standard 1 guidelines require a buffer for scientific uncertainty in determining the acceptable biological catch level, and providing a buffer for management uncertainty in achieving a particular catch target. Three national workshops of Council Scientific and Statistical Committee members were held to explore the scientific basis and best practices for establishing the scientific uncertainty buffer. With the help of this collective groundwork, all of the Councils were able to meet the MSA requirements by amending existing Fishery Management Plans, and ACL provisions have been fully implemented.

However, experience dealing with ACLs and AM specifics has shown that there are still improvements to be made in both the scientific basis and management application areas. Many people do not support how ACLs and AMs are currently implemented. Challenges remain in addressing scientific and management issues such as taking into account multi-year overfishing definitions, accounting for discards, operating in mixed-stock fishery situations, identifying and quantifying scientific and management uncertainty buffers, and ensuring accountability of unharvested (carry-over) allocations from one year to the next. Some believe implementation of the new ACL system has greatly reduced the amount of fish they are allowed to catch compared to previous management approaches, and that the scientific and management uncertainty buffers represent an overly precautionary risk policy. On the other hand, there are others who believe that the Councils' policies do not adequately protect against systematic uncertainty, and therefore undermine the long-term sustainability of fishery resources.

One area of concern that has emerged is how to develop and implement ACLs effectively when the requisite data are lacking (also known as a "data-limited" situation). This includes situations where essential data are lacking or no data collection program is in place, and when major natural fluctuations in stock abundance occur more rapidly than stock assessments can be updated. ACLs have greatly increased demand for timely and accurate stock assessments, but resources (such as surveys, quantitative assessment analysts, landings and bycatch information processing) are not available to fully address these issues. When less information about a stock is available, or the data are outdated, the current model calls for a Council to set a particularly low ACL compared to the theoretically maximum allowable catch, out of recognition of a higher level of scientific uncertainty. This can be frustrating for fishermen who believe fish to be in great abundance based on their observations, but who are restricted from catching the fish because of the limited scientific data available to set a higher ACL. It can also lead to severe economic consequences when a rarely-caught stock about which little is known appears occasionally in a healthy mixed-stock fishery, and a new, highly buffered ACL for this rare stock suddenly requires a large reduction in catch, creating a bottleneck species that closes or substantially reduces an otherwise healthy fishery (Oliver 2011).

The purpose of this focus topic session was to consider experiences with ACLs to date, to discuss ways to address problems and limitations, and to attempt to reach findings to improve current practices. Prior to this conference, NOAA Fisheries convened a National ACL Science workshop in February 2011 to advance understanding of the issues (Methot et al. 2013), and an Advanced Notice of Proposed Rulemaking process was issued in 2012 to collect a broad perspective of issues and possible solutions (NMFS 2005). Trigger questions to propel conference dialogue are shown below.

Trigger Questions

1. How can we advance sustainability with ACLs?
2. Are the Councils' risk policies for setting ACLs overly precautionary with regard to accounting for scientific and management uncertainty?
3. What socioeconomic and biological factors influence the right degree of precaution?
4. What is the appropriate way to set an ACL for a complex of species?
5. How can we better manage data-limited stocks with ACLs?
6. Are ACLs for data-limited stocks effective in meeting the dual objectives of National Standard 1 (prevent overfishing and achieve optimum yield)?
7. Is there an alternative management approach that would be more effective than ACLs in meeting the dual objectives of National Standard 1?
8. Are multi-year average ACLs the best approach for highly fluctuating stocks?
9. Have sector ACLs improved fishery management? (e.g. separate commercial and recreational ACLs and AMs)
10. How could the MSA or National Standard Guidelines be changed to provide additional details on ACLs?

Session 1, Topic 2

Rebuilding Program Requirements and Timelines

The MSA requires that if a stock is designated overfished, the relevant Council must implement conservation and management measures to rebuild it. The MSA further requires that a time period for rebuilding must be as short as possible (taking into account the biology of the fish stock, the needs of fishing communities, international recommendations, and ecosystem interactions); and not exceed 10 years (with few exceptions: biology of the stock, environmental conditions, international agreements). The MSA also specifies that overfishing restrictions and recovery benefits must be fairly and equitably allocated among sectors of the fishery.

The National Standard 1 guidelines provide additional details on how Councils should address rebuilding. In particular, the MSA term "as short as possible" is interpreted to be the amount of time it would take a stock to rebuild to maximum sustainable yield (MSY) biomass level in the absence of any fishing mortality, including directed fishing and incidental take in all other fisheries, regardless of how minor the incidental take may be. Further, the guidelines note that if the time for the stock to rebuild in the absence of fishing is 10 years or less, then the maximum rebuilding time must be 10 years. This can be problematic if it requires complete closure of all fisheries with any incidental take. If the time period to rebuild in the absence of fishing is more than 10 years, the National Standard 1 guidelines state that rebuilding must take place in the minimum time to rebuild with no fishing, plus one generation time (time between birth of an individual and birth of its first offspring).

There have been numerous disputes about how to appropriately take into account "the needs of fishing communities" in setting a rebuilding date target that otherwise rebuilds as quickly as possible. Notably, current policy has been shaped by challenges in court, and subsequent court decisions, claiming that the Councils and NMFS have not interpreted these criteria appropriately. For example, in a court decision on the West Coast regarding a challenge that the Pacific Fishery Management Council and NMFS chose too lengthy of a rebuilding period, the Court described the need for the Pacific Fishery Management Council to avoid "disastrous short-term consequences for fishing communities" in achieving the correct balance between impacts to communities and the benefits of rebuilding as quickly as possible (NRDC vs. NMFS 2005).

On the other hand, some believe the current practice is too generous to the short-term needs of fishing communities because the long-term socioeconomic benefits of rebuilt stocks have not been adequately described. Still others believe that current scientific methods are incapable of detecting real biological differences and benefits in rebuilding long-lived species over a period of many years, and that more flexibility is needed in weighing policy choices about the benefits of shorter rebuilding targets.

The purpose of this session was to use our experience with past and current rebuilding plans to discuss issues associated with these plans in order to identify improvements. The following trigger questions helped propel conference dialogue.

Trigger Questions

1. Is 10 years a reasonable time span for a rebuilding requirement? If not, what should the time span be, and why?
2. How does one properly evaluate stock rebuilding effects many decades into the future?
3. What is the best way to address factors to extend rebuilding times beyond the shortest time possible?
4. Is there a better scientific approach to setting and modifying rebuilding targets for long-lived stocks, when it is expected that stock assessments will show a great deal of variability and methodological change over the course of the rebuilding plan?
5. What type of environmental conditions should be presumed when calculating the minimum time to rebuild and setting a rebuilding date target? How should rebuilding parameters be adjusted if an environmental regime shift occurs during the course of the rebuilding plan?
6. Should the MSA be amended to add clarity to a "disaster" criteria, as described above in litigation case history, in balancing impacts to fishing communities with speed of rebuilding?
7. Should there be more situational flexibility for Councils to rebuild stocks at an optimum rate for fishermen, communities, and the ecosystem?
8. Can longer rebuilding times be adopted without sacrificing essential elements of a fully sustainable approach?
9. Would it be more appropriate to emphasize control of fishing rate in rebuilding, rather than focusing on

achieving rebuilding by a specific date?

10. How can cooperative research, and information besides full stock assessments, be used to monitor whether stocks are making adequate progress in rebuilding?
11. Should the overfished designation be redefined as depleted to acknowledge habitat and environmental effects?

Session 1, Topic 3

International Fisheries Management: Leveling the Playing Field

Over the last decade, the U.S. has promoted the application of its domestic model of science-based, precautionary fisheries management to the highly migratory fish stocks subject to the jurisdiction of various international Regional Fisheries Management Organizations (RFMOs). The demand for international cooperation is high, since a large proportion of seafood consumed in the United States (approximately 84 percent) is imported from other nations, and there is a broad expectation of equity in the conservation burden of international fisheries that provide seafood to American markets. The 2006 MSA reauthorization and the 2011 Shark Conservation Act contained provisions designed to enhance U.S. influence in international fishery management arenas. The application of these provisions is seen as having mixed success by those involved and affected by the changes: while most U.S. constituents generally support the current provisions, they also believe that limitations in the statute have prevented the United States from being as effective as possible in addressing fishing activities of concern by foreign fishing fleets, including especially illegal, unreported, and unregulated (IUU) fishing. Further, there is broad concern about an uneven "playing field" that results in international seafood production and common stock conservation when some countries practice high levels of precautionary management and compliance with internationally-adopted measures and other countries do not.

The 2006 reauthorization of the MSA required that NMFS and the Councils take various steps to advance the sustainability of international fisheries and level the playing field, strengthen RFMOs, combat IUU fishing, and reduce the bycatch of protected marine species such as sea turtles, marine mammals, and corals. It also required a biennial report to Congress to include a list of nations whose vessels have been identified as engaging in IUU fishing or insufficient protection of identified bycatch species. After notification and a process of consultation with the nation in question, remedial actions are required or enabled that range from negotiation of bilateral agreements to institution of economic sanctions. Two biennial reports to Congress have been written in response to the charge to identify IUU fishing or insufficient protection of protected species, one in 2009 and one in 2011. Both reports indentified six countries engaged in IUU fishing (NMFS 2009, 2011).

There have been both successes and difficulties in promoting the U.S. domestic model of science-based, precautionary fisheries management as a global model. Catch data collection and reporting, observer systems and vessel tracking technologies, scientifically defendable overfishing and overfished reference points, fishing gear and operations practice improvements, ACLs designed to not exceed quotas, intensified post-season evaluations and at-sea enforcement practices are just a few of the approaches U.S. delegations have emphasized in the RFMO arenas. Further, there has been continued success in international fishery management at the bilateral level, such as the International Pacific Halibut Commission, the U.S.-Canada Pacific Salmon Treaty and the U.S.-Canada Resource Sharing Agreement in the Northeast region. While there have been successes, there have also been difficulties. Convincing countries to alter their fishery management practices toward a preferred U.S. model in unanimous consent RFMO arenas is time consuming and complicated. Some feel the U.S. has made insufficient progress in enhancing international conservation objectives. On the other hand, there are those who are critical of U.S. positions to lead by example, characterizing the positions as "leading with their chin" that fail to garner conservation improvements from foreign countries and, by default, provide them a competitive advantage in the international seafood markets.

The promotion of international cooperation and assistance warrants further consideration. Given the highly migra-

tory nature of some U.S. fish stocks and protected living marine resources, it is crucial for the U.S. to work cooperatively with its international partners to implement fishery management programs, improve data collection and monitoring, and utilize fishing gear and practices that reduce bycatch and adverse impacts of fishing. One of the most effective ways to promote these practices is to provide other nations with the tools, training, and technical resources to increase their own ability to manage sustainably and enforce effectively. Consistent with authority provided under the MSA, Federal agencies and Councils have been involved in many international technical assistance efforts. The U.S. has hosted workshops on how to reduce bycatch of turtles and other protected species; conducted cooperative research to understand species statistics and improve harvesting practices; and provided training to strengthen enforcement of IUU fishing and improve fisheries observer programs in other countries.

Trigger Questions

1. What measures are necessary to level the playing field in RFMO forums?
2. What international activities (research, management, enforcement) should receive priority?
3. What Congressional action is needed to mandate stronger consequences for nations with IUU or inadequate protection of certain bycatch species, or when U.S. fishermen are regulated more than fishermen from other countries when fishing for international stocks?
4. How should NOAA and the Councils change the way they currently implement international fishery management policy?
5. How can consideration of transfer effects be incorporated into management of international stocks?
6. Should inadequate compliance with international fishery conservation measures, such as typically exceeding quotas and incomplete catch reporting, be incorporated into a broader definition of IUU fishing?

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PAPERS

Session 1
Improving Fishery Management Essentials

Topic 1
Annual Catch Limit Science and Implementation Issues, Including Managing "Data-Limited" Stocks

Managing Recreational Fisheries: A New Perspective is Needed

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Commercial and recreational fisheries are fundamentally different activities, with dissimilar harvest data collection systems and requiring different management approaches. Yet the last reauthorization of the Magnuson Stevens Act, for all intents and purposes, uses the same management strategies for both. A Blue Ribbon Panel was convened in 2010 to examine recreational data and management. One of the key recommendations was "it may make more sense from both fiscal and management effectiveness standpoints to adapt management approaches, tools and strategies to reflect available information rather than doing the reverse" (recommendations of the Blue Ribbon Panel on Recreational Fishing Data, TCRP 2010).

Commercial fisheries are managed for yield. They are prosecuted by relatively few fishers, all with the same goal—to catch as many fish as possible as efficiently as possible, in order to maximize profit from the sale of whatever species they pursue. Commercial landings can usually be counted or weighed in real time, thus quotas can be enforced in real time. This allows managers to close a fishery before the allowable catch is exceeded. In short, a commercial fishery's catch can be managed in real time, based on verified landings.

Recreational fisheries, on the other hand, are dynamic in nature, prosecuted by millions of individuals with diverse goals; some try to catch fish for food, some like to catch and release fish, some just fish in order to enjoy the outdoors. They are responding to stock abundance, weather, the economy, or any of a myriad of factors. Catch is estimated, not counted, with a significant time lag for producing such estimates. Landings estimates, at best, are compiled 45 days after the end of each two-month sampling wave; thus two months pass before any real knowledge of what anglers are catching in a particular fishery can be developed. Real-time quota management under the current recreational harvest information system is, as a practical matter, impractical. In reality, managers actually manage the catch of recreational fishermen by managing anglers' behavior.

It is telling that poundage-based management is not contemplated when managing upland game, waterfowl or most inland fisheries, where similar challenges to developing accurate data exist.

Though recreational fishermen do not directly value fish caught in dollars per pound, they do produce a lot of economic activity and value, which is often far in excess of that generated by competing commercial fisheries.

Such recreational fisheries should be managed for expectation as opposed to yield. Anglers need to believe they will have opportunity to encounter fish, with the hopes they may catch some, possibly including some large enough to take home, and perhaps even catch a trophy sized fish. Instead of yield, abundance and age structure are key elements to recreational fisheries, since those factors govern both the rate of encounters and the size of the fish caught. Maximizing yield has little meaning in most recreational fisheries; since more conservative fishing mortality targets produce increased abundance and a better age structure, they actually lead to a greater number of satisfied anglers.

Current law includes the requirement of calculating, where possible, and managing towards maximum sustainable yield (MSY). The concept of producing the most yield in pounds is antithetical to managing most recreational fisheries. MSY-based management is a risk-prone management strategy, and is inappropriate for a fishery which emphasizes encounters over yield. An angler who manages to land a limit of fish over the course of a day, and releases a dozen others, will be far more satisfied than an angler who bags a limit, but catches nothing more. In general, the recreational fishery should be managed for abundance and age structure, which maximizes encounters, not yield. This dictates an approach that sets mortality targets below F_{msy}, sometimes far below. Such a concept is embodied in the definition of "optimum," which is already a part of Federal fisheries law but, unfortunately, is seldom employed effectively in practice.

The MSY approach, and particularly the practice of setting annual catch limits (ACLs) just below MSY, arises largely from the commercial sector's desire to efficiently remove fish from a population. MSY management, by definition, attenuates the age structure and produces a population dominated by younger fish, so that a fishing rate set slightly below F_{msy} will result in a large stock of young fish and nearly the same yield as a population with more larger fish which, by definition, must be left in the water longer before being harvested from the larger stock. It is analogous to management for a high-yield pine forest as opposed to a mature oak/hickory forest. One is purely for yield and the other incorporates other values: aesthetics, wildlife, etc.

Recreational fisheries respond to population abundance. As populations increase, and fish become easier to catch, they draw more anglers into the fishery and drive up recreational effort and catch; as populations decrease, effort and catch decline. In Figure 1, angler effort (in catch/day) and the estimated abundance of fully recruited (age 4+) South Atlantic black sea bass are illustrated from 1981–2011. In this example, there is a very good relationship between abundance and angler effort. It is worth noting that the fishing season was 365 days until 2011, when it was reduced to 180 and 95 days in 2012.

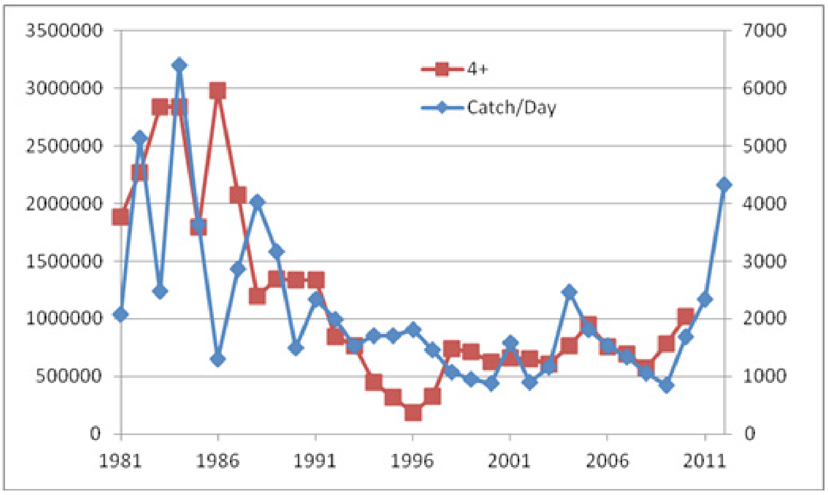

Figure 1. Black sea bass recreational catch/day and catch of 4+ fish over time. John Carmichael, SAFMC

Stock assessments on most popular stocks are done sporadically, usually every three to five years. This delay may lead to hard ACLs placed on a stock which are generated from a three-year-old assessment, based on four-year-old data, which likely no longer reflect the current state of the stock (and the resultant allowable catch). Yet it is the current stock size that is driving the recreational effort and catch. This is especially problematic in a rebuilding plan where the recreational catch, driven by increasing abundance, is higher than an outdated assessment, and resultant ACL, would allow, but is not actually harmful given the current stock size.

The hard ACL requirement sometimes leads to management measures that are simply not credible. If stock size decreases, an ACL in a recreational fishery will likely not be met, and no management restrictions are taken. If the stock size decrease is transitory, that's fine. However, if the stock size decrease continues, it would seem some management restriction should be contemplated. Yet, if the stock size increases and catch rates go up, the ACL is more likely to be exceeded and management restrictions could be implemented. Thus the message to fishermen is that management success causes punishment and declining stocks are okay. That's just illogical and frustrating to anglers, and kills managers' credibility.

In Figure 2 we created a hypothetical stock (using mid-Atlantic black sea bass as the basis for the model). In our example, the stock had not been assessed in several years, while a strong year class or two recruited into the fishery and increased the biomass above equilibrium conditions. Fishermen, responding to the large stock size, exceeded a poundage-based ACL, and were reduced the following year. Once below the ACL, restrictions are relaxed and the recreational sector goes over once again due to the large stock size, thus creating a management "yo-yo" effect. After several years the harvest reduces the stock back to the long-term equilibrium, yet the halting fashion in which they arrived there would have made anglers angry and frustrated. Had managers been able to ascertain the current conditions of the stock, they would have known anglers were responding to increased abundance and not causing harm to the stock. Both management measures ended up in the same place, yet the latter would have had much more angler acceptance.

It is worth noting that few, if any, inland fish or wildlife species are managed at or near maximum sustainable yield. They are generally managed more conservatively. One reason this is more readily accepted by inland fishers and hunters is there is no commercial sector competing for the same resource. Most anglers would gladly forego harvest in order to keep a population healthy, but that is a much tougher argument when there is another sector competing for those fish foregone by anglers. For anglers, the concept of optimum yield may include fish left in the water.

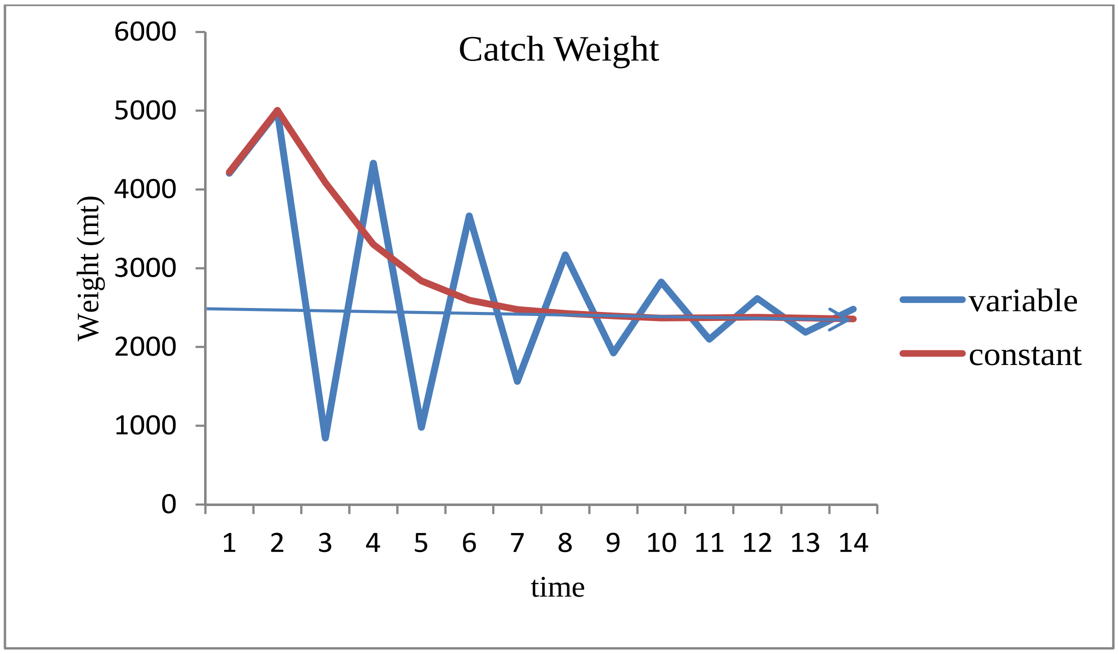

Figure 2. Hypothetical graph of exploitation over time of a stock that starts above MSY and is reduced back to equilibrium harvest. Dr. Gary Shepherd, NOAA Fisheries.

Unfortunately, despite the inherent differences in the recreational and commercial fisheries, managers employ the same basic tools to manage both sectors—the use of an annual catch limit in pounds or numbers, tied in some way to maximum sustainable yield to constrain harvest, with closures used to prevent overages, and pound-for-pound paybacks imposed in subsequent years to compensate for whatever overages may occur. Using the same management tools to regulate two fundamentally different approaches to prosecuting a fishery, when most of the current management science and tools are geared towards determining and managing commercial harvest, is now a thoroughly documented recipe for failure with respect to managing the recreational fishery.

Managers must finally recognize that recreational fisheries differ fundamentally from commercial fisheries, and management for predominantly recreational fisheries should be different from the way commercially-dominated species are managed. Some states already manage recreational fisheries in this manner: red drum in the Southeast and striped bass in the Mid-Atlantic and New England area. It is no coincidence that both of those species are among the five leading recreational fisheries in the United States.

Here are the specific recommendations:

1. This strategy is contemplated for fisheries that are either primarily recreational or have a high value to

recreational fishers. Clearly this type of management would not be appropriate for primarily commercial species such as sable fish, butterfish, golden crab or even Atlantic croaker.

2. Institute F-based management for those species determined to be of high recreational importance. The ACL in such fisheries should be a contemporary estimate of permissible F based on the state of the stock, not a poundage-based ACL rooted in past harvest. This is the most critical issue for recreational fisheries. Make the $F_{threshold}$ the ACL and the F_{target} the annual catch target, so that we are managing to a fishing mortality rate and not absolute removals. Estimates of F are likely to be more robust than estimates of biomass or B_{msy}. From a biological standpoint, controlling the magnitude of F is more important than merely capping the poundage of removals, without reference to the size or age of the fish harvested.

   ACLs based on poundage are largely inapplicable to recreational fisheries. They represent an archaic approach carried over from the times when only commercial fisheries were considered. ACLs based on the proportion of fish that are harvested from a stock, which must inherently account for the changing age and size structure comprising such stock, would represent a much more effective and informed approach to managing recreational fisheries.

   This can easily be accomplished via the current MSA. The language in the MSA does not specify pounds or numbers, it simply states a mechanism must be in place to prevent overfishing:

   109-479 *(15) establish a mechanism for specifying annual catch limits in the plan (including a multiyear plan), implementing regulations, or annual specifications, at a level such that overfishing does not occur in the fishery, including measures to ensure accountability.*

   NMFS would have to adjust their guidelines to implement such a strategy.

3. F-based fisheries management ideally would require annual updates on the relative fishing rates, similar to the annual surveys currently performed for waterfowl, which base each year's harvest rates on a May-June pond index (i.e. habitat survey) and an annual breeding waterfowl survey (i.e. a harvest independent survey). These surveys are then used to determine each fall's harvest regulations.

An Example

There is a current example of such management: Atlantic striped bass, which are managed by the Atlantic coast states from North Carolina through Maine under a fishery management plan adopted by the Atlantic States Marine Fisheries Commission (ASMFC).

The Atlantic striped bass stock was essentially collapsed in the late 1970s and early 1980s by the usual combination of factors—unrestrained harvest, ineffective minimum size limits, habitat loss and poor recruitment. In response to the precipitous decline in abundance, Congress enacted the Striped Bass Conservation Act in 1984, giving the ASMFC the authority to promulgate management measures. Ultimate enforcement of the management measures was vested in the Secretary of Commerce, with the authority to enforce a moratorium on any jurisdiction that violated the management measures.

The stock recovered to a high abundance in the late 1990s and early 2000s and has declined somewhat since, due largely to below average recruitment.

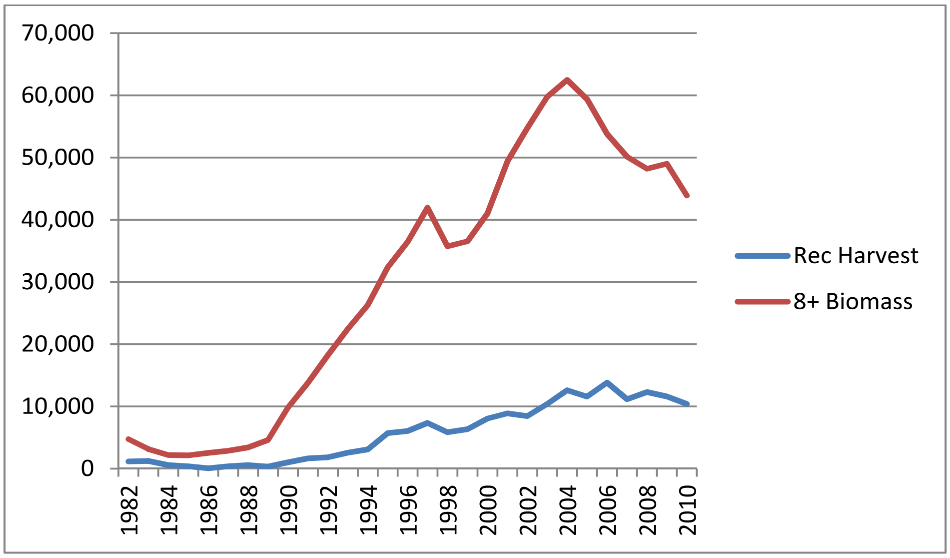

Figure 3. Striped bass recreational harvest and abundance in metric tons. Kate Taylor, ASMFC

The ASMFC recognized striped bass were one of, if not the premier, recreationally sought species in the mid- and north-Atlantic regions. They set a commercial harvest at an historic level with a hard quota, and set an allowable harvest rate that allowed the recreational fishery to respond to abundance. The recreational fishery went from catching 5,700 mt when the stock was declared recovered in 1995 to a high of 14,000 mt in 2006, a nearly 300 percent increase in harvest in 12 years. Yet the target fishing mortality rate was never exceeded.

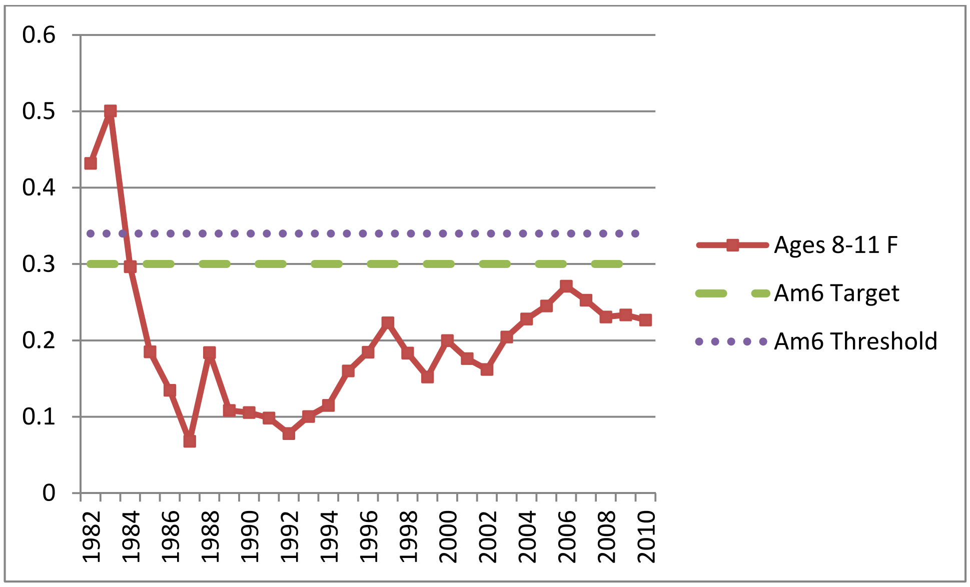

Figure 4. Fishing mortality on fully recruited striped bass in relation to the FMP fishing mortality threshold and target. Kate Taylor, ASMFC.

Imagine a hard quota scenario during that time period, set at 5,700 mt for 1997, when 7,300 mt were in fact caught. The paybacks, if implemented, would have caused great frustration and ultimately had little effect on resultant stock size. This important stock has recovered and largely done well for over 15 years, with recreational catch rising and falling with abundance, never exceeding the F_{target} level.

Fishing Industry Perspective on Impacts of Annual Catch Limit Implementation and Consequent Changes in Fishing Regulations

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Introduction

Annual catch limits (ACLs) implemented to prevent or eliminate overfishing can serve as a legitimate, proven and effective management tool provided they are applied in appropriate situations and based on current and adequate stock assessments. An ACL is only one of many tools available to fisheries managers, but unfortunately it has predominated and supplanted other, sometimes equally effective management efforts due to Congressional mandates in the last Magnuson-Stevens Act (MSA) reauthorization.

The end result is that a number of ACLs have been implemented based on inadequate or outdated scientific information in order to comply with the MSA. National Standard Guidelines that require the integration of risk and uncertainty into management decisions are a major problem leading to overly conservative ACLs that result in lost yield to fisheries from lower sustainable harvests than either maximum sustainable yield (MSY), optimum yield (OY), or long-term average catch might permit. These problems all converge on the issue of science and our commitment to achieving the best information possible.

Frustrating to fishermen and scientists alike is the need for adequate and reliable data and stock assessments, all of which are attainable provided fisheries managers and our government are willing to commit the necessary resources to achieve these goals. "The current scientific information used to support fishery management decisions is inadequate to meet the NOAA's approach to implementing the Act. The problem is twofold: 1) there are major deficiencies in the quantity, quality and frequency of stock assessments and fishery statistics, and 2) National Standard Guidelines for implementing the Act pose unrealistic demands on the scientific system" (Cadrin 2011).

Without substantial and formal commitments to address these issues, fishermen will continue to suffer lost jobs and substantial loss of income, and consumers will have little alternative but to seek seafood produced outside of the United States. While domestically produced seafood is the highest quality product in the world, harvested to the most stringent of environmental, health and sustainability mandates, we continue to import 91 percent of the seafood consumed in this country (NOAA, Fishwatch, U.S. Seafood Facts).

Industry Impacts from Annual Catch Limits

Current implementation of precautionary ACLs negatively impacts fisheries through artificial creation of derby fisheries, the absence of socioeconomic impact analyses, and in some cases an overly restrictive definition of transboundary stocks—all of which can undermine maximum yield. Irrespective of what nomenclature we apply, any limitations on harvest levels, including an ACL, are a quota, and oftentimes result in a derby fishery.

A now common solution to resolve the damaging social and economic impacts of derby fisheries is to implement additional restrictions such as catch shares, sector shares or limited access programs to minimize or mitigate the negative impacts precipitated by an ACL. These remedies can be as or more disruptive and damaging economically to the fishery as the ACL itself. Catch share and sector share implementation in Alaska, New England and the Gulf of Mexico has caused significant fleet reduction and job loss (Food and Water Watch 2011).

It is clear that socioeconomic factors and the impacts of various fishery management programs, including ACLs, need to be addressed more thoroughly and given greater consideration in the decision-making process. Most fishing communities in the United States consist of small, coastal towns where the commercial fishing industry contributes significantly to the backbone of the local economies. The Florida Keys are a perfect example; the 100 mile archipelago of islands has a total population of 73,873 and the largest incorporated city, Key West, has a population of 24,909. All other Keys communities, whether incorporated or unincorporated have a population under 10,000 (U.S. Census Bureau). Yet, next to tourism, the commercial fishing industry is the second largest economic engine and employer in the islands producing more than $50 million in annual, ex-vessel value.

Collectively, the Florida Keys commercial fishing industry represents the largest commercial seaport in the State of Florida and the second largest in the Southeastern Atlantic (Fisheries of the United States 2009). Obviously, preserving the character of these coastal communities and the livelihoods of generational fishermen should be just as important and aggressively undertaken as our efforts to maintain the sustainability of the species they harvest and the environment in which they conduct their businesses.

On a broader, national scale, according to NOAA statistical information from 2006, saltwater fishing as a whole generated more than $185 billion in sales and supported more than 2 million jobs. Of those totals, $103 billion and 1.5 million jobs were generated by the commercial sector and $82 billion and 534,000 jobs came from the recreational side (NOAA News Release, January 15, 2009, NOAA Issues Final Guidance on Annual Catch Limits to End Overfishing).

Regarding trans-boundary stock impacts and ACLs, Gulf of Mexico spiny lobster (*Panulirus argus*) serves as an excellent example of the need for an expansion of the qualifying criteria for transboundary ACL exemptions. Economically, this is one of the most valuable species harvested in the State of Florida, estimated to be $35 million dollars in annual, ex-vessel value. Recent scientific evidence indicates the Florida fishery is nearly 100 percent dependent on external recruitment from the Caribbean Basin and waters off the countries of Nicaragua, Southern Cuba, Mexico, Panama, Belize, and Columbia (Hunt et al. 2009). Approximately 6 percent of the worldwide annual harvest of spiny lobster takes place in waters off Florida, and harvest cycles have remained consistent for more than 20 years. The ACLs currently in place offer little protection for the fishery and are not based on a population-wide, Pan-Caribbean stock assessment, and such a comprehensive assessment is unlikely any time in the near or long-term future. Lacking a formal international treaty on spiny lobster, the species does not qualify for a transboundary exemption under current provisions in the MSA. Thus, precautionary ACLs could vary widely based on any vagary or variation in catch levels unrelated to the actual health of the population. This could result in unnecessary and economically harmful restrictions on the fishery.

The yellowtail snapper fishery in the southeastern United States is an example of the lost yield that can occur from overly restrictive ACLs not based on up-to-date stock assessments, which can lead to potentially serious negative impacts on a local economy. Of the two million pounds of yellowtail snapper harvested annually off the coast of Florida, approximately 90 percent comes from the waters of Monroe County and the Florida Keys. There are roughly 100 full-time fishermen engaged in the fishery and 185 part-time, multi-species fishermen. Yellowtail represents the most valuable finfish resource in South Florida. In September of 2012 National Marine Fisheries Service (NMFS) announced a planned closure of the yellowtail snapper fishery by projecting the quota would be reached in mid-October of the same year. This assumption was based on an ad hoc ACL derived from an out-of-date stock assessment completed nine years earlier (in 2003).

At the same time the closure was being announced, the state of Florida had a more recent stock assessment completed earlier in 2012 indicating the stock was in excellent condition and that yellowtail snapper were in such abundance it was being categorized as an "underutilized species." Even though the Councils and NMFS acted quickly to ward off a closure, the derby fishery that developed in anticipation of the closure was problematic for the entire market, from fishermen to fish houses to restaurants. The results were a glutted market, widely fluctuating prices, and significant lost income for many fishermen.

Developmental History of Management Measures

Part of the intent of the original MSA was to scientifically calculate and establish sustainable harvest levels to MSY and OY. As years passed, inadequacies in science or our commitment to obtain it have caused failures in fisheries management. The consequent evolutionary process has been to establish more conservative targets and benchmarks, even as some populations like King and Spanish mackerel and black grouper have recovered. However, not all has been for naught.

We have progressed from focusing on preventing a stock from becoming depleted to establishing more sustainable targets, albeit accompanied by an unnecessary increase in bureaucratic complexity, confusion and jargon. We have tempered the management formula from the basic premise of attaining MSY and OY to include overfishing limits (OFLs), acceptable biological catch (ABC), ACLs, and annual catch targets (ACTs). In a sense, these are more complex concepts for doing nothing more than implicitly and confusingly redefining MSY and OY.

Additionally, NMFS, under the policies of National Standard 1 (NS1), has mandated that scientists buffer ABC by some indefinable and vague level of scientific uncertainty. And further, that the Regional Fishery Management Councils (RFMCs) establish an additive precautionary risk-averse approach (more than required by the law) in setting ACLs by requiring consideration of yet another indefinable and unquantifiable level of management uncertainty. In essence ACT has supplanted OY as the management target, reducing harvest levels far in excess of what is necessary to sustain a fishery resource.

Do we continue on this path or streamline the process? One of the most comprehensive analyses of existing management efforts and suggestions for improvement was recently presented by Merrick Burden of the Marine Conservation Alliance in comments to NMFS/NOAA on an advance notice of proposed rulemaking regarding NS1 Guidelines (Burden 2012). Burden's management approach is two-pronged: 1) long term average concepts, 2) annual concepts.

Long term average concepts	Annual concepts
• MSY • OY	• OFL • ABC • TAC

The analysis by Burden and the Marine Conservation Alliance not only offers management alternatives, they provide clearer definitions for important management terminology such as "overfishing," "overfished," and "uncertainty." Most importantly, and echoing universal sentiment, the Burden analysis is affirmation that an ACL/total allowable catch should be based on sound science and stock assessments and be realistically applied.

Science

Fisheries management based on science is the foundation of the MSA and NMFS, with a long established credo emphasizing "best scientific information available" in guiding fisheries management decision-making (NS2). While nobly intended, a thorough examination of that approach is long overdue and warranted, because in many instances the available science is not sufficient for an adequate evaluation of complex fisheries issues and especially inapplicable from an ecosystem point of view.

Of the 528 fish stocks currently managed by NOAA, only 114 are considered to be adequately assessed by the agency. Approximately 80 of those 114 assessments occur on economically important stocks in Alaska and New England, where in some cases assessments are made on an annual basis (Marks 2011). Assessments in the Gulf of Mexico and the southeastern United States occur far less frequently, resulting in data-poor science on commercially important species such as red snapper, yellowtail snapper, gag grouper and golden crab. Of additional concern is the lack of stock assessments and quantitative analysis of trans-boundary species such as spiny lobster.

Yet with that limited knowledge and understanding of most of these managed species, the regional Councils were compelled to move forward to establish ACLs on all of them in order to comply with the MSA by 2011. We must ask ourselves—are we making the necessary financial commitment to support fisheries management based on science?

Perhaps more importantly, is the best available science adequate for the level of management decision-making currently mandated by Congress and the NS1 Guidelines, and is it sufficient for the scientific community to realistically measure and integrate uncertainty without merely figuring less harvest is better?

And, finally, is it appropriate to dictate incorporation of risk-averse policies based on immeasurable levels of uncertainty? It is beyond time for the Councils and their respective Scientific and Statistical Committees (SSCs) to identify and set minimum standards on what constitutes acceptable science for legitimate fisheries management actions?

The lack of stock assessments for many managed fish species undermines the ACL process, jeopardizes the integrity of our scientific process, and forces unnecessary, precautionary decision-making. If we do not assess all stocks equally, then should all stocks be treated the same under the strict MSA and NS1 standards?

Perhaps ACLs (and associated accountability measures) should be firm point-specific requirements for the largest and most economically important stocks for which we have reliable stock assessments or for stocks perceived to be undergoing overfishing or are overfished. Stocks of lesser economic value, or those incidentally harvested, could be managed with estimates of MSY/OY as long-term average yields and "softer" targets rather than hard, precise pinpoint ACLs since we know so little about them. The basic concept here is to link management capability with scientific capacity. Transparent prioritization and increased frequency of assessments on key species should be implemented regionally (and organized nationally) within a clearly articulated assessment schedule for the coming five year period.

Improved data collection and scientific research are necessary but ongoing challenges. By working with industry through formal regional cooperative research programs, we can greatly improve our data collection and knowledge base. Strengthening the relationship between agency, academia and industry and other regional partners can be potentially more cost effective than the exclusivity and expense of NOAA research efforts. If done properly, these programs can be designed to generate assessment-grade data for direct incorporation into stock assessments and cultivate better relationships between fishery managers and fishermen.

In recent years, anecdotal information provided by fishermen has been given short shrift, yet the catch statistics, gear selectivity, information on spawning and aggregation areas and migratory behavior, and other similar information provide the basis for the science we employ to manage fish stocks. Better utilization of fishermen's on-the-water knowledge could prove extremely beneficial to enhance scientific results. Industry highly recommends each of NOAA's regional science centers be annually funded to develop and maintain cooperative research programs.

Adaptation to modern methods of dealer and fisheries reporting is an important step with application to cooperative research. Electronic logbooks and submission of dealer reports in a timely fashion speeds the decision-making process and provides for greater accuracy. Electronic reporting is endorsed by many in the commercial industry, and some regions are working on pilot projects to develop this technology. We encourage those efforts.

Core Issues With Regard to Annual Catch Limit Implementation

ACLs can be an effective tool in advancing sustainability and are one of many management options. The key is to use them when and where appropriate, with decision-making authority best left to the discretion of the RFMCs. Regularly assessed and economically important species should carry the highest priority and consideration; non-assessed or lesser value species can be dealt with by other, proven and effective, management measures such as spawning season closures, size and bag limits, trip limits, target by-catch levels or other accountability measures.

ACLs should be based on sound science and current stock assessments and an assessment of what impacts they may have on other species. This is a major challenge for which there is no best approach. The answer depends on the relative knowledge we have on each species in a complex and the complex productivity as a whole.

For data-poor stocks within a complex, it would be inappropriate to apply a species-level ACL. The current practice of using an indicator species seems to be a starting point for our SSCs, but it is not accurate for any species except the indicator species itself. It may be neither appropriate to set an ACL based on the most vulnerable nor the most resilient species in a complex. Without a stock assessment, you cannot determine whether a data-poor stock is undergoing overfishing or is overfished. Therefore, it would be prudent for the SSC and regional Council to first evaluate if a stock warrants an ACL.

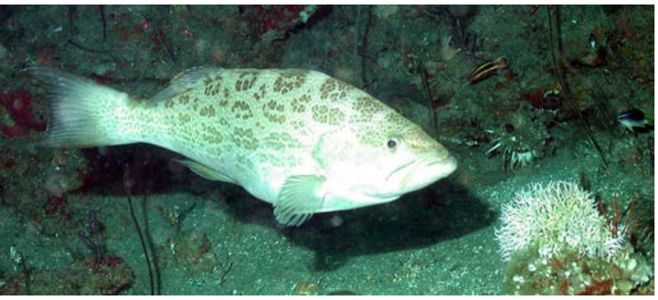
The Councils should not be required to set ACLs on all species, and to that end should consider establishing minimum requirements for setting ACLs based on stock assessments. Councils should also consider setting ABC or ACL at OY since the MSA requires calculating and managing OY. Also worth considering is a risk-neutral approach to setting ABC without the application of uncertainty buffers. Accounting for scientific and management uncertainty is also important to consider when setting an ACL. However, Councils need to exercise caution in this area. How we deal with scientific uncertainty is the focus point, and incalculable without stock assessments. Calculating uncertainty remains a problematic issue among scientists and fisheries managers. A clearer definition of uncertainty should be addressed in the MSA.

In the southeastern United States there has been no mechanism for explicitly incorporating social and economic factors into measures of risk policy or uncertainty. Industry believes these factors should also carry great weight in the decision-making process, with specific consideration of community dependence, fleet reduction, job loss, and disruption of fishing dynamics.

National Standard 1 and the Magnuson-Stevens Act

We should revisit the MSA, which is up for reauthorization, with a clear intent of streamlining the management process. Climate change, weather anomalies such as hurricanes and tropical storms, regime shifts, changes in life-cycles, changes in fishing methods, and equipment and technology developments all dictate a need for greater flexibility in fisheries management. Councils should have greater authority and freedom in making management changes in order to adapt to these issues on a timely basis. Amending the MSA every ten years or routinely petitioning Congress for changes is not an efficient or effective way to change basic decision-making approaches to fisheries management.

Councils need greater flexibility in establishing rebuilding programs to eliminate unnecessary economic hardship, including a phase-in approach to eliminate overfishing on stocks not overfished. We can achieve this by setting annual specifications so that overfishing is ended in a timely manner. Appropriate accountability measures should also be mandated, including post-season accountability measures on bycatch or incidental species.



Councils should not be required to set ACLs on every managed species of fish, and on data-limited species in particular. Instead "soft" ACLs should be considered, on a case-by-case basis for all user groups, on any species where stocks are not undergoing overfishing or overfished, tempered by post-season AMs.

Summary Recommendations

On behalf of the Florida Keys Commercial Fishermen's Association I thank you for this opportunity to participate in this invaluable process. I respectfully offer the following recommendations for consideration both within the upcoming MSA reauthorization process as well as ongoing NS1 review processes:

- Reflect change in the MSA such that the NS1 Guidelines clearly reflect removing "uncertainty" from the decision-making process.
- Establish separate and clear definitions for "overfishing" and "overfished" and if retained, "uncertainty." Further, we suggest a phased-in approach over time to eliminate overfishing when a stock is not overfished.
- Establish a transparent national catch share referendum process so that all permitted fishermen in any given fishery are afforded a vote to approve any new catch share plan.
- Clarify the ACL transboundary exemption such that the actual biology of the species is a determining factor rather than a prerequisite for a formal, international agreement to which the U.S. is a party.
- Recommend MSA changes establish a clear linkage between management capability and scientific capacity. Construct a management system to work within our limitations and not set unreachable goals which then undermine the system with overly precautionary decision-making. This can be accomplished by prioritizing which stocks are "core," "minor," and "incidental," and then tailoring a management approach to fit a specific model.
- We recommend NMFS, Councils, and SSCs formally construct a transparent regional and national stock assessment and survey schedule designed to meet the specific scientific needs of the MSA.
- Suggest NMFS utilize Saltonstall-Kennedy funds to design, develop and annually fund a dedicated Cooperative Research Program in each region of the country.
- Recommend MSA reauthorization allow specific consideration of "mixed or multi-stock" approaches and allow Councils more flexibility to consider alternatives to single-species level management.
- Allow Councils greater flexibility to extend rebuilding programs to address socioeconomic concerns based on whether the stock is showing signs of rebuilding.

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A Scientific Perspective on Challenges and Successes with Annual Catch Limits, and Possibilities to Improve Fishery Sustainability

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Abstract

A major challenge for all participants in the fishery management process is the achievement of a balance between the prevention of overfishing and the attainment of high, sustainable catch levels and fishing opportunities. The rate of fishing needed to attain close to maximum long-term yield requires attentive monitoring of the stocks and frequent management adjustments. Scientific fish stock assessments guide these adjustments to minimize over- and under-fishing. Full stock assessments can estimate the current fishing rate and the rate that would be overfishing, but even the best assessments have uncertainty and most assessments do not have sufficient data to precisely calculate fishing rates and their impact on the fish stock. The National Standard 1 (NS1) Guidelines for prevention of overfishing and attainment of optimum yield call for a science-based approach in which the degree of uncertainty in scientific estimates is used to set a precautionary buffer between the target rate of fishing and the imperfect estimate of the overfishing rate.

All Regional Fishery Management Councils have included these buffers in their fishery management plan amendments for setting annual catch limits (ACLs) with accountability measures. For some Councils, the change to ACL management was a major shift from previous fishery management approaches, and numerous challenges have emerged. In this paper, the ACL approach is briefly outlined and refined approaches are described. Themes addressed include the relative roles of scientific and management uncertainty in the measurement of overfishing; the timeframe over which phase-in of ACL adjustments could be made; the identification of target, non-target, and ecosystem component (EC) stocks; and the contrasting approaches to management of stock complexes versus multi-stock fisheries.

Introduction

Fishery management in the U.S. has a long history of science-based approaches (Darcy and Matlock, 1999; Tromble et al., 2009; Methot et al. 2013). First implemented in 1976, the Magnuson-Stevens Fishery Conservation and Management Act (MSA) mandated the prevention of overfishing and the attainment of optimum yield from our fisheries. Its reauthorization in 2006 introduced new requirements to end and prevent overfishing through the use of ACLs and accountability measures (AMs). The MSA makes three statements that establish the foundation for this science-based ACL concept:

- The Councils must "establish a mechanism for specifying ACLs in the fishery management plan (FMP) … at a level such that overfishing does not occur in the fishery, including measures to ensure accountability" (MSA section 303(a)(15)).
- Each Council shall develop ACLs for each of its managed fisheries that may not exceed the "fishing level recommendations" of its [Scientific and Statistical Committee] SSC or peer review process (MSA section 302(h)(6)). ACLs are required in all fisheries, with the only exception being interna-

tionally-managed fisheries and fish stocks with one-year life cycles.

- Each SSC "shall provide its Council ongoing scientific advice for fishery management decisions, including recommendations for acceptable biological catch [ABC], preventing overfishing, maximum sustainable yield, and achieving rebuilding targets, and reports on stock status and health, bycatch, habitat status, social and economic impacts of management measures, and sustainability of fishing practices" (MSA section 302(g)(1)(B)).

The NS1 Guidelines introduced, in 1998, a section on using a precautionary approach when implementing fishery management measures to prevent overfishing (Restrepo et al, 1998; Darcy and Matlock 1999). The 2007 Act's strong call for the prevention of overfishing, "…such that overfishing does not occur…," raises the question of just how confidently must the fishery management system prevent overfishing? Thus, the January, 2009 update to the National Standard 1 Guidelines clarify the role of scientific and management uncertainty in the fishery management process, and the guidelines describe the need to set a buffer between the level of fishing that is estimated[1] to be overfishing and the level of fishing that would prevent overfishing with a certain degree of confidence while still attaining a large fraction of the biologically sustainable yield. These buffers operationalize a precautionary approach. This ACL framework is described here, along with some challenges and potential adjustments.

In May 2012, National Marine Fisheries Service (NMFS) issued an Advanced Notice of Proposed Rulemaking (ANPR) with regard to the NS1 Guidelines. The NMFS is currently considering its response to the comments received on the ANPR. The discussion in this paper represents the views of the author from a scientific perspective. It is not a preview of the agency's action in response to the ANPR.

Annual Catch Limit Framework

The terminology used in the NS1 Guidelines refers to rates of fishing (F) and levels of catch (C). If B is the biomass of the stock that is available to the fishery, then catch is approximately equal to F * B. The assessment models make the relationship exact as they take into account age-specific, seasonal and other factors.

The ACL framework starts from the estimate of the fishing mortality rate (F) that would, in theory, produce the greatest long-term average catch (maximum sustainable yield, MSY) from the stock (Mace 1994) (Figure 1). The F level that would produce MSY is termed the F_{msy}. Because the stock's B fluctuates over time due to natural (climate, ecosystem, habitat) and fishery factors, the target level of catch must be adjusted annually if the F is to be maintained exactly at the rate that would produce MSY (Figure 1). Exceeding, or not attaining, F_{msy} will produce, over the long-term, less yield than MSY. Fortunately, over a range of F levels close to F_{msy}, an average catch only slightly below MSY can be obtained (Hilborn 2010). Scientific uncertainty, time lags, and management uncertainty prevent us from maintaining F at the perfect level, so MSY is best considered a theoretical upper limit that can be approached but never quite attained (Figure 1). In most cases, F_{msy} cannot be directly measured so scientists use a proxy for F_{msy} based upon studies that have shown that proxy to be a reasonable approximation for F_{msy}. Typically these proxies will target reduction of the stock to around 35-40% of its unfished level.

The F_{msy}, or its proxy, is then the basis for setting the fishing rate that would be considered overfishing. This is termed the maximum fishing mortality threshold (MFMT). The ACL that corresponds to the MFMT is the overfishing limit (OFL), so OFL = MFMT * B. Table 1 (next page) documents the relationship among some of these catch quantities used in the fishery management process.

1 The term "estimate" is used to mean that the rate of overfishing can only be measured approximately. With good data and accurate models of fish populations, these approximations can be quite good, but they will never be as precise as the application of a tape measure to determine the size of a box. The scientific estimates of fish abundance, fishing mortality rates, overfishing levels, and other quantities all have scientific uncertainty. By following a good scientific process, the degree of scientific uncertainty itself can be measured.

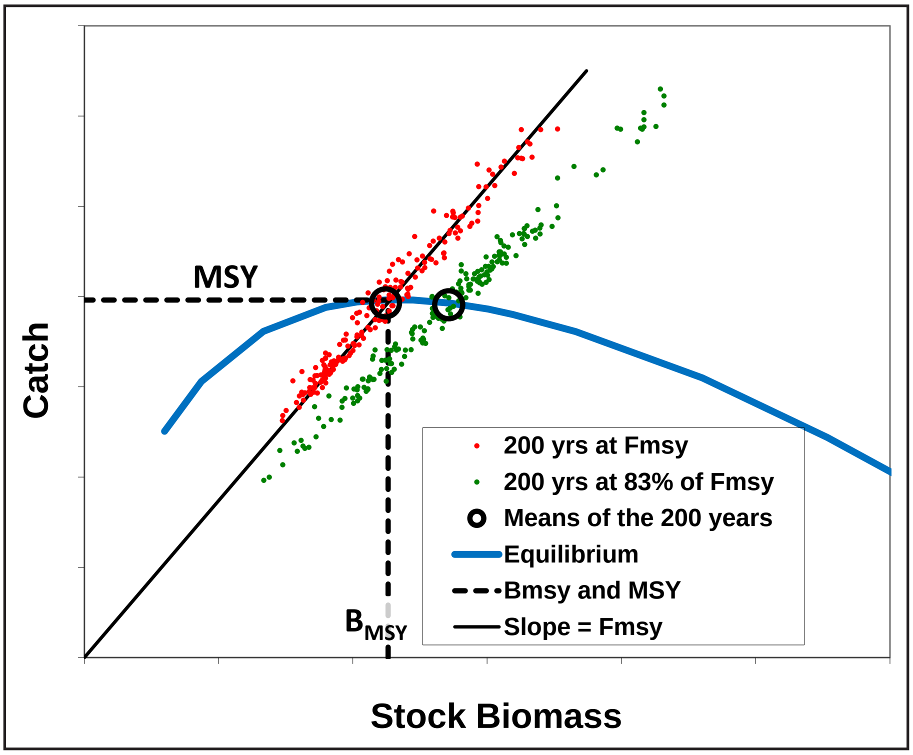

Figure 1. The scientific basis for sustainable fisheries shows that fishing at a moderate rate, F_{msy} (shown as the slope of the diagonal line) can produce a maximum long-term average catch, MSY, while maintaining the stock near an intermediate biomass level, B_{msy}. This MSY is a theoretical maximum because stocks are not perfectly in equilibrium, as shown by the blue curve, nor are scientific forecasts and fishery controls perfect enough to track the natural fluctuations over time. The red dots show that, if control actually was perfect, the long-term average would be close to the equilibrium value. The blue equilibrium curve is fairly flat over a range of F values above and below F_{msy}. Actual science-management systems cannot be perfect, so the realized F fluctuates over some range such that the realizable long-term average yield is somewhat less than the theoretical MSY. Setting target F somewhat below F_{msy} (83% in this example), can produce nearly as much catch as MSY while maintaining the stock, on average, above B_{msy}.

The Council's SSC is expected to recommend a level of catch, the ABC, that is below the OFL according to the degree of scientific uncertainty (which can be calculated scientifically) and the Council's acceptable chance of allowing overfishing (Shertzer et al. 2008; Ralston et al. 2011). The expected relationship between the SSC's role and the Council's role is shown in Figure 2 (next page). It is expected that the process for setting the ABC be specified in a control rule, which is set of formulas and procedures described in the Council's FMP. The complication is that the Council's tolerance to getting close to the overfishing limit depends, in a complex and hard to quantify way, on social, economic and ecosystem factors. So the factors that go into the ABC Control Rule are a step towards a process to define optimum yield (OY). Because the control rule becomes a statement of the Council's tolerance for allowing occasional (less than 50 percent) chance of overfishing, it is important that it is analyzed with short-term and long-term biological, social and economic impacts taken into account to the extent possible. Because the ABC Control Rule sets the catch below the OFL, there will be short-term reductions in fishing opportunity if previous levels of catch were near or exceeded the OFL. Fortunately though, lower fishing rates are expected to raise the average abundance of the stock, and then continuing to apply that lower rate to the larger stock will produce, on average, nearly as much long-term catch as the theoretical MSY (Figure 1). Of course, these expectations depend upon current ecosystem and environmental conditions persisting into the future. A recent study (Vert-Pre et al. 2013) indicated a large number of situations in which unexplained shifts in productivity seem to have occurred, thus adding more variability to forecasts of stock rebuilding and setting of ABC.

Table 1. Relationship among various annual and long-term catch quantities used in the fishery management process.

Basis	Annual Catch Quantity	Long-Term Average	Role
MFMT and biomass	OFL	MSY	Status determinations
OFL and scientific uncertainty	ABC	<MSY	Upper limit for ACL
Science-Management transition	ACL	N/A	Basis for accountability Measures
Management uncertainty	ACT (optional)	N/A	Optional target to ward against exceeding ACL
Additional social, economic, ecological factors	Variously named; modified ACT; annual catch target; annual OY	Optimum Yield (OY)	Actual expected performance of the fishery

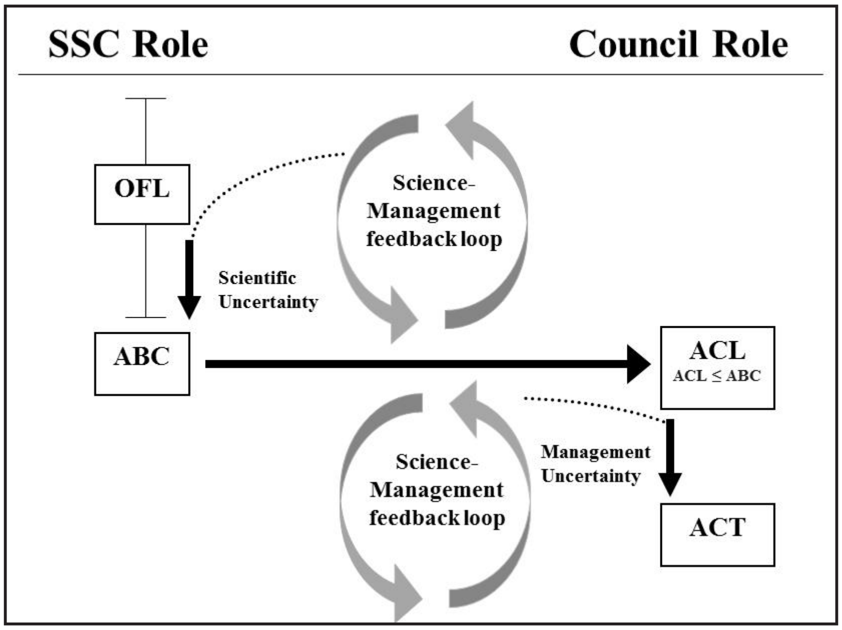

Figure 2. A schematic describing the related roles of the Councils and their Scientific and Statistical Committee (SSC) in translating scientific information into recommendations for catch limits.

The SSC's recommendation of the ABC then forms the basis for the Council setting the ACL. The ACL will typically be set equal to the ABC; it is the science-management handoff. There is an important distinction. The ABC is the endpoint of the scientific process. The ACL is a management limit and is no longer an estimate. It is the basis for management actions and accountability measures for a given fishing year. After setting the ACL, the Council may then need to make further adjustments (to create an annual catch target [ACT]) to account for management uncertainty regarding the capability of the system to manage actual catch close to the ACL. Other adjustments will account for bycatch reduction, interactions among fisheries, and other factors.

Discussion

What Does Overfishing Mean?

Overfishing is catching too many fish, which reduces the stock's abundance and productivity, and prevents the stock from producing as much catch, in the long-term, as the larger stock could have produced given the prevailing environmental conditions. Thus, overfishing jeopardizes a fish stock's capacity to produce maximum sustainable yield.

This reduced stock will also have a diminished role in its ecosystem, the higher fishing effort associated with overfishing may have more bycatch, and the catch per unit of fishing effort will be lower and less able to provide revenues over the costs of that fishing effort. So, there are several good reasons to prevent overfishing. ACLs with accountability measures are intended to prevent overfishing. Their perceived and real success in doing so requires some attention to the ways in which overfishing is measured, and the time frame over which it is measured.

Measuring Overfishing

The National Standard 1 Guidelines describe two ways to measure overfishing scientifically and then to make a formal status determination. One is to set a MFMT, and then use a subsequent stock assessment to measure whether or not the actual catch for the most recent year has resulted in a level of F that exceeds the MFMT. The other approach is to use a stock assessment (which could be as simple as a calculation made from historical average catch) to forecast a level of catch that is the OFL and then simply measure whether or not the actual annual catch exceeds this amount. OFL is in the same terms, catch amount (measured in weight or number of fish), as the ABC and the ACL. The MFMT is a rate, so is not expressed in the same terms as the ACL (i.e., catch). With some exceptions, the OFL approach is used predominantly in the FMPs of the Pacific and North Pacific Councils, and the MFMT approach is used predominantly in the Councils along the Atlantic and Gulf of Mexico. These two approaches and some of their pros and cons are outlined in Table 2 (next page), using the status determination for year 2014 as an example.

The OFL approach depends upon assessments to guide adjustments to OFL over time. Stocks are constantly fluctuating in abundance and productivity, so the catch limits needed to maintain the F rate below the threshold must also be adjusted, or there must be an effective control of fishing effort so that it remains constant at the level to produce the target F. For example, the abundance of North Pacific groundfish stocks fluctuates from year to year, so assessments for most stocks occur annually just months before the fishing season begins. Once the OFL has been set for the year, whether or not it is exceeded depends only on the timeliness and effectiveness of management practices for that year (i.e., management uncertainty). However, scientific uncertainty can compound that challenge. For example, the OFL for a year will typically be set before there is knowledge of the most recent level of recruitment of young fish into the stock. If this recruitment is much higher than expected, then fishermen may catch fish at a high rate, causing an earlier than expected attainment or exceeding of the OFL. But a subsequent assessment may show that because of the high recruitment, the F was not above the MFMT even though the OFL may have been exceeded. Conversely, if recruitment is poor the stock is smaller than expected and the catch will be concentrated on the remaining stock, thus causing a higher F even though the OFL was not exceeded. So, accurate and timely forecasts of the available biomass for the upcoming fishing season are important for good implementation of the OFL approach, even though the status determination itself only depends upon catch and the OFL.

The MFMT approach also needs assessments, as it is the assessment that hindcasts the fishing mortality rate for the previous year and calculates the probability that overfishing did or did not occur. So, because the MFMT approach depends upon an assessment, the scientific uncertainty associated with that assessment will also influence whether or not the assessment finds that F exceeded the MFMT. Stocks that have overfishing determined by the MFMT approach also will use assessments to forecast ACLs that will be intended to prevent overfishing. The catch could be less than that ACL, but the updated calculation by a subsequent assessment may show that the F caused by the catch could exceed the MFMT because of the scientific uncertainty associated with the assessments, including fluctuations in stock abundance. This reduces public trust in the value of the assessments because the management limit, the ACL, was followed but the subsequent assessment finds that overfishing still occurred. Whether the OFL approach or the MFMT approach is preferable largely depends upon the precision and timeliness of the assessments and the expected degree of OFL change from year to year. Given the need for forecasts of ABC and ACL for all managed stocks, the OFL seems advantageous in many situations.

Table 2. Outline of the procedures for making overfishing determination using the OFL approach versus the F approach.

OFL Approach for 2014	MFMT Approach for 2014
Use MFMT and 2013 assessment to forecast Biomass and OFL for 2014, and perhaps years beyond. OFL could also be from a non-forecasting, simpler assessment.	
Forecast of ABC and ACL for 2014 similar to OFL forecast	Same as OFL approach
Throughout 2014 and early 2015, catch for 2014 compared to ACL for accountability measures.	Same as OFL approach
Status Determination: In 2015, catch for 2014 compared to OFL to determine if overfishing has occurred. No updated assessment is needed.	
Assessment in 2015 or later will update estimate of B and MFMT for 2014 and calculate the F for that 2014.	Same as OFL approach
OFL based overfishing determination is not reconsidered on basis of the new assessment.	Status Determination: Calculation of F for 2014 compared to MFMT to determine if overfishing occurred.
Pro: Can be applied in situations where data are too limited to calculate F levels Pro: Formal status determination not directly influenced by scientific uncertainty Pro: Easily explained to public because OFL, ABC and ACL are in the same terms	Pro: If fishery effort is relatively constant, can work better when natural stock fluctuations are high
Con: If stock fluctuations are high and assessments not timely and precise enough to forecast changes, then OFL approach will cause fluctuations in F Con: No accountability measure is associated with later finding that F was greater than MFMT	Con: If assessments have much uncertainty, there is possibility for a finding of overfishing even if catch was kept below ACL. Con: Delayed assessments mean that status determinations cannot be updated Con: Harder to explain to public because the ABC and ACL forecast are based on a different assessment than the subsequent assessment used for the status determination

Types of Overfishing

Status determinations to determine if overfishing has occurred are designed to prevent the stock from experiencing actual overfishing and declining into an overfished state. However, scientific and management uncertainty mean that simply setting targets below limits does not necessarily prevent the stock from experiencing overfishing. We perceive overfishing on the basis of estimated F being greater than MFMT or catch being greater than OFL, but these are based on estimates so cannot perfectly reflect what is happening to the fish stock. Four levels of overfishing may be identified to clarify this situation.

The first level can, unfortunately, best be termed intentional overfishing. This occurs when the catch quota or other management measure is set above the overfishing level, or by allowing fishing to occur with no effective management controls. With the MSA and the Councils' implementations of the 2009 NS1 Guidelines, the U.S. has ended this type of overfishing by requiring ACLs that are below the overfishing level and by requiring accountability measures to assure that ACLs are not frequently exceeded. However, this does not mean that other types of overfishing will not occur in the future.

The second level of overfishing occurs due to management uncertainty. In this situation, the ACL has been set at a level that, if followed, would prevent overfishing. But if the control of the fishery allows excessive catch, the ACL and the OFL (or MFMT) can be exceeded. This could be accidental (inseason management procedures were in place but they were implemented too late due to data lags or other factors, or failed to slow fishing effort sufficiently), or structural (no credible accountability measures were in place to keep catch under control within the fishing season). In fishery management plans that define overfishing on the basis of annual catch exceeding the OFL, management uncertainty will be the typical way in which a finding of overfishing will be made.

The third level of overfishing occurs due to scientific uncertainty that causes a subsequent assessment update to have an upward revision of historical estimates of fishing mortality rates, or downward revision of the MFMT. Whether or not this results in a formal finding of overfishing will depend upon whether the FMP uses the OFL approach or the MFMT approach. In either case, the best science information available now indicates that fishing has had too large of an impact on the stock. An accountability measure could be a larger buffer between OFL and ABC to guard against this type of overfishing. While management uncertainty can be corrected on annual basis through the use of accountability measures, scientific uncertainty can be persistent for many years before new information or assessment approaches cause a shift in the assessment outcome. Ralston et al (2011) examined the history of updated assessments for U.S. West Coast groundfish to determine the overall level of scientific uncertainty from the year-to-year assessment changes and used this to guide creation of a buffer between the OFL and the ABC.

The fourth level of overfishing is not yet formally defined, but is essentially ecosystem overfishing. This occurs when the model/paradigm under which the overfishing limits of single-species assessments are biased, and/or inadequately account for important factors. We may not find out about this until decades later. It is essentially a long-term form of scientific uncertainty. For an analogy, consider the many decades of forest fire suppression that occurred before finding that some level of fire was beneficial to forest ecosystem health. An example from fisheries might be a case where ecosystem shifts have caused a changed in natural mortality over time. Because single-species assessments have little inherent ability to detect such shifts, the natural mortality rate is held constant in the model year after year and a perplexing degree of retrospective bias in the assessment occurs as the model attempts in vain to deal with mismatches in the data being analyzed. Only after bringing results from ecosystem models into direct consideration is the shift in natural mortality detected and incorporated into the improved, next generation assessment. It is important to anticipate this possibility and consider the cumulative impact of fishing on the entire ecosystem (Murawski 2000). When managing at the system level, research suggests that MSY and other reference points should be more conservative than those based on traditional single-species stock assessments (Fogarty et al., 2012; Meuter and Megrey 2006). An explicit buffer for ecosystem uncertainty has yet to be addressed, although the 2,000,000 ton catch cap in the Bering Sea is a step in this direction.

Uncertainty Buffers

Concerns have been raised that stock assessment methods themselves, the accounting for scientific uncertainty, and the accounting for management uncertainty causes excessive and duplicative buffers in the prevention of overfishing. It is important that all sources of uncertainty be taken into account in a cumulative way so that the total buffer attains the desired degree of protection against overfishing, but this does not make them duplicative. The stock assessment itself should be as objective as possible and not take any steps that are intentionally conservative, so that a risk neutral estimate of MFMT and OFL is provided to managers along with information on the uncertainty of those estimates. Prior to the 2009 update of the NS1 Guidelines and its creation of an explicit buffer for scientific uncertainty, it is possible that some assessment calculations embedded that uncertainty into their baseline advice. That should no longer be the case. When the SSC asserts that the assessment is the best scientific information available, it does not mean that it is perfect information regarding the abundance and status of the stock. Perfection only occurs in a theoretical sense; reality has imperfection and uncertainty. The buffer associated with the determination of ABC acknowledges this scientific uncertainty. Once the operational limit, ACL, for the year has been set, then it is management uncertainty that controls how close to the ACL the catch will be. The investments needed to reduce management uncertainty are different than the investments needed to reduce scientific uncertainty. Low management uncertainty typically requires a good, timely inseason catch accounting system and a responsive set of management tools. Reduced scientific uncertainty in assessments typically requires better fishery-independent surveys, data on fish ages, and ecosystem studies of process changes. Analysis of the impact of scientific and management uncertainty needs to take the combined effect of both into account, but they are measuring different aspects of the science-management system.

Time Frame for Updating Assessments and ACLs

The time frame on which assessments should be updated and ACLs adjusted depends upon four major factors: the expected frequency and degree of natural fluctuation in stock abundance, the level of uncertainty in the stock assessments, value of the stock (which generally leads the fishing community to want the stock's fishing mortality rate to approach the level of F_{msy}), and assessment capacity of the regional NMFS Center and the Councils to assess all managed stocks (the number of stocks managed by regions/Councils varies widely, as well as their capacity to assess each stock due to funding and data limitations). Stocks that have high natural fluctuations need frequent assessment updates to track the changes and reduce foregone yield due to over or under-fishing. Attaining MSY is theoretically possible if the ACL adjustments were perfect and occurred instantly as needed. On the other extreme, stocks that do not have frequent assessments typically have their ACL kept constant for several years because there is no information to guide ACL changes to track stock fluctuations. In between are the stocks for which the fishery management system attempts to adjust ACL frequently, but scientific uncertainty produces perceived fluctuations in stock abundance that do not match the actual changes in stock abundance. The ACLs are updated essentially in lock-step with the assessment results through a control rule that translates the assessment output into OFL and ABC values that limit the ACL. So there is a dichotomy between allowing an ACL to be unchanged for several years when there is no assessment update, then expecting it to fully change when a new assessment is completed, no matter how much uncertainty there is in the new assessment.

The up and down fluctuations in ACL to prevent overfishing and foregone yield is not always an ideal way to manage the fishery because in some cases they tend to have a negative short-term effect on fishing communities. This is particularly true for recreational fisheries, so it is important to assure that the ACL adjustments are beneficial. If the adjustments are strongly influenced by scientific uncertainty, then the long-term benefits of close tracking are diminished and could be out-weighed by the short-term negative effects. Management uncertainty has been shown to be increased by large scale fluctuations in the ACLs (i.e., > 20% change), because developing effective management measures for a moving target is a difficult task to achieve (Patrick et al. 2013).

A way around this problem is to build inertia into the OFL control rule to smooth out the changes over time. When the assessment is updated and a change in ACL is indicated, the change could be phased in according to a pre-agreed formula. Such an approach is commonly seen in the management procedure approach to control rules (Butterworth and Punt 1999). It is quite reasonable to also use such an approach in the application of assessment results to guide changes in ACL. For example, next year's ACL could be set equal to 60 percent of last year's ACL plus 40 percent of the ACL indicated by the new assessment. Other approaches could put a limit on the degree of ACL change allowed from year-to-year. For example, the International Pacific Halibut Commission adjusts its quotas according to a "slow up/full down" policy. Multi-annual plans for some European marine fisheries limit annual change to 15 percent under all but extreme conditions for the stock. The exact formula and percentage that would be helpful for management of U.S. stocks would be situation specific and would depend upon factors including the natural mortality rate of the stock (its inherent inertia to change), the status of the stock, the degree of scientific uncertainty in the assessments, the degree of variability in recruitment and other biological factors, etc. For each situation, a management strategy evaluation should be performed to investigate the performance of the proposed phase-in rule, including the degree to which the rule would still keep stock abundance near the target level of abundance while providing an average yield nearly as large as MSY, with less annual fluctuation than occurs when a constant fishing mortality rate is applied to point estimates of stock abundance. With such a prior investigation of the expected benefits, control

rules that incorporate inertia to change seem within the scope of the NS1 Guidelines.

This management strategy evaluation is essentially a computer simulation of the biological-scientific-management-fishery system. It is guided by stakeholder input and is designed to inform all participants about how the actual management approach will perform, rather than just assuming that the management approach will perform according to some ideal scenario. The management strategy evaluation can be used to investigate not only the phase-in approach, but also the impact of scientific and management uncertainty. They can include social and economic factors.

At first glance, this phase-in approach would appear to be underfishing during years of increasing stock abundance and possibly overfishing during periods of declining abundance. However, that would only be in comparison to a management regime that was based on nearly perfect, very timely assessments. That regime is ideal or theoretical, but essentially unattainable. The phase-in approach would be designed to prevent overfishing on a longer-term basis. This is essentially what happens today for stocks without annual assessments and with OFL and ACL held constant for several years in between assessment updates.

This phase-in of OFL and ABC changes is different from the multi-year averaging approach that can be used to determine whether the ACL is being exceeded. It seems possible that an approach to multi-year averaging of OFL overages/underages could be developed as an alternative to the phase-in approach to OFL changes. The multi-year averaging may even be preferable in situations with highly fluctuating stocks for which it is not feasible to forecast the needed OFL changes and for which an OFL phase-in would be too slow to keep up with the stock changes. The merit of phase-in versus multi-year averaging probably depends on the relative level of true stock fluctuations versus perceived fluctuations due to assessment uncertainty. The phase-in approach has the advantage of proactively reducing the degree of ACL change from one year to the next in situations where some of that change would have been based on assessment uncertainty and not true changes in the stock.

Stocks in a Fishery

The 2009 NS1 Guidelines created a category of fish stocks termed ecosystem component (EC) species. These were defined as non-target stocks that are listed in fishery management plans, but are not overfished or expected to become overfished and are generally not retained for sale or personal use. These ecosystem component species are not required to have status determination criteria or ACLs. The creation of the EC species category was necessitated by the great diversity in species inclusiveness that occurs across the many FMPs. Some FMPs are for single or a few species, and bycatch species, if any, are not included in the plan's list of managed stocks. Other FMPs have been broadly inclusive of species, some of which are clearly not targets of the fishery. The EC designation allows for a more uniform approach across FMPs. Although EC stocks are not part of the fishery, they deserve some monitoring and protection, as does the entire ecosystem, but this does not warrant the extra work to estimate the same quantities as are needed for the target stocks.

Target stocks are the focus of the fishery and are in need of management supported by stock assessments, status determinations and ACLs. Generally, they are the reason that the FMP exists. In between target and EC are the non-target species, which typically do not have sufficient data to support conducting full assessments. There are a large number of stocks in this potential category.

Table 3. Categorization of commercial and recreational catch in 1999. Salmon, corals, and highly migratory species are omitted for clarity. The rows and columns are the lower limit of a catch category, so "10" means catch is between 10,000 lbs and 99,999 lbs, inclusive. Tabulated values are the number of stocks with that level of catch in 1999.

Commercial catch (1000s of lbs)	Recreational Catch in 2009 (1000s of lbs)							
	0	<1	1	10	100	1000	10000	ALL
0	53	5	4	5	4			71
<1	17	4	7	7				21
1	17	9	6	3	1			36
10	25	3	9	8	9			54
100	35	4	6	14	19	9		87
1000	46		2	2	3	9	1	63
10000	24	2		1	1	4		32
100000	7	1		1				9
1000000	1							1
ALL	225	18	34	41	37	22	1	388

Table 3 uses commercial and recreational catch data from 2009[2] and summarizes into broad categories of catch levels (with units of thousands of pounds). Salmon, corals, and highly migratory tuna/billfishes are not included in order to focus the presentation. There are 53 stocks with no reported commercial or recreational catch in 2009, many of these were subsequently classified as EC stocks or merged into complexes and a few had no reported catch due to confidentiality or other reasons. The tremendous range of catch levels is striking, with many stocks showing catch levels less than one thousand pounds, and with 19 stocks showing 100,000 lbs. of both commercial and recreational catch. The large number of stocks with low catch levels indicates either that some stocks are exceedingly rare or they are only being incidentally caught by the fisheries. Designation of a non-target classification will be difficult, but could greatly assist in the prioritization of assessment efforts.

Typically, these non-target stocks may be retained when caught, so do not warrant the current EC designation, but they are part of the fishery, so are required to have status determination criteria and ACLs. However, the level of fishing mortality experienced by these non-target stocks relative to the level experienced by the target stocks with which they co-occur surely must cover a very wide range. Collecting enough data to conduct full assessments for these many non-target stocks is infeasible, so many of their ACLs have been based on approximate, preliminary assessments using limited data (Berkson et al. 2011), but these methods are no long-term panacea. A revised management approach for these non-target species seems useful, but a first step would need to be development of criteria to distinguish target from non-target stocks, and possible revise the dividing line between EC and non-targets. Simply sweeping them up into a complex is not advisable because they would then get even less individual protection.

If a non-target category of stocks could be adequately defined, then perhaps the ACL for un-assessed, non-target stocks could have a modified accountability measure. Rather than a trigger for accountability measures to immediately reduce catch, the ACL would be a trigger for longer-term actions. First, it seems reasonable to routinely use multi-year averaging of ACL overages for such weakly monitored stocks. Second, inseason accountability for the ACL overage of non-target stocks could be suspended in lieu of actions spread over a longer time frame, unless there was evidence of immediate jeopardy to the stock. By frequently reaching the ACL there is an indication that the stock could be becoming a target stock with a fishing mortality rate that needs to be closely monitored to prevent overfishing. In this case, there should be increased priority for improvements to that stock's data collection so that an assessment could be conducted in the future. Whether or not that data collection occurred solely through agency funding or through greater involvement of the fishing community could be situation specific. In general, the potential role of fishery participants in providing information to determine the sustainability of their fishery is

2 These catch data were assembled by a NMFS working group that is developing a prototype approach for prioritization of fish stock assessments. For more information, contact Richard.Methot@noaa.gov.

addressed through cooperative research. In some cases, it may make sense to seek a more concerted role in having them provide the primary information needed to support full stock assessments.

Multi-Stock Fisheries and Stock Complexes

There is a dichotomy between the management approach for stock complexes and the management approach for multi-stock fisheries. A stock complex is a collection of stocks in a region that are asserted to be sufficiently similar in geographic distribution, life history, and vulnerabilities to the fishery such that the impact of management actions on the stocks is similar. Management of complexes can be guided by tracking an assessed indicator stock; however, in many cases the recent average catch of the stocks within the complex are summed to calculate a stock complex level ACL. The stocks in the complex typically have little assessment data, so there is no realistic option to assess and manage them individually. Methods are available to estimate the vulnerability of stocks to overfishing (Patrick et al. 2010), but it is difficult to be confident that the chosen indicator stock is the most vulnerable member of the complex. Somewhat paradoxically, when a stock in a complex is first assessed there is a tendency for the Council to remove it from the complex and manage it with its own ACL and status determinations, rather than use it as an indicator for the complex; thus, stock complexes often lack indicator species and none have multiple indicators.

For a multi-stock fishery, there is recognition that the stocks are caught together in varying proportions depending on the fishing fleet (i.e., gear and vessel type) and region fished. These stocks each have enough assessment information to guide the setting of status determination criteria and ACLs for each individual stock. However, because of the ways in which the stocks are caught together, it is extremely difficult to design a fishery management system that can achieve each stock's ACL exactly, or for fishermen to target the catch of specific stock with sufficient precision that it does not result in the bycatch of other species. As a result, the mandate to prevent overfishing leads towards management systems for multi-stock fisheries that forego yield for some stocks in order to prevent overfishing other stocks.

So there is a logical discontinuity between the management approaches for un-assessed stock complexes versus assessed multi-stock fisheries. Unassessed stock complexes have higher levels of uncertainty but by being managed as a complex they are not limited by the most vulnerable stock, unless there is enough information to select the most vulnerable stock as the indicator stock and to keep it in the complex. On the other hand, assessed stocks that have lower levels of uncertainty but are managed as a mixed-stock fishery may forego yield of some stocks when the most vulnerable stock in the fishery approaches its ACL. Thus, greater scientific uncertainty for stocks in multi-stock complexes can result in relatively lower yields than what those might have produced when managed as a complex.

Reduction of this discontinuity could involve modification to both the complex and the multi-stock approaches. For complexes, there could be a greater effort to identify multiple indicator stocks and keep them in the complex so that there would be more information on the status of the more vulnerable members of the complex. Also, because most kinds of scientific uncertainty cannot even be calculated for the complexes, there could be an explicit buffer used when calculating ACLs for complexes from simple data such as the summed catch of all complex members. For the multi-stock fisheries, there could be a greater effort to conduct a bio-economic tradeoff analysis. In the multi-stock fishery, a fishing rate on some stocks that is slightly above the overfishing level will reduce that stock below its target level of abundance and will prevent attainment of the full MSY for that stock, but it will not necessarily reduce the stock below its overfished limit and it may allow fishing rates on the entire multi-stock fishery that would better attain the optimum yield for that entire fishery. This can be analyzed by stock assessment, ecosystem and economics scientists working together. This role of a bio-economic analysis will be as helpful in exploring feasible approaches to multi-stock fisheries as they will be in guiding the desirable degree of temporal phase-in of ACLs as described earlier.

Conclusion

The Regional Fishery Management Councils completed implementation of the ACL provisions of the reauthorized MSA in 2012. Implementation of science-based ACLs with accountability measures in all fisheries establishes a firm metric to reduce overfishing. Limited instances of overfishing may still occur due to management uncertainty, which allows catch to sometimes exceed the ACL, and scientific uncertainty, which acknowledges that the ACL set for a year is based on estimates and these estimates can change over time as more scientific information in collected. Whether overfishing is better measured as catch exceeding a catch threshold, or fishing mortality rate exceeding a fishery mortality threshold, depends upon the relative magnitude of management and scientific uncertainty and the scale of true fluctuations in the stock. The scientific process that provides the ACL estimates is limited in scope. Over a timeframe of decades we will learn to bring more ecosystem and climate factors into the analysis, and may find long term overfishing has been occurring in some situations.

Scientific and management uncertainty are taken into account when buffers are established between overfishing thresholds and fishery management targets. The magnitude of these buffers should balance the prevention of overfishing against short-term reductions in fishing opportunity needed to achieve that degree of prevention. A greater role of social and economic analysis is needed to better understand that tradeoff. Continued improvements in the scientific enterprise supporting sustainable fisheries are needed, in cooperation with the fisheries that benefit from this science.

Fishery control rules tend to be simple in form so that when a new assessment is conducted, the change in stock biomass results in a nearly proportional change in the recommended catch levels. The biomass estimates are intended to track true changes in the stock, but they also have scientific uncertainty that introduces noise into the system. It should be possible to use a management strategy evaluation to understand the pros and cons of building inertia into the control rules so that ACL changes over time are less extreme, while still preventing overfishing on a reasonable time scale.

The near 500 fish stocks in U.S. FMPs are quite varied with regard to the degree of fishing pressure they attract and the level of catch they produce. The 2009 NS1 Guidelines created a category of stocks termed ecosystem component species which are distinct from the managed stocks in the plan that need status determination criteria and annual catch limits. The managed stocks could perhaps be separated into target species and non-target species to assist in the prioritization of assessment efforts and in a differential management response for the non-target stocks.

Within the set of managed stocks, some are managed individually as members of a multi-stock fishery, and some are aggregated into stock complexes for management purposes. This creates a dichotomy because the stocks in a multi-stock fishery tend to be managed conservatively to protect the weakest stock from overfishing, and the stocks in the complex are managed according to a simple approach or by an indicator stock that may not be the weakest stock in the complex, so some stocks may be experiencing some level of overfishing. A more consistent middle ground would use multiple indicator stocks for the complexes in order to do better at protecting the weaker stocks, and would use more economic analysis of the multi-stock fisheries in order to determine the overall benefits that may be obtained by allowing small degree of overfishing of some stocks in order to obtain the full available yield from other stocks.

There is common ground between allowing smoothing of ACLs over time and allowing an overall harvest rate on a multi-stock fishery to obtain the best benefits for the fishery, essentially smoothing harvest rate across stocks. When the ACL for a stock is kept constant for several years, the system is tacitly allowing a smoothing over time; and when stocks are aggregated into a complex the system is tacitly allowing a smoothing of harvest rates across stocks. Data-rich, intensively managed stocks can be analyzed more completely to allow a reasonable degree of smoothing in time and across stocks to benefit the fishery, prevent stocks from becoming overfished, and make better use of the available scientific information. Beyond cooperative research, in some circumstances fishery participants may be able to

assist in providing more of the core scientific data needed to reduce assessment uncertainty.

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SCIENTISTS SORTING CATCH ON 2012 WEST COAST GROUNDFISH SURVEY (PHOTO: NMFS)

DISCUSSION SUMMARY AND FINDINGS
Session 1 Topic 1

Annual Catch Limit Science and Implementation Issues, Including Managing Data-Limited Stocks

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Moderator

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Discussion Summary:

Annual Catch Limit Science and Implementation Issues, Including Managing Data-Limited Stocks

The Magnuson Stevens Fishery Conservation and Management Act (MSA) reauthorization of 2007 created an annual catch limit (ACL) framework designed to prevent and end overfishing. All sources of fishing-related mortality, including discard mortality, are counted against specified ACLs. Accountability measures (AMs), or management controls, are designed to prevent fisheries from exceeding ACLs. Panelists, presenters and other attendees to this session agreed the ACL framework has effectively reduced overfishing and achieved many of the mandates of the reauthorized MSA. However the ACL framework has constrained catches of some sustainable stocks and the optimum yield (OY) is reduced to take into account the uncertainty. There was general agreement that regional needs vary substantially and that increased flexibility in regulations may be necessary to address different fisheries and regional issues. Many of the attendees to this session recommended some finer scale changes to the ACL framework to increase OY attainment and foster greater management and fishery stability. The issues that were discussed including those that were determined to be findings are summarized for four broad subject categories: 1) National Standard 1 Guidelines, 2) Tools and strategies for managing recreational fisheries, 3) Stock assessment considerations, especially for those stocks where status and abundance are poorly informed by limited data, and 4) Accountability measures.

National Standard 1 Guidelines

There was considerable discussion of how to formulate ACLs based upon the National Standard Guidelines. It was acknowledged that ACLs serve to address intentional overfishing by imposing hard limits, however issues remain with how to address management and scientific uncertainty in formulating appropriate ACLs. The Acceptable biological catch (ABC) buffer, which is intended to account for scientific uncertainty in the OFL, should be relied on to prevent annual overfishing. Some participants recommended removing prescriptive language regarding uncertainty and risk from ACL guidelines. There was general agreement that assessments and resulting OFLs should be risk-neutral so that the risk aversion is only in setting the ABC/ACL below the OFL. Some concern was expressed, however, with cases where inadequate science was thought to be used to set ACLs as well as cases where there were negative impacts as a result of ACL compliance, resulting in lost yield and a general lack of consideration of socio-economic impacts. Analyses of ACL provisions should explicitly evaluate the tradeoff between forgone catch and reducing the risk of overfishing.

There was discussion of the need for providing the Councils greater flexibility in compliance with both ACL provisions and rebuilding plans. Some participants suggested that managing ACLs as hard limits (rather than as targets) is not appropriate for stocks that are neither overfished nor undergoing overfishing.

There was discussion of OY, noting that social and economic considerations must be considered. Currently, some fishery management plans (FMPs) simply define OY for each single stock in terms of retained catch from a target fishery. The North Pacific Fishery Management Council defines OY in terms of total catch for all stocks in the FMP. No Councils have brought forth OY definitions that fully embrace multi-species and economic considerations.

General concerns were raised regarding data availability and the uncertainty associated with inadequate data. Management uncertainty could be minimized with better in-season data.

Findings

CONSIDER MULTI-YEAR MINIMUM STOCK SIZE THRESHOLDS AND ANNUAL CATCH LIMITS FRAMEWORK

One unintended consequence of implementing the new ACL framework is management and fishery instability caused by early attainment of an ACL for a constraining stock or a new assessment with different results than the previous information used to manage fisheries. This can be especially disconcerting when the science is highly uncertain resulting in large interannual variation of our understanding of stock status and a stock's harvestable surplus. To this end, many attendees to this session recommended consideration for a framework where multi-year minimum stock size thresholds (MSSTs) and ACLs are specified. Specifically, there is concern when a stock is declared overfished based on one uncertain assessment. Therefore, the attendees recommended a policy where an overfished determination is not based on a single assessment. In this case, precautionary management measures could be implemented and a more robust assessment could be prepared before declaring a stock overfished. Further, many of the attendees recommended allowing the use of multi-year ACLs to better achieve the management objective of attaining OY and to foster management and fishery stability. There was widespread concern regarding large year-to-year variation in many specified ACLs due largely to assessment uncertainty. To address this concern, the group recommended constraining large interannual changes in ACLs for stocks subject to high scientific uncertainty. It was noted that the European Union policy does not allow catch limits to vary from year to year by more than ±15%, except under extreme circumstances. Multi-year ACLs could also be specified, whereby exceeding an ACL could allowed in any one year as long as there was a compensatory decrease in catch in subsequent years, such that the overall multi-year ACL was not exceeded. Such a provision would also enable easier implementation of carry-over provisions that allow participants in a catch share program to carry over a portion of their quota surpluses or deficits to the next year (deficits to be covered with newly-issued quota).

ALLOW AND PROVIDE GUIDANCE FOR USING THE MIXED STOCK EXCEPTION

The mixed stock exception is allowed in the National Standard 1 guidelines but has never been implemented as it has not been clear how a mixed stock exception would work for sustainably managing all stocks in a mixed stock fishery. The mixed stock exception could provide improved access to healthy stocks in mixed stock fisheries. Otherwise, achieving OY may never be attainable without a mixed stock exception. Management strategy evaluations (MSEs) can inform managers of the risks associated with invoking the mixed stock exception. The key is to demonstrate that occasional and moderate levels of overfishing of some stocks is sustainable and can allow attainment of full OY for other stocks.

USE MANAGEMENT STRATEGY EVALUATION TO EVALUATE THE PERFORMANCE OF HARVEST CONTROL RULES

MSEs can be used to simulate a fish stock's response to current and proposed changes in ACL policies to improve managers understanding of risk. Managers need to understand whether the management system is robust to noise and assessment uncertainty, or whether the system, in effect, amplifies noise and creates fishery instability. An MSE would also be helpful in gaining understanding of stock-level impacts of exceeding ACLs. MSEs help to better understand the effect of scientific uncertainty buffers (e.g., ABC control rules) designed to mitigate potential risks of overfishing. MSEs provide a powerful tool to understand the impacts of managing stocks, given the scientific and management uncertainty inherent in the Regional Fishery Management Council system.

PROVIDE BETTER GUIDANCE ON SETTING ACLS FOR TRANSBOUNDARY STOCKS WHERE NO INTERNATIONAL TREATY EXISTS AND ONLY U.S. REMOVALS ARE KNOWN

Many of our nation's fisheries target transboundary stocks that are distributed both in the U.S. Exclusive Economic Zone (EEZ) and in the EEZs of other nations adjacent to our borders. There was a concern expressed that overly restrictive ACLs are specified for such stocks—even in cases where the domestic fishery has little impact on the status of the stock (the example discussed was spiny lobster in the Florida Keys). Participants recommended better guidance be developed on how to set ACLs for transboundary stocks, and some recommended an exemption from Federal requirements to set ACLs for transboundary stocks. Currently, the MSA only allows an exemption to setting ACLs for transboundary stocks when there is an international treaty agreement. Some participants recommended the better guidance for transboundary stocks is to evaluate removals outside the EEZ relative to domestic harvest when setting domestic ACLs. There was also an acknowledgement that there needs to be an understanding of the potential of stock distribution shifts across international boundaries as climate changes.

Different Tools and Strategies for Managing Recreational Fisheries

Recreational fisheries are fundamentally different from commercial fisheries. Commercial fisheries seek to maximize yield, which occurs when a population is dominated by younger faster growing fish (i.e., when stock biomass is at B_{MSY}). Recreational fisheries seek to maximize fishing opportunity, which occurs when there are higher numbers of older and larger fish (i.e., when stock biomass is higher than at B_{MSY}). The group discussed how formulation of catch limits should be tailored to fit these different fisheries. Many modifications for recreational fisheries may not necessitate a change in MSA directly, but rather in the mechanism used to set the ACLs yet still meet the intent of ACLs in protecting against overfishing and stock depletion.

Findings

ELIMINATE HARD QUOTAS MANAGED IN-SEASON FOR RECREATIONAL STOCKS. ADJUST PRE-SEASON INPUT CONTROLS (E.G., BAG LIMITS, SEASONS) TO STAY WITHIN ACL (BASED ON NUMBERS OF FISH, NOT POUNDAGE)

Some attendees to this session recommended ACLs be set or be managed such that an ACL can be occasionally exceeded (i.e., "soft ACLs") for stocks dominant in recreational fisheries. Further, some attendees recommended that inseason adjustment of bag limits and seasons be done to stay within ACLs, and that these limits be based on numbers of fish rather than in poundage. There was no consensus on this. There was a recommendation to instead consider setting an annual catch target (ACT) for recreational-dominant stocks. Alternatively, there was a recommendation to not set ACLs for non-target stocks when there is no concern for stock status. Many of the attendees remarked that all sources of fishing-related mortality need to count against ACLs and recreational fisheries should not be exempt from this requirement. Further, it was pointed out that the MSA conceptually combines ACLs and AMs. It was not clear how one can design a system where only an AM is used without specification of an ACL.

The group discussed a recommendation to set ACLs for recreational fisheries based on numbers of fish rather than poundage. While this approach would be an improvement for managing most recreational fisheries, implementation may prove challenging in cases where a stock is caught in both recreational and commercial fisheries. It was noted that a numbers-based ACL for recreational fisheries was considered for Pacific groundfish, but was rejected because most stocks targeted in recreational fisheries are also targeted in commercial fisheries and commercial value is based on the poundage of landings. Nevertheless, assessment models are capable of providing catch forecasts in terms of both numbers and poundage on a fleet-by-fleet basis, so the technical underpinnings are available if the management protocols can be developed.

MANAGE WITH LONG-TERM MORTALITY RATES FOR MORE STABILITY (E.G., ELIMINATE WIDE FLUCTUATIONS IN CATCH LIMITS)

Many attendees recommended recreational fisheries be managed using long-term mortality rates to create more stability. The sponsors of this initiative argued that management objectives for recreational and commercial fisheries differ. Commercial fisheries are managed for maximized yield at low cost while recreational fisheries should be managed on expectations (abundance, age-structure and access), not yield and cost/benefit. Recreational effort responds to current stock abundance resulting in similar trends. Therefore, if recreational fisheries are managed using a constant mortality rate, they will naturally respond to fluctuations in stock abundance. Recreational participation is directly related to abundance, while recreational management measures often lack the flexibility or adaptability to respond to changes in stock abundance. This recommendation also depends on increasing the frequency of stock assessments to more closely track abundance. It was noted that ACLs are not static when projected stock biomass is projected to change. Detractors noted that most of the stocks targeted in recreational fisheries are also targeted in commercial fisheries. Therefore, a competing management framework for different fisheries targeting the same stock could be problematic. Further, in this fiscal climate, funding for more stock assessments is unlikely. It was noted that it might be more tractable to develop an annual index of abundance for the target stock and adjust ACLs according to how relative stock abundance is estimated by the index.

Assessments and Data-Poor Stocks

Considerable discussion focused on stock assessments, data availability, and the treatment of data-poor stocks. These discussions included both the data available to assess stocks, data available in-season to manage ACLs, as well as policy considerations for setting informed ACLs where data is limited.

Findings

PRIORITIZE ASSESSMENT OF TARGET STOCKS OVER NON-TARGET STOCKS

Many of the attendees recommended that assessments for target stocks should be prioritized over those for non-target stocks. Target stocks sustain the fishery and account for the most significant socioeconomic impacts associated with fishing. Budget shortfalls necessitate prioritization of assessments, and target stocks are an obvious priority.

SET MINIMUM DATA QUALITY STANDARDS FOR STOCK ASSESSMENT

Some attendees recommended establishing minimum data quality standards for stock assessments and minimum scientific standards for setting ACLs. Others noted that managers are bound to prevent overfishing even if data are insufficient to do this with exactitude. However, it was noted that minimum standards may not fully address the issue, but rather, additional guidance on how to use uncertain assessment results would be helpful. One way to address this would be to characterize scientific uncertainty and establish terms of reference for assessment information and the incorporation of uncertainty into management decisions. The goal is to have an assessment that accurately captures the inherent uncertainty and can be used as a basis for informing management.

DO NOT REQUIRE ACLS FOR DATA-POOR STOCKS

Some attendees recommended not requiring ACLs for data-poor stocks. The argument was that setting an ACL for stocks where stock status and harvestable surplus are poorly known can result in very low catch limits that unfairly penalize the fisheries. Detractors argued the framework calls for greater precaution for setting ACLs for data-poor stocks as part of the precautionary principle. If average catch is used to set ACLs for data-poor stocks, this may be less precautionary and inherently more risky. With only catch data, it may be impossible to know if the stock is being under-harvested (i.e., a higher harvest would not jeopardize the stock), harvested at a sustainable rate, or is being harvested at too high a rate. One consideration offered would be to not set an ACL for those non-target stocks where there is no status concern.

IMPROVE DATA-POOR ASSESSMENT METHODS

There was general consensus from attendees that efforts should be made to improve data-poor assessment methods. In this fiscal climate, developing more fishery-independent surveys and more robust catch sampling are unlikely. Many attendees recommended increasing the amount of collaborative research with fishermen to collect some of the data needed to inform management. It was also recommended to capture fishery-dependent data more quickly using electronic monitoring of fisheries.

CONSIDER DEFAULT BUFFER (E.G., 75 PERCENT MAXIMUM FISHING MORTALITY THRESHOLD)

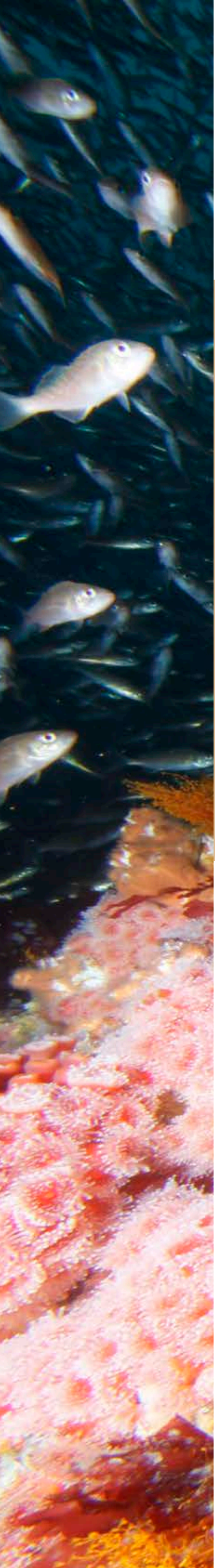
One presenter recommended that a default buffer of 75 percent of the maximum fishing mortality threshold (MFMT) be used, which provides for a "pretty good yield" that while less than MSY, would greatly mitigate risk and increase management and fishery stability. Scientific uncertainty, time lags, and management uncertainty prevent us from maintaining F at the perfect level (i.e., the MFMT), so MSY is best considered a theoretical upper limit that can be approached but never quite attained. A pretty good long-term yield near 90 percent of MSY can be obtained if the fishing rate is reduced to approximately 75 percent of the MFMT. Many attendees embraced this threshold especially for data-poor stocks. However, some questioned whether the target should be at 75 percent of MFMT or whether a different buffer might be more appropriate. An MSE may be a good way to simulate population response managing with a target of 75 percent of MFMT or a different buffer below the MFMT.

MORE THAN ONE INDICATOR SPECIES IN A COMPLEX LEADS TO A BETTER ESTIMATE OF HARVEST SPECIFICATIONS (OFL, ACL)

The use of more than one indicator stock in managing a species complex may lead to better estimates of OFL and ACL that reduce the risk of potential overfishing of stocks managed within the complex. Currently, most species complexes are assessed using a single indicator stock that may be the most abundant in the complex, but may not be the most vulnerable species or the best indicator of overall status of the complex. The use of multiple indicator stocks may help in setting ACLs for stock complexes recognizing the MSY levels and the quality of data and assessment results vary between indicator stocks and other stocks co-managed in a complex. In any case, managers are challenged to resist the tendency to pull assessed stocks out of a complex as an automatic response to a new assessment since the use of indicator stocks can help to manage a complex of species sustainably. It could be risky to continue to manage stocks that are always an assemblage of unassessed, data-poor stocks.

ACCOUNTABILITY MEASURES

There was general agreement that the purpose of accountability measures was to mitigate the impact of exceeding ACLs. However, there is a need for more transparency in the process of setting and managing ACLs to ensure higher accountability. Control rules should be considered which ratchet down fishing mortality below a biomass threshold (as with the North Pacific and Pacific ABC control rules for groundfish). When correctly specified, ACLs should not be exceeded, and when exceeded more than once in a four-year period, the control rule should be revisited. Ongoing discussions relative to the next MSA reauthorization provide a timely opportunity to review progress on ACLs and AMs. Despite issues inherent to their establishment and potential revision, ACLs and AMs have driven unprecedented reversals in overfishing and overfished stock status.



PAPERS

Session 1
Improving Fishery Management Essentials

Topic 2
Rebuilding Program Requirements and Timelines

On the Road to Recovery: Recommendations for Ensuring the Continued Success in Rebuilding U.S. Fisheries

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Abstract

Over the past decade, significant progress has been made in rebuilding overfished populations in the United States. This progress, important from both ecological and economic standpoints, resulted from the requirements of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), the work of fishery managers in implementing the law, and the efforts of fishery stakeholders. The MSA is integral to this progress, providing a framework that includes the essential elements for success found in a global analysis of rebuilding program performance while providing flexibility for incorporating social and economic needs. Analysis of current rebuilding programs suggests that the Regional Fishery Management Councils (RFMCs) and the National Marine Fisheries Service (NMFS) have interpreted and applied the MSA's rebuilding requirements with ample flexibility in establishing target rebuilding dates upon which to base annual catch limits.

Progress in rebuilding overfished populations is overall positive, yet challenges remain. To address these challenges and ensure the long-term health for our ocean, the prosperity of our nation's fishing industries and associated businesses and the opportunities for world-class recreational fishing, we offer a number of recommendations: build on the successful legal framework provided by the MSA by ensuring the proper application of annual catch limit and accountability provisions; setting criteria for when a population is considered overfished in a manner that avoids significantly depleted populations and lengthy rebuilding timelines; considering the use of management strategy evaluation/management procedure to improve management; take an ecosystem approach to rebuilding; and implement a monitoring, observation and research program for our nation's large marine ecosystems to provide additional information for successful management.

Introduction

The substantial progress during the past decade in rebuilding overfished populations in U.S. fisheries—economically and ecologically important—is a function of the requirements of the MSA, the work of fishery managers in implementing the law and the efforts of fishery stakeholders. The MSA's sustainable fishery framework contains the elements for successful rebuilding programs while providing flexibility for incorporating social and economic needs. Progress in rebuilding overfished populations has been generally positive, yet challenges remain.

In this paper we provide an overview of the rebuilding provisions of the MSA as interpreted by the courts, detail the benefits of the current rebuilding program, assess the flexibility utilized by decision-makers for incorporating social and economic needs and offer recommendations for improving performance in restoring overfished populations and ensuring that the need for rebuilding is a thing of the past. Central to our recommendations is that the current rebuilding provisions of the MSA are preserved in any future reauthorization effort.

Overview of the Rebuilding Requirements of the Magnuson-Stevens Act

While rebuilding was mentioned in the original 1976 Act, the 1996 Sustainable Fisheries Act amendments provided specific mandates for rebuilding overfished populations, including provisions to ensure success. These changes were driven, in part, by the significant depletion of key groundfish species in New England. To address this issue, major revisions that now form the basis of the Federal rebuilding program include:

- An explicit requirement to rebuild overfished species[1];
- Secretarial identification of overfished species and official notification to the RFMCs[2];
- A time limit for RFMCs to develop and implement a rebuilding plan once notified[3];
- A requirement that populations are rebuilt in a short a time as possible but not to exceed ten years, with limited exceptions[4];
- A requirement that conservation and management measures (including rebuilding) take into account the importance of fishery resources to fishing communities and, to the extent practicable, minimize adverse economic impacts[5];
- An annual report to Congress and regular Secretarial review of rebuilding plans to provide accountability[6]; and
- A requirement that the Secretary act to develop a rebuilding plan if an RFMC fails to do so.[7]

A number of court cases have interpreted these provisions shaping implementation of the MSA. Key decisions include:

Natural Resources Defense Council v. Daley, 209 F.3d 747 (D.C. Cir. 2000)

National Standard One (prevent overfishing/achieve optimum yield on a continuing basis) takes precedent over National Standard Eight (economic/community considerations); management measures (including rebuilding) must have at least a fifty percent chance of achieving the target fishing mortality rate.

Natural Resources Defense Council v. National Marine Fisheries Service, 421 F.3d 872 (9th Cir. 2005)

Conservation has clear priority over short-term economic interests under the MSA. The short-term economic needs of fishing communities are not a sufficient reason to breach the ten-year rebuilding timeline cap. However, the needs of fishing communities is still considered in making rebuilding timelines as short as possible, regardless of whether the ten year cap has been breached for other reasons. NMFS must set the target length of a rebuilding plan (T_{TARGET}) by starting with the shortest rebuilding time possible with no fishing (T_{MIN}), and justifying upward based on the need to "avoid disastrous short-term consequences

1 16 U.S.C. § 1853(a)(1), (10).
2 *Id.* § 1854(e)(1), (2).
3 *Id.* § 1854(e)(3) (modified in the 2006 MSRA amendments).
4 *Id.* § 1854(e)(4).
5 *Id.* § 1851(a)(8).
6 *Id.* § 1854(e)(1), (7).
7 *Id.* § 1854(e)(5).

for fishing communities." Regardless of the needs of fishing communities, in no case may T_{TARGET} be set beyond the maximum permissible year for rebuilding (T_{MAX}).

Natural Resources Defense Council v. Locke, No. 01-cv-421 (N.D. Cal. Apr. 23, 2010)

Re-emphasized the importance of the rebuilding mandates and timelines of the MSA. When balancing the length of a rebuilding plan and socioeconomic needs of fishing communities, conservation has priority over short-term economic interests. The agency may consider the short-term economic needs of fishing communities in establishing rebuilding periods, within the Natural Resources Defense Council v. NMFS framework laid out by the Ninth Circuit, but may not use economic needs as justification for exceeding T_{MAX}.

The law, as interpreted by the courts, includes the essential attributes identified in successful programs for restoring overfished populations in a recent assessment of global rebuilding programs. These include (in part):

- Well-defined objectives;
- Finite time scales;
- Rebuilding plan established in an open and transparent process;
- Credible, consistent and transparent scientific monitoring of progress;
- Simple and easily understood metrics of status and success;
- Predefined rules for triggering corrective management action; and
- Substantial, measurable reductions in fishing mortality at the onset of the plan (Murawski 2010).

The rebuilding mandates of the MSA also provide flexibility (discussed in greater detail below) to NMFS and the RFMCs for incorporating social and economic considerations. The law requires rebuilding in as short a time as possible and includes a ten-year deadline (with limited exceptions). The short-term economic needs of fishing communities may be considered in setting a rebuilding target date, but economic needs are not a sufficient reason to breach the ten-year deadline. This combination of specific rebuilding mandates including deadlines and flexibility, provides the United States with the legal framework to ensure the successful rebuilding of overfished populations.

Benefits of the MSA Rebuilding Requirements

Unprecedented Progress in Restoring U.S. Fish Populations

The MSA rebuilding requirements are achieving the stated goals of recovery for the benefit of the environment and coastal economies. Over the past five years, unprecedented progress has been made in ending overfishing and rebuilding overfished species. According to the 2011 Report to Congress, Status of U.S. Fisheries (Status of Stocks report) and accompanying press release, 27 stocks have been fully rebuilt in the last eleven years (NOAA 2012). Furthermore, a recent evaluation of all 44 stocks subject to rebuilding plans to comply with the 1996 Sustainable Fishery Act amendments and with sufficient information to assess progress under the plans found that 64 percent had been rebuilt or had made significant rebuilding progress (defined as achieving at least 50 percent of the rebuilding target and at least a 25 percent increase in abundance since implementation of the rebuilding plan) (NRDC 2013). Figure 1 shows the decline in the percentage of managed stocks subject to overfishing and in an overfished condition from 1997-2011. Rebuilding success stories include Atlantic sea scallops in New England, bluefish in the Mid-Atlantic; lingcod in the Pacific and blue king crab in the North Pacific.

The addition of science-based annual catch limits and accountability measures to the law in 2007[8] strengthens the management framework to achieve not only continued success in rebuilding overfished species but also significant safeguards against future fishing-related depletion.

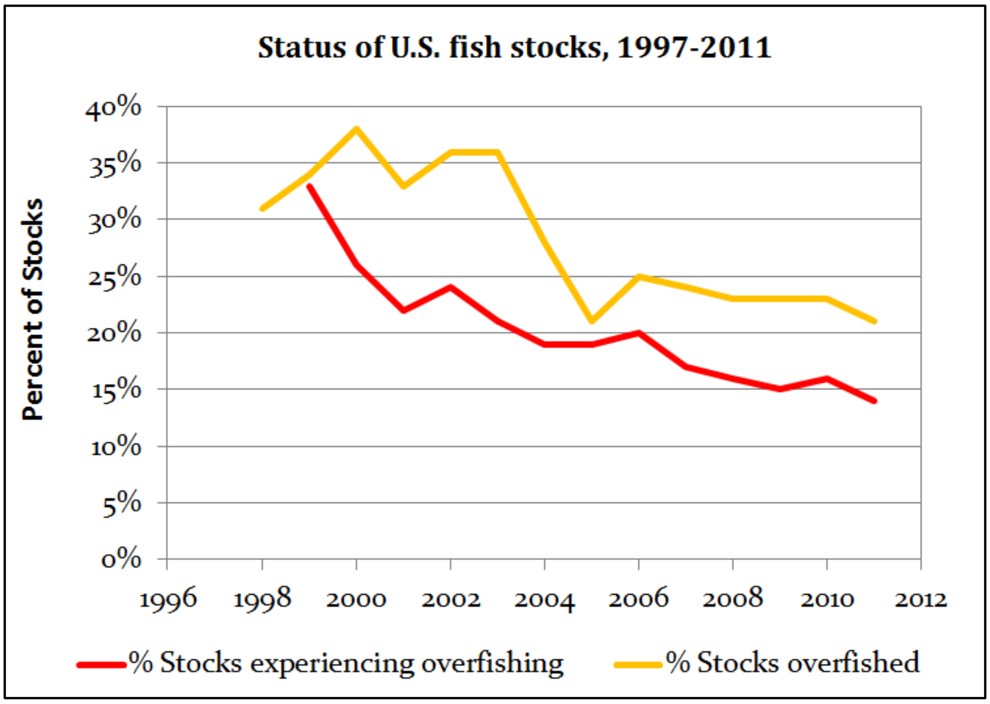

Figure 1. Status of U.S. fish stocks, 1997-2011. Source: 2011 Report to Congress. Status of U.S. Fisheries. National Marine Fisheries Service. May 2012.

Avoiding the Perils of Depleted Fish Populations

The MSA rebuilding framework is essential to the health of our ocean and the economic and social well-being of our nation's coastal communities. Aside from the obvious loss of yield and accompanying socioeconomic benefits that cannot be realized from a depleted population, maintaining fish populations at low abundance levels poses significant risks, in particular to fishery stability. Fishing generally alters the age and size structure of a population by removing the older, larger individuals from the population (Berkeley et al. 2004). Depleted populations are often made up predominantly of younger fish with population dynamics dominated by recruitment variability that is largely influenced by environmental factors. This leads to greater fluctuations in biomass and fishery yield, instability and unpredictability in the fishery (Hsieh et al. 2006, Shelton and Mangel 2011, Brunel and GerJan 2013). Increased variability combined with low population size is a factor in increased extinction risk (Johst and Wissel 1997).

An additional peril of delayed rebuilding is that the likelihood of fishing-induced regime shifts increases when key populations are highly depleted. A regime shift in marine ecosystems occurs when ecological systems and the services they provide are transformed from one stable state to an alternative state. Examples of this can be found in several North Atlantic large marine ecosystems where trophic cascades due to fishing-induced changes in top predator abundance (most notably cod) have led to an increased abundance of lower trophic species (for example, see Frank et al. 2005, Österblom 2007). The best way to prevent such sudden and catastrophic ecosystem changes is to maintain ecosystem resilience by maintaining large, stable populations and maintaining biodiversity (Folke et al. 2004, Scheffer 2001).

8 16 U.S.C. § 1853(a)(15).

Ample Flexibility to Incorporate Social and Economic Considerations

A popular criticism of the MSA is that it provides little flexibility to managers for incorporating socioeconomic concerns into rebuilding programs. We analyzed rebuilding timelines of the 65 stocks currently subject to rebuilding plans which were included in the 2011 Status of Stocks Report to Congress "Fish Stocks in Rebuilding Plans" trend analysis to determine what level of flexibility is utilized by the RFMCs and NMFS (NMFS 2011). We analyzed all stocks reviewed by NMFS in the analysis except those 1) that have been rebuilt, 2) for which a formal rebuilding program had not been submitted under the MSA (Atlantic salmon), 3) for which a rebuilding plan was not required (South Atlantic pink shrimp), 4) that did not have reliable estimates of biomass and/or fishing mortality (all Caribbean and Western Pacific complexes and species identified as overfished), and 5) that are highly migratory species. We also did not include West Coast salmon rebuilding plans. For the remaining thirty-seven plans, we requested T_{MIN} (the rebuilding timeframe in the absence of all fishing), T_{MAX} (the maximum amount of time allowable for rebuilding under the protocol set forth in the national standard guidelines) and T_{TARGET} (the target date chosen for rebuilding) information from NMFS and the RFMCs in order to assess the amount of flexibility used in setting rebuilding targets.

Overall, the analysis shows that the RFMCs and NMFS have interpreted and applied the MSA's rebuilding requirements with ample flexibility in establishing target rebuilding dates upon which to base annual catch limits. In only one of the nineteen rebuilding plans in our analysis for which T_{MIN} information was available did the T_{MIN} estimate actually come close to the ten-year rebuilding limit (Pribilof Island blue king crab managed by the North Pacific Fishery Management Council [NPFMC]). In five of the nine stocks to which the ten-year rule applied, RFMCs set target rebuilding timelines at the maximum legally permissible limit, even though shorter rebuilding timelines were possible. Until recently, New England set rebuilding targets for most stocks at the ten-year limit if it was determined that a stock could be rebuilt in ten years or fewer (Nies, pers. comm.) T_{MIN} values were considered but not documented in rebuilding plans and associated analytical documents. Another conclusion from our analysis is that the Pacific Fishery Management Council acts the most consistently with the "as short a time period as possible" language of the MSA. That is, the Pacific Council routinely sets T_{TARGET} below T_{MAX} when the ten-year rebuilding limit does not apply (Figure 3). The following section contains our findings by region; Figures 2 and 3 provide summaries.

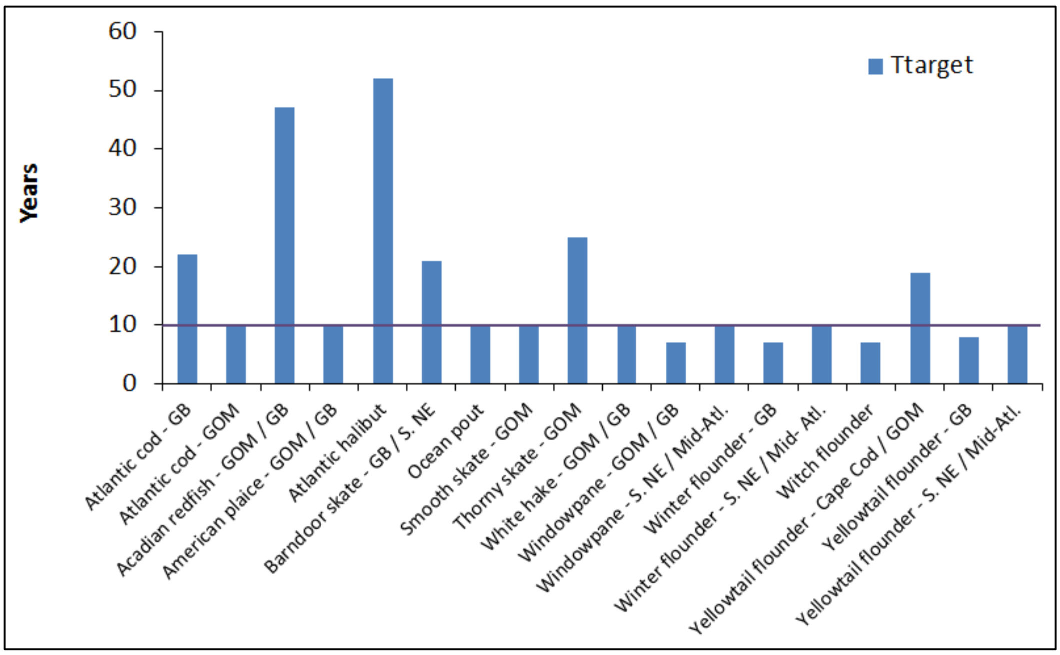

Figure 2. Target (T_{target}) rebuilding times for stocks subject to a rebuilding plan in New England where values of T_{max} (maximum) and T_{min} (minimum) rebuilding times were not available. The horizontal line marks the ten-year rebuilding deadline.

Regional Results

Our study group included 37 stocks, eighteen of which are managed by the New England Fishery Management Council. T_{MIN} and T_{MAX} for New England stocks were not documented in early rebuilding plans (and thus unavailable for our analysis) and most T_{TARGET} dates were set at ten years. Of the eighteen New England species included in our analysis, six had rebuilding targets that exceeded ten years (ranging from nineteen to fifty-two years), and eight had T_{TARGET} set at ten years. Only four stocks (witch flounder, Georges Bank windowpane, Georges Bank yellowtail flounder and Georges Bank winter flounder) had rebuilding targets less than ten years when the rebuilding plans were first enacted (Figure 2).[9]

The Mid-Atlantic Fishery Management Council manages two overfished species included in this analysis, both subject to the ten-year rebuilding limit. In the case of tilefish, the Mid-Atlantic Council has set $T_{TARGET}=T_{MAX}$ where T_{MIN}=five years. In the case of butterfish, the rebuilding target chosen by the Mid-Atlantic Council is five years (Figure 3).[10] The rebuilding plan states that the stock could be rebuilt in less than five years, but it does not state the exact T_{MIN} value.

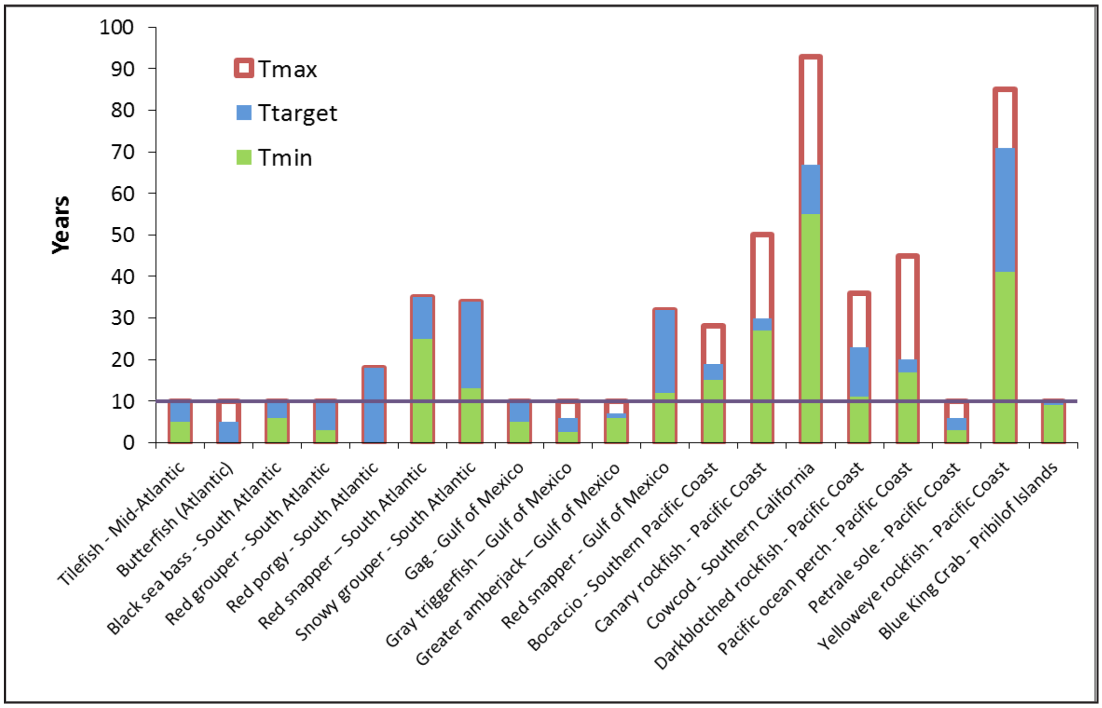

Figure 3. Minimum (T_{min}), maximum (T_{max}) and target (T_{target}) rebuilding times for stocks subject to a rebuilding plan, where values of T_{min} and T_{max} were available. The horizontal line marks the ten-year rebuilding deadline.

Five of the overfished species included in our analysis are managed by the South Atlantic Fishery Management Council. Of these, only two are subject to the ten-year rebuilding limit. In these cases, significant flexibility was used by the South Atlantic Council to set $T_{TARGET}=T_{MAX}$ where T_{MIN} is three and six years for black sea bass and red grouper, respectively (Figure 3).

The Gulf of Mexico Fishery Management Council manages four overfished species included in this analysis, with three of them subject to the ten-year rebuilding limit. The Gulf Council used significant flexibility in setting rebuilding targets. In two cases—greater amberjack and gray triggerfish—the Gulf Council chose rebuilding targets higher than T_{MIN} but lower than T_{MAX}, and in one case—gag grouper—the target was set at the ten-year maximum allowable timeframe (Figure 3).

9 The rebuilding timeline for Georges Bank yellowtail flounder has recently been revised and now exceeds ten years.

10 Note that the status of butterfish is unknown, yet it remains listed in the *Status of the Stocks* report as in a rebuilding plan. Tilefish is estimated to have exceeded its rebuilding target but because there is considerable uncertainty about the actual status of the stock, it hasn't been declared rebuilt.

The Pacific Council manages seven overfished species included in this analysis, one of which is subject to the ten-year rebuilding limit. In this instance, flexibility is reflected by T_{MIN}=three years, T_{TARGET}= six years and T_{MAX}= ten years (Figure 3).

The North Pacific Council manages one overfished population. This is the one case where the ten-year rebuilding deadline provided limited flexibility as T_{MIN}=nine years and T_{TARGET}=ten years (Figure 3).

Benefits of Fully Restoring U.S. Fisheries

There are significant economic, social, and ecological reasons for fully restoring overfished populations. From an economic standpoint, while a full accounting of increased profitability for commercial and recreational fisheries does not exist, rebuilding is estimated to at least triple the net economic value of many U.S. fisheries (Sumaila et al. 2005). NMFS estimates that rebuilding U.S. stocks would increase the current ex-vessel value by an estimated $2.2 billion (54 percent) annually, from $4.1 billion to $6.3 billion annually. Rebuilding would generate an additional $31 billion in sales and support an additional 500,000 jobs (Murawski 2009). From an ecological standpoint, benefits of rebuilding include helping to restore ecosystem structure, function and resilience. These improvements ensure continued production of ecosystem goods and services beyond just fisheries benefits. As described below, the ecosystem benefits of rebuilding could be increased if a broader view of rebuilding is adopted.

Future Considerations and Recommendations

While the overall rebuilding trend is positive, challenges remain. Several rebuilding plans are not resulting in adequate progress, including Georges Bank and Gulf of Maine cod, ocean pout, Southern New England/Mid-Atlantic winter flounder, white hake, thorny skate, Gulf of Mexico greater amberjack and Pribilof Islands blue king crab (NRDC 2013). To address these challenges and to deliver on the sustainable fishery goals of the MSA we recommend that any future changes to the law, national or regional policies build upon the current legal framework for successful rebuilding as described below.

Importance of Annual Catch Limits and Accountability Measures

The addition of requirements for setting science-based annual catch limits (ACLs) and accountability measures (AMs)[11] has profoundly impacted rebuilding success and the future need for rebuilding plans in a positive manner. With ACLs and AMs now in place for all managed species, NMFS recently declared that the United States has turned the corner on ending overfishing (NOAA 2011). A review of the past Status of the Stocks reports shows that indeed RFMCs with a history of science-based catch limits that are monitored closely against actual catch and bycatch have fewer species classified as subject to overfishing. These new management requirements, if implemented properly, should end the serial depletion of fisheries by preventing overfishing and by achieving established management targets.

One important aspect of success is ensuring that catch accounts for directed landings plus bycatch mortality, given the significant role that bycatch mortality can play in overfishing. Ending and preventing overfishing is the goal of the MSA, and catch includes all sources of mortality. As interpreted by the National Standard One Guidelines, annual catch limits and accountability measures must account for "the total quantity of fish . . . taken in commercial, recreational, subsistence, tribal, and other fisheries . . . as well as mortality of fish that are discarded."[12] The MSA provision requiring a standardized bycatch reporting methodology to assess the amount and type of bycatch occurring in the fishery[13] is also a critical component of long-term success. For those RFMCs lacking an adequate methodology, factoring management uncertainty into the catch-setting process becomes especially important.

11 16 U.S.C. § 1853(a)(15).

12 50 C.F.R. § 600.310(f)(2)(i) (defining "catch") (emphasis added); Oceana, Inc. v. Locke, 831 F. Supp. 2d 95, 115-16 ("Since the 'catch' limited by [annual catch limits] includes both fish that are retained (landed) and bycatch that are discarded at sea, see 50 C.F.R. § 600.310(f)(2)(i), the [annual catch limits for the stocks at issue] may be exceeded by accumulation of bycatch alone.").

13 16 U.S.C. § 1853(a)(11).

Another important aspect of success is carefully tracking progress in preventing overfishing and recovery of overfished species. The review requirements of the law and National Standard One Guidelines, which focused on assessing adequate progress and incorporating new information into rebuilding trajectories,[14] are important provisions that must be fully embraced in the regions to ensure rebuilding success.

Recommendations: Revise processes for setting annual catch limits and accountability measures consistent with the "one in four rule" contained in the National Standard One Guidelines as needed; ensure that annual catch limits adequately address bycatch; establish adequate standardized bycatch reporting methodologies as required by the MSA; ensure that Secretary of Commerce review of rebuilding plans is conducted to assess progress, incorporate new information, and guide plan modifications.

Proper Setting of Criteria for When a Population is Overfished

Minimum stock size threshold (MSST) is a key benchmark used by RFMCs to determine when a fish population is overfished and requires a rebuilding plan. The Technical Guidance on the Use of Precautionary Approaches to Implementing National Standard 1 of the Magnuson-Stevens Fishery Conservation and Management Act (Technical Guidance) offers a number of suggestions for setting MSST correctly. In order to avoid perceived conflicts with the MSA's ten-year rebuilding limit, MSST must be set in a manner that best ensures a short rebuilding timeline. This kind of thinking is already incorporated into the existing Technical Guidance in the recommendation that natural mortality be taken into account when setting MSST (Restrepo et al. 1998). Following this recommendation means that species with low natural mortality rates, or that exhibit evidence of depensatory natural mortality (such as cod, haddock and Alaskan walleye Pollock) (Keith and Hutchings 2012), which generally take longer to recover from an overfished status, will have MSSTs set closer to the biomass level at MSY (B_{MSY}) than species with higher resilience. In cases where the acceptable biological catch (ABC) is set such that fishing mortality declines when biomass falls below B_{MSY}, it is somewhat less critical to properly define MSST, as those management procedures, in theory, are self-correcting. However, not every region employs such a control rule. Linking the MSST specifically to a T_{MAX} that prevents excessively lengthy rebuilding periods can help ensure healthy fisheries.

Recommendation: Use existing information like life history, catch and bycatch to set MSST at a level that will avoid lengthy rebuilding timelines. For species with low resilience or in cases where information is lacking, set MSST close to MSY to rebuild more quickly and buffer against uncertainty.

Rebuilding Directly to Biomass at Optimum Yield

Optimum yield (OY), as defined by the MSA, is the MSY as reduced by economic, social, and ecological factors.[15] This means the biomass at optimum yield levels (B_{OY}) is greater than B_{MSY} to incorporate important social, ecological or economic considerations. These considerations include desired management targets (for example, a focus on larger fish as opposed to maximizing total pounds landed for recreational fisheries) and ecosystem health and resiliency (managing population levels above those at MSY to best fulfill roles in the ecosystem). There is currently an inconsistency in MSA objectives with regard to fish population levels, depending on whether or not stocks are in an overfished condition. For the management of stocks that are not overfished the goal is OY, which occurs at $B_{OY,}$ and is greater than B_{MSY}.[16] However, the goal for overfished stocks is to rebuild to B_{MSY}.[17] Thus, MSY is treated as both a limit and a target, depending on whether or not a stock is overfished. Given that the goal of national standard one is to achieve optimum yield on a continuing basis, the goal of a rebuilding plan should also be to rebuild directly to a population level supporting OY, as opposed to rebuilding to B_{MSY} and then having to take subsequent management action to achieve B_{OY}.

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14 16 U.S.C. § 1854(e)(7); 50 C.F.R. Part 600.310(j)(3)(ii).

15 16 U.S.C. § 1802(33)(B).

16 National Standard One, 16 U.S.C. § 1851(a)(1) ("Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry.").

17 16 U.S.C. § 1802(33)(C).

Recommendation: Amend the MSA to specify that the rebuilding biomass target is the biomass at optimum yield, where OY occurs at some level below MSY and consequently at a biomass level above B_{MSY}.

Use of Management Strategy Evaluation/Management Procedure Approach

The "traditional" approach to managing fisheries consists of evaluating the status of the resource via the stock assessment process. Scientists' advice to managers about current stock status and allowable future catches, including rebuilding trajectories, is usually based on a "best" model run, chosen to be the most likely representation of reality from a number of possible configurations of one or more model families. There are a number of problems with this approach that can lead to poor performance of the fishery management system and failed rebuilding plans. First is the variability in catch level advice that can result from one assessment to the next due to the addition of new data, change of modeling environment or change of model configuration. These types of assessment changes can also lead to significant changes in rebuilding targets which can throw off rebuilding progress. Second is an inability to properly evaluate long-term tradeoffs among alternative rebuilding strategies, including proper consideration of risk, which directly impacts rebuilding success. Third is the political haggling that arises over setting management benchmarks such as ABC that provide the upper limit for ACLs. In the absence of a proper risk policy that determines acceptable risk of overfishing in light of all the proper tradeoffs, RFMCs have the ability to reject their scientific advisers' ABC recommendations on the basis that they would like a different risk level.[18]

Management strategy evaluation (MSE) or the management procedure (MP) approach present alternative ways to manage a fishery (Butterworth 2007). MSE and MP are able to deal with the above issues inherent in the "traditional" approach and therefore have the potential to result in increased success of rebuilding plans. These methods employ catch control rules that specify how ABC is calculated from available data on an annual basis, but unlike the traditional approach, these catch control rules are thoroughly evaluated against alternative options via simulation testing before they are implemented. The simulations determine which of the alternative catch control rules perform best in terms of achieving management goals (such as rebuilding by T_{TARGET} with a certain probability) while avoiding undesirable outcomes (such as falling below a minimum biomass threshold or exceeding some pre-specified socioeconomic limit reference point). Candidate control rules or rebuilding strategies are tested against factors like observation error, model misspecification, management uncertainty, environmental variability. Where the MSE/MP approach has been applied successfully, there has been a more thorough evaluation of risk, less inter-annual catch variability, and less scientific and management debate about catch limits. MSE and MP also allow evaluation of simpler ABC-setting methods that are not necessarily model-based, which can save time and resources in the long-run. Although these methods may take time to develop initially, the benefits of implementing the resulting more robust management and rebuilding strategy generally outweigh the cost of the initial investment in the long run.

Recommendation: NMFS, RFMCs and Scientific and Statistical Committees (SSCs) should consider the use of MSE and MP in making management decisions, including specification of biological reference points and evaluation of alternative rebuilding strategies against management goals in rebuilding plans.

Taking an Ecosystem Approach to Rebuilding

The ecosystem approach to fisheries management recognizes that there are broad ecosystem impacts of fishing that can compromise the persistence of natural populations, the fishery that depends on them, and the services ecosystems

18 An example for this can be found in the current Gulf of Mexico ABC Control Rule which gives the Council the ability to set risk on an *ad hoc* basis: "The indicated default risk of exceeding overfishing limit for Tier 2, or default acceptable biological catch buffer levels for Tier 3a and 3b, are to be used unless specified otherwise by the Council on a stock by stock basis." GMFMC. 2011. *Final Generic Annual Catch Limits/Accountability Measures Amendment for the Gulf of Mexico Fishery Management Council's Red Drum, Reef Fish, Shrimp, Coral and Coral Reefs, Fishery Management Plans.*

provide. The single-species approach ignores the effects of fishing on things like population demography, population dynamics, food web dynamics, species interactions, and habitat. Fishery models that rely on the single-species theory of fishing, and do not take into account ecosystem factors when trying to explain trends in population biomass and dynamics, may predict stock recovery rates that are much higher than subsequently observed in the fishery; the classic example of this phenomenon is Atlantic cod (Murawski 2001, 2010). Similarly, rebuilding strategies that focus solely on attaining single-species fishing mortality and biomass goals fail to recognize the importance of rebuilding ecosystem structure, diversity, and processes which are crucial to maintaining or rebuilding resilience of ecosystems and the coastal communities that rely on revenue from fish stocks and ecosystem services (Pitcher and Pauly 1998).

In a world of increasing environmental variability, we face greater uncertainty today about how fish stocks and ecosystems are going to respond to human activities, including rebuilding measures. Accounting for this uncertainty by taking an ecosystem approach will be critical to rebuilding success for U.S. fisheries. This approach will likely require the development of new rebuilding metrics and management reference points that go beyond the traditional biomass and fishing mortality thresholds and address other factors vital to proper fisheries management such as population demographics, ecosystem characteristics and services, and socioeconomics. One reference point that should be further evaluated is fishery selectivity pattern, which determines population age and size structure on the single-stock scale and community properties such as the size-spectrum slope on an ecosystem level (Brunel and GerJan 2013, Garcia 2012).

Recommendation: NMFS, RFMCs, and SSCs should take into account ecosystem factors when assessing stock status and recovery. The MSA's rebuilding requirement and rebuilding benchmarks should be broadened to include aspects of ecosystem rebuilding such as restoring population demography, habitat, ecosystem structure and diversity, and resilience of coastal communities.

Establish Monitoring, Observation and Research Programs for Our Nation's Large Marine Ecosystems

Given the significant stressors facing our nation's large marine ecosystems and the longstanding call to transition fisheries to an ecosystem-based management approach, the RFMCs and NMFS can greatly benefit from reliable and timely information on existing and changing environmental conditions in order to manage fisheries sustainably, including recovery under rebuilding plans. Investments in regional monitoring, observation and research programs for each of the nation's large marine ecosystems can help provide fishery managers and the public with information necessary to make better informed decisions. The resulting data can also help ensure that other uses of marine resources are compatible with fishing, fisheries management, and the community benefits that come from resilient ecosystems and robust fish populations.

Recommendation: Establish monitoring, observation and research programs for our nation's large marine ecosystems to provide additional information for management.

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Rebuilding Program Requirements and Timelines: A Perspective from the Northeast Commercial Groundfish Fishery

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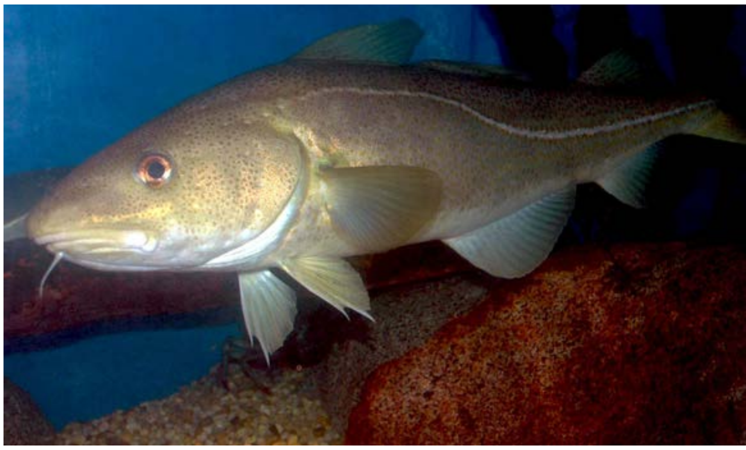
Disclaimer: This paper is based off of my experience as the Executive Director of the Northeast Seafood Coalition since 2003. Any opinions contained in this paper are mine and should not be interpreted as being a formal position of the Northeast Seafood Coalition.

Abstract

The Northeast Seafood Coalition's experience with the rebuilding requirements of Magnuson-Stevens Act (MSA) is limited to the Northeast multispecies fishery, otherwise known as the groundfish fishery. Most attempts to project rebuilding targets and track progress during rebuilding timelines have proven to be a serious challenge. This is most likely due to the nature of the Gulf of Maine and Georges Bank ecosystems, the unknown and often unpredictable interactions between stocks within the groundfish complex and with other fish stocks, the effects of water temperature fluctuations and a long list of other factors that contribute to stock recruitment, natural mortality and growth. Such complexity has led to usually large fluctuations in perceived stock status from one assessment to the next. In turn, the extreme fluctuations in allowable catches that are the result of often inexplicable changes in stock status are vastly exaggerated by attempts to get some stocks back onto a trajectory to meet their rebuilding target. To further complicate matters, many of the assessment models have been plagued with retrospective patterns that tend to overestimate spawning stock biomass and underestimate fishing mortality. Retrospective patterns are a systematic inconsistency among a series of estimates of population size, or related assessment variables, based on increasing periods of data (Mohn 1999). In some cases, "fixes" that have been applied to reduce retrospective errors have resulted in a determination that "overfishing" had occurred even if the fishery performed below the total allowable catch (TAC) prescribed during that management period. Managing in hindsight may be less problematic in other fisheries throughout the United States but it is a difficult reality for the groundfish industry in New England. MSA rebuilding timelines only compound the problem by placing an even greater reliance upon assessments and projections which have proven to be volatile. Conservation goals need to recognize the limitations and uncertainty in the science. Environmental conditions and ecosystem dynamics need to be accounted for. Rebuilding timelines and targets should be replaced with fishing mortality rate-based strategies, which on average over the long term will rebuild a stock to biomass at maximum sustainable yield (B_{MSY}). Such a strategy would achieve the core objective of fisheries management, to sustain commercial and recreational "fisheries" while preventing overfishing. Such an approach would also bring greater stability to the groundfish fishery by focusing on current stock status and near-term projections rather than relying on long-term individual stock performance in a complex multispecies fishery during an arbitrary timeframe.

Introduction

Overview of the Northeast Multispecies ("Groundfish") Fishery



The Northeast Multispecies Fishery, otherwise known as the groundfish fishery, encompasses fifteen groundfish species and twenty stocks that inhabit the waters from Maine to New Jersey. Some of these species have a geographic component (cod, haddock, winter flounder, yellowtail flounder, windowpane flounder) with areas defined in the Gulf of Maine, Georges Bank and Southern New England/Mid-Atlantic regions while others have only one geographic component. Although the fishery is managed under a large and small mesh multispecies program, largely due to the operational differences used to target specific stocks (silver hake, red hake, and offshore hake), this paper focuses on the large mesh fishery.

The groundfish fishery consists of over 1,300 limited access permits with approximately 450 active groundfish vessels. These vessels range in size from roughly 30 to 90 feet and fish with all predominate commercial gear types (trawl, sink gillnet, longline, handline). The fishery is largely comprised of small, family-owned, and in many cases owner-operated, businesses. Total nominal revenue from all species on groundfish trips in 2011 was U.S. $121.5 million. Groundfish specific nominal revenue on groundfish trips in 2011 was U.S. $89.8 million (Murphy et al. 2012).

The first Northeast Multispecies Fishery Management Plan was implemented in 1986. Since that time, the plan has been revised many times to meet biological objectives. These actions have included, but were not limited to, restricting the number of permits in the fishery (limited access), seasonal and year-round area closures, minimum fish size limits, trip limits, special access programs, gear restrictions, and modifications to number of allowable days allowed to be fished (days-at-sea or DAS), including changes to the DAS baselines, reductions in DAS, reclassification of DAS (otherwise known as A, B and C category days), caps on DAS usage, and differential counting of DAS. These changes have been made under both Amendments and Framework Adjustments. As of May 1, 2013, the fishery will be operating under Framework Adjustment 50 to the fishery management plan.

Each management action has contained measures that have significantly affected the fishery. In the last ten years two management actions in particular, Amendment 13 and Amendment 16, have resulted in major changes to the fishery and the rebuilding criteria for stocks in the multispecies complex.

Amendment 13, implemented in 2004, was based primarily on a suite of effort controls including gear restrictions, seasonal and permanent closed areas, trip and day limits and limits on the number of days at sea to achieve mortality and rebuilding goals. Additionally, Amendment 13 began the process to move away from effort controls to output controls—hard TACs. Hard TACs encompass landings and discard mortality managed in near real time with consequences, depending on the sector of the fishery, for exceeding a limit. This was accomplished through the approval of the "B-Day" program (B regular and Special Access Programs), a groundfish sector referred to as the Georges Bank Cod Hook Sector and a United States and Canada Transboundary–Resource Sharing Understanding.

In 2010 Amendment 16 adopted hard TACs for all managed groundfish stocks in response to mandates set forth by the MSA in 2006. Amendment 16 also approved 17 new groundfish sectors[19] to receive and manage the allocations (Annual Catch Entitlements or "ACE") for each stock. Approximately 98 percent of the catch in the groundfish fishery today is associated with vessels operating in the groundfish sector system. The remaining vessels are still managed under days-at-sea, which is referred to as the common pool.

19 Amendment 16 defines a sector as " a group of persons holding limited access vessel permits under the fishery management plan through which the sector is being formed, who have voluntarily entered into a contract and agree to certain fishing restrictions for a specified period of time, and which has been granted a total allowable catch (TAC) in order to achieve objectives consistent with the applicable FMP goals and objectives."

Overview of Rebuilding in the Northeast Multispecies Fishery Management Plan

As mandated under the Sustainable Fisheries Act of 1996, Amendment 9 to the Northeast Multispecies FMP approved in 1998 defined and adopted maximum sustainable yield (MSY) control rules, status determination criteria[20] (overfishing definitions) for overfished groundfish stocks. These measures were based on recommendations set forth by an Overfishing Definition Review Panel report in 1997 that was specifically convened to specify objective and measurable criteria for with which to identify a stock as overfished (Applegate et al. 1998).

After Amendment 9 there were a few volatile years for the groundfish fishery which included reviews on legal and policy guidance, new stock assessments and lawsuits. Eventually, by 2004, formal rebuilding programs to meet Sustainable Fisheries Act mandates were adopted under Amendment 13.

Amendment 13 modified the control rule to determine stock status and adjusted target fishing mortality rates according to rebuilding strategies. Amendment 13 resolved many issues associated with Amendment 9. Specifically, Amendment 9 included language defining stock status that was more restrictive than the National Standard Guidelines (NSGs). This difference created confusion when determining whether a stock was overfished or if overfishing was occurring. Amendment 13 addressed the issue and consistent with the NSGs defined a stock overfished when "the actual size of the stock or stock complex in a given year falls below the minimum stock size threshold or reasonable proxy thereof." It also defined overfishing as occurring when "the fishing mortality rate exceeds the maximum fishing mortality threshold for a period of one year."

Additionally, Amendment 13 incorporated the Final Report of the Working Group on Re-Evaluation of Biological Reference Points for New England Groundfish (NEFSC 2002a) which applied different methods for evaluating status determination criteria, recommended changes to those criteria, and provided numerical estimates. Amendment 13 stated the following:

> Further complicating the situation was the application of different analytic techniques in March, 2002 to estimate status determination criteria parameters (NEFSC 2002a). These techniques resulted in suggestions to change both the parameters and numerical estimates of those parameters for all groundfish stocks. In some cases, the revised biomass targets were outside the range of stocks sizes observed during the assessment time horizon (generally since the 1960s). Consternation over these new targets, as well as other concerns over the science underpinning the amendment, led to a formal peer review of the biomass targets, stock assessments, and trawl surveys in February 2003. A formal independent peer review of revised biological reference points, stock assessments, and trawl surveys was conducted in February 2003. The report of that peer review is subject to differing interpretations.

Lastly, Amendment 13 established ten-year rebuilding programs for stocks under a formal rebuilding plan and used a combined rebuilding strategy approach, referred to as the phased and adaptive management strategies. The phased strategy allowed overfishing to continue for a few years for some stocks while the adaptive strategy planned to fish at or below F_{MSY} immediately. The adaptive strategy set fishing at F_{MSY} through fishing year 2008, and then adjusted mortality in order to rebuild most stocks by 2014 (Amendment 13 2003).

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20 Amendment 13 definition of Status Determination Criteria: "Status determination criteria define appropriate biomass and fishing mortality levels for the stock to insure sustainable harvests. The National Standard Guidelines (NSGs) (50 CFR 600.310) require specification of two criteria: a minimum stock size threshold (or a proxy), and the maximum fishing mortality threshold (or a proxy). Minimum stock size thresholds are often specified as some fraction of the biomass level that will produce MSY (B_{MSY}). B_{MSY} is commonly referred to as the biomass target, though this term is not used or defined in the NSGs and at present there is no explicit requirement to specify this value. According to the NSGs, the minimum stock size threshold should be equal to the greater of the following: one-half the MSY stock size, or the minimum stock size at which rebuilding to the MSY level would be expected to occur within ten years if the stock or stock complex were exploited at the maximum fishing mortality threshold specified. The maximum fishing mortality threshold is frequently based on the fishing mortality rate (F) that produces MSY (F_{MSY}).

In 2010, Amendment 16 made further changes to the status determination criteria and formal rebuilding programs established under Amendment 13. Measures contained in Amendment 16 were also guided by the 2006 Magnuson-Stevens Reauthorization Act (MSRA), which established new mandates for annual catch limits (ACLs) and accountability measures (AMs) and revised National Standard Guidelines. MSRA required ACLs to be in place by 2010 or 2011, depending if a stock was subject to overfishing, and ACLs had to end overfishing immediately upon implementation. Amendment 16 measures replaced the MSY control rule as adopted in Amendment 13 with an acceptable biological catch (ABC) control rule. As noted under Amendment 16, these ABC control rules are used "in the absence of better information that may allow a more explicit determination of scientific uncertainty for a stock or stocks." The ABC is the catch associated at the fishing mortality target F_{MSY} of 75 percent F_{MSY} or $F_{rebuild}$, whichever is lower, in order to meet rebuilding timelines.

It's important to note, contrary to public perception, there are numerous steps in the process where uncertainty is accounted for prior to setting catch limits. Since stock recruitment relationships have often been difficult to determine for groundfish stocks in the Northeast, the target mortality rate used for most groundfish stocks since 2002 is based off of an F_{MSY} proxy or F40% maximum spawning potential (2002 Final Report of the Working Group on Re-Evaluation of Biological Reference Points for New England Groundfish, NEFSC 2008, NSC Memorandum to the NEFMC 2013). Fishery managers then base their catch advice off of the median catch expected to result from F_{MSY}, which under Amendment 16 has been 75% F_{MSY} or F rebuild as stated above.

The Northeast Seafood Coalition

Since 2002, the Northeast Seafood Coalition (NSC) has been actively involved in crafting management alternatives to complex fishery problems. NSC's policy efforts have focused on solutions that follow Magnuson mandates—to end overfishing and rebuild fish stocks—while also preserving the longevity of small family-owned fishing businesses and a diverse fleet, consistent with National Standard 8: Communities. Currently, NSC represents over 250 commercial fishing entities which hold over 500 limited access groundfish permits. These businesses operate out of ports stretching from New Jersey to Maine, utilize all predominate groundfish gear types (trawl, gillnet and long line) and fish on vessels ranging in size from small (30 feet) to large (90+ feet) fishing.

Over the years, NSC has put forward many management proposals for consideration by the New England Fishery Management Council. In 2003, the industry alternative NSC put forward, otherwise known as Alternative 5, was adopted by the Council as the baseline management measures for Amendment 13. NSC's alternative focused on management measures that achieved a mix of the adaptive and phased reduction rebuilding strategies. The approach was designed to meet the phased reduction rebuilding strategy for Georges Bank cod, Cape Cod/Gulf of Maine yellowtail flounder, Southern New England/Mid-Atlantic yellowtail flounder, and white hake. For all other stocks that require a formal rebuilding program, the alternative was designed to achieve the adaptive rebuilding strategy. In addition, the alternative was geared toward developing opportunities to harvest stocks that did not require reductions in fishing mortality. In 2010, NSC developed and sponsored the twelve sectors referred to as the Northeast Fishery Sectors. NSC developed the sectors to be inclusive of the full diversity of the groundfish fleet and community demographics. All Northeast Fishery Sectors are 501(c)(5) entities that have their own governance and decision-making processes relating to quota reporting and management.

Rebuilding Groundfish Stocks

UNCERTAINTY SURROUNDING STOCK ASSESSMENTS

The groundfish fishery is part of a highly complex and dynamic ecosystem. Much work has been done over the years to better understand environmental conditions which include predator-prey relationships and the impacts of water temperature fluctuations and other oceanographic conditions. However, assessment models continue to be focused

exclusively on individual stocks and the degree to which these factors influence the rebuilding of groundfish stocks has not been incorporated into the assessment process.

Rebuilding requirements place a great deal of reliance upon the certainty and precision of the science. Rebuilding assumes scientists and managers know, with a high degree of certainty, the status of the spawning stock biomass today and can adequately project its growth for years to come. In reality, there are strong and weak recruitment years, unpredicted predator and prey relationships and unpredictable environmental conditions outside of our control.

Stock assessments in the Northeast follow a thoughtful and often arduous process. To provide a simplified overview, there are three formal processes established for evaluating groundfish stocks: Northeast Regional Stock Assessment Review Workshop (SAW/SARC), Groundfish Assessment Review Meeting (GARM), and the Transboundary Resource Assessment Committee. The Northeast Regional Stock Assessment Review Workshop and GARM processes are formal scientific peer-reviewed processes. These assessments include a broader review of the models and scientific parameters used to assess stocks. The Transboundary Resource Assessment Committee process is exclusively focused on stocks managed under the United States and Canada Resource Sharing Agreement. Additionally, there are abbreviated assessments known as data or operational updates where recent survey and catch data are inserted into previously approved assessments and models in order to assess fishing mortality, reference points, rebuilding status, and to update projections as necessary for catch advice.

Each stock assessment contains varying degrees of uncertainty. The recent Groundfish Assessment Update in 2012 (operational update) identified the following sources of uncertainty in assessments: changes in weights at age, or questions about other life history parameters; estimates of catch that depend on available or estimated historical data, and/or assumed discard mortality rate; which years in the recruitment time series to include in projections, whether the research surveys are representative of stock size/abundance; importance of the conversion to a new research survey vessel in 2009; and retrospective patterns in the Virtual Population Analysis model output (NEFSC 2012).

In addition to these sources of uncertainty that have been identified, many of the key groundfish stocks have revealed strong retrospective patterns over the past ten years. Retrospective patterns are a systematic inconsistency among a series of estimates of population size, or related assessment variables, based on increasing periods of data (Mohn 1999). In other words, these patterns indicate something is inconsistent in the data (missing catch, increase in natural mortality rate, or a change in survey catchability) or within the model assumptions (Legault 2008). There have been a series of “adjustments” made to reduce retrospective patterns in order to make stock assessment models perform better. But these adjustments are only aliases; they do not solve or fix the underlying problems.

GARM III in 2008 found the retrospective pattern to be severe enough for seven of the 14 stocks reviewed to warrant an adjustment. The two approaches used were splitting the survey time series (following an adjustment process used formerly for the Georges Bank yellowtail flounder assessment), and adjusting current population numbers based on the observed retrospective pattern in the recent past (GARM III 2008). The “split” used a moving window analysis for survey catchability and catch at age data to determine the time period where a split seemed appropriate. The retrospective pattern appeared to be reduced when the survey time series data was split in 1995. The split approach was applied to five assessments whereas the Rho-adjusted or Monh’s rho, a metric used to evaluate the magnitude of a retrospective error (Mohn 1999), was used to adjust the numbers at age in the terminal year of the analysis for two assessments (GARM III 2008).

The adjustments incorporated under GARM III changed the status for four groundfish stocks. Georges Bank cod and Georges Bank yellowtail stocks changed to experiencing overfishing. Gulf of Maine winter flounder and witch flounder changed to experiencing overfishing and being overfished. More recent groundfish assessments, such as the Assessments and Data Updates for Thirteen Groundfish Updates March 2012, have applied Mohn’s Rho adjustments to the terminal year estimates for abundance as well as to estimate spawning stock biomass and fishing mortality in 2010.

UNCERTAINTY IN STOCK PROJECTIONS

In the case of groundfish stocks in the Northeast, another source of uncertainty is the ability to accurately project stock size as part of providing for harvesting advice. Recently this has applied to the setting of the ABCs. Based on growing evidence, and performance reviews conducted by the Council's Groundfish Plan Development Team, stock projections have demonstrated a tendency to predict more rapid stock growth than is realized. The most recent findings were reported in a January 16, 2013 memo by the New England Council's Plan Development Team to the Science and Statistical Committee:

> Over the last few years evidence has increased that the projections used to set future catches and plan rebuilding strategies do not perform well—that is, the projected catch does not result in the desired fishing mortality, and stock growth does not occur as expected. This has been documented in several plan development team reports to the Scientific and Statistical Committee, as well as at the 2012 Groundfish Assessment Updates meeting. The recent Georges Bank cod benchmark assessment concluded that projections should not be used to calculate F rebuild. An alternative to using the projections for catch advice has not been developed. The observed performance of the projections should be taken into account when determining ABCs.
>
> In the past, groundfish rebuilding strategies adopted by the Council have generally used an F rebuild calculated to achieve the target by a defined year with a desired probability of success. Typically the projections predict steadily increasing stock sizes catches. On the whole, these approaches have not been successful even though catches were often less than the ACLs because the projections (generally) appear to over-estimate future rebuilding [NEFMC PDT memo to SSC 2013].

Managing in Hindsight

Managers have consistently set target total allowable catches or targets (TTACs) based on scientific advice. Contrary to public perception, the groundfish fishery over the past ten years has performed well under these management TACs. However, based on updated science and "realized fishing mortality rates" the status for some stocks has changed to overfishing and in some instance a stock being classified as overfished. In other words, although the fishing industry was at or below the allowable catch prescribed in a given year, the science after the fact based on the results of an updated assessment has reported that overfishing is occurring or the stock is determined to be overfished. This determination has occurred under both target and hard total allowable catch management regimes in the groundfish fishery.

As noted under the Amendment 16 Final Supplemental Environmental Impact Statement October 2009:

> Since 2004, the management measures have succeeded in keeping catches below the specified TTACs for 95 percent of the TTACs specified, yet overfishing continues on thirteen stocks (GARM III) and fishing mortality exceeded rebuilding targets for many stocks. One possible interpretation of these results is that the TTACs were mis-specified and did not adequately incorporate scientific uncertainty. As previously explained, the way TTACs were calculated by the New England Fisheries Science Center in 2004 and 2005 lends support to this argument for those two years. Since 2006, when more realistic assumptions were used in the projections, the explanation weakens when specific stocks are examined. For example, witch flounder catches from 2005—2007 were 40 percent or less of the TTAC and yet fishing mortality in 2007 was estimated as 1.5 times the overfishing level; Gulf of Maine cod catch in 2007 was 53 percent of the TTAC yet fishing mortality in 2007 was over twice F_{MSY}. It will be difficult for ACLs to incorporate enough uncertainty to account for such large differences between predicted catches and realized fishing mortality rates unless there is substantial improvement in the performance of projections [Amendment 16 2009].

Case Studies

As noted earlier, Magnuson mandates assume *managers know the current stock size, the target biomass, and can accurately predict a rebuilding trajectory. However, looking back over the past ten years, numerous examples reveal these legal requirements are based on a false assumption.* In some instances, an updated assessment has shown stock size had previously been under-estimated, but in most cases updated assessments have shown that stock size has been over-estimated during a previous assessment. A review of the performance on projections and associated catch advice can be found in the Groundfish Assessment Review in 2012 (Nies 2012). Additionally, below are two examples that reveal the degree to which the understanding of stock size and status has evolved to the detriment of the fish and the fishery.

GULF OF MAINE COD

Gulf of Maine cod is likely the most widely-known and historically significant groundfish stock. Although it has been the staple of the commercial catch for centuries, cod has increasingly become an important component of the recreational fishery. Looking back over the past fifteen years, total catch (commercial and recreational) per year from 1996 through 2011 ranged from a high of 8,354.7 metric tons (mt) (2009) to a low of 3,078.1 mt (1999). The median yearly catch through the 1996 to 2011 time period was 6,159.7 mt.

In 2004, Amendment 13 adopted the ten year rebuilding plan for Gulf of Maine cod. The rebuilding plan was based upon the adaptive management strategy. The reference points established for Gulf of Maine cod were based off of the Working Group on Re-Evaluation of Biological Reference Points for New England Groundfish (NEFSC 2002). These values were SSB_{MSY} 82,830 mt, F_{MSY} 0.225 and MSY 16,600 mt. The biomass target increased from the previous target utilized under Amendment 9 which was based off of the Applegate et al. 1998 report. The previous value was B_{MSY} 22,100 mt (Amendment 13). The Working Group in 2002 re-considered the biomass and fishing mortality rate targets for all 19 stocks based upon the new quantitative approaches (NEFSC 2002). This target represented an almost four-fold increase for Gulf of Maine cod.

GARM III in 2008 estimated fishing mortality in 2007 to be 0.46 and spawning stock biomass (SSB) to be 33,877 mt. The reference points were reported as follows: F40% proxy F_{MSY}= 0.237, SSB_{MSY} = 58,248 mt and MSY = 10,014 mt. Since the spawning stock biomass in 2007 was over ½ SSB_{MSY} the stock was no longer considered to be overfished. However, overfishing was occurring because the fishing mortality was estimated to be twice above the F_{msy} level. Results from the projections showed that if the fishing mortality rate was reduced (F rebuild level), the stock would be rebuilt (meet the SSB_{MSY} target) by 2009-2010, well before the 2014 deadline (GARM III 2008). Unlike other stocks, GARM III did not make any retrospective adjustments to Gulf of Maine cod. However, the assessment and projections from GARM III was heavily weighted upon the strength of a 2005 year class.

The most recent assessments for Gulf of Maine cod (Stock Assessment Workshop 53 and Stock Assessment Workshop 54) concluded that the assumption of the 2005 year class were not accurate. As of January 2013, SAW 54 reported the Gulf of Maine cod stock is overfished and overfishing is occurring. This is the conclusion based off of two assessment models that were put forward, notable M 0.2 (natural mortality, M = 0.2) and M Ramp (M ramps up from 0.2 to 0.4). Spawning stock biomass (SSB) in 2011 is estimated to be 9,903 mt or 10,221 mt which is 18 percent or 13 percent of the SSB_{MSY} proxy (54,743 mt or 80,200 mt) in the M 0.2 or M Ramp models (SAW/SARC 55).

The spawning stock biomass for Gulf of Maine cod changed from 33,877 mt as reported in 2008 to 9,903 mt or 10,221 mt as estimated from the recent assessment. This was due to the change in the assumed strength of the 2005 year class based on updated catch and survey data as well as other facts such as the lowering of the weight at age calculations used in the assessments (SAW 53).

The ABC approved by the New England Fishery Management Council for fishing year 2013 is 1,550 metric tons. This figure represents the lowest catch that has ever been recorded in history. Contrary to public perception, this low catch is not the result of a management TAC being exceeded during the time period.

GEORGES BANK YELLOWTAIL FLOUNDER

Georges Bank yellowtail flounder is and has been an important stock for the offshore otter trawl fleet. The stock is also an important component of the catch in the scallop fleet. Since 1996 catch (landings and discards) of Georges Bank have averaged well over 5,000 mt. However, in recent years, the groundfish fleet has been restricted to the lowest catch of Georges Bank yellowtail flounder on record due to a change in the reported stock status. Additionally, the catch allocated to the United States Northeast groundfish fleet has been reduced significantly overtime to accommodate for an allocation to Canada based off of a United States-Canada Transboundary Resource Sharing Understanding formula that has shifted the weighting of the shares to rely heavily on trawl survey results.

Since 2001, the Georges Bank yellowtail flounder stock has been managed under a Transboundary Resource Sharing Understanding between the United States and Canada (TMGC 2002). Amendment 13, implemented in 2004, adopted this Understanding. The Understanding contains a formulaic method using both historical catch and current spatial stock distribution as determined by bottom trawl surveys to establish the shares for each country (TRAC 2012). All catch (landed and discarded) is counted against the TACs allocated for each country. Due to inconsistency in rebuilding mandates between U.S. and Canadian law, Congress passed the International Fisheries Clarification Act in 2010 to better align management objectives between the two countries. The fishing mortality target used for Georges Bank yellowtail flounder is based off of an F reference (F_{Ref} is comparable to a precautionary F_{MSY}).

The perceived status of the Georges Bank yellowtail flounder stock has completely changed since 2002. In 2002, the fishing mortality rate was reportedly very low and the stock was on trajectory to meet the SSB_{MSY} target within a year or two. Under Amendment 13 it was noted,

> Georges Bank yellowtail flounder is unusual, in that it was previously declared overfished but was rebuilt to the then-current estimate of B_{MSY} in 2001 (TRAC 2001, MSMC 2001). Since the stock was rebuilt prior to the re-estimation of reference points, and is greater than the minimum biomass threshold, a formal rebuilding program is not required for this stock [Amendment 13 2003].

Unfortunately, by 2005, the perceived stock status changed significantly. An updated benchmark assessment concluded that the stock size had been over-estimated and fishing mortality was severely underestimated (TRAC 2005).

To address the strong retrospective pattern, a new model was developed and adopted ("Major Change" VPA model) to provide stock management advice in 2005. The Major Change model utilized a split in the survey time series between 1994 and 1995 to reduce the retrospective pattern. This adjustment, along with subsequent adjustments and revisions to the model in more recent years, has not eliminated the retrospective pattern. Furthermore there have been reportedly poor recruitment years which have only exacerbated the perceived status of the stock. The most recent TRAC 2012 concluded that the spawning stock biomass in 2011 was estimated to be 4,600 mt. The catch advised by the TRAC in 2012 ranged 300 to 500 mt (U.S./CA shared).

This summary is an extremely abbreviated version of the science and policies used to manage the Georges Bank yellowtail flounder stock over the past ten years. However, it is important to note this stock has been managed under a hard TAC since 2004. Also, although management for this stock is no longer constrained by a biomass target and rebuilding timeframe, the rebuilding target set for Georges Bank yellowtail by GARM III in 2008 was 43,200 mt. The present SSB_{MSY} reported by the TRAC in 2012 was 4,600 mt. And as previous noted, in 2002 the status of the stock was reportedly nearing "rebuilt" status.

Discussion

No one can deny that the groundfish fishery is part of a highly complex and dynamic ecosystem. Much work has been done over the years to better understand the degree to which factors such as predator-prey relationships, water temperature, and other oceanographic conditions influence the status of groundfish stocks.

In the Northeast, the management response to newly revised stock assessments has either resulted in large fluctuations in the catch advice over short periods of time, or has resulted in the ratcheting down of the allowable catch in order to stay on trajectory to rebuilding goals. Both approaches have proven to have significant negative consequences for the commercial fleet and dependent fishing communities.

As seen from the Gulf of Maine cod and Georges Bank yellowtail flounder examples alone, stock assessments have shown a great degree of variability in the Northeast. Scientific understanding of spawning stock biomass is constantly subject to change. The most recent benchmark assessment for Gulf of Maine cod (SAW 53) reduced the previously reported spawning stock biomass in 2008 by approximately 70 percent. Georges Bank yellowtail flounder not subject to rebuilding timelines but managed under a hard TAC since 2004, went from nearly rebuilt to only 10 percent of its SSB_{msy} in less than 10 years. It's hard to imagine the situation for Georges Bank yellowtail flounder could have been worse for the fishery and not likely any better for the rebuilding of the fish stock, if U.S. rebuilding timelines and targets applied.

Keeping a fishery intact through the recalculations and modifications made by mangers to stay on trajectory to rebuilding timelines and targets is a challenge. As stated in NSC public comments (NSC 2012),

> Generally, large and rapid fluctuations in catches present real problems for producers (fishermen), processors and the market which, being comprised of small businesses, seek stability and predictability as a general rule. Unusually low catch limits (supply) can cause loss of fishing businesses, shoreside enterprises and associated infrastructure resulting in an irreversible loss of access to a working waterfront. Low supply can result in loss of market position and product substitution, which can be permanent. Drastic reductions in catch can lead to a Federal disaster declaration and/or other efforts to provide economic assistance that are costly to the nation. Unusually high catch limits (supply) can depress prices to fishermen and create temporary, instable sources of demand for processing capacity/employment, and in the market. Lower prices driven by high supply creates more work for less money for fishermen and processors.

Taking all of the above into account, the most effective way to manage for groundfish stocks and the fishery would be to control and manage fishing mortality according to our present knowledge of the stock. Present scientific knowledge, although far from perfect, is far more certain than projections, especially long-term projections. There are too many factors in the ecosystem—natural variability—that are outside of our control. Stocks should be allowed to rebuild naturally —according to environmental conditions and ecosystem dynamics, while fishery impacts are limited to the precautionary levels associated with an F_{MSY} strategy.

NSC has a long history of public comments which clearly shows its support for policy that is focused on setting fishing mortality rates that prevent overfishing while allowing stocks to rebuild naturally, according to the natural environment and ecosystem dynamics. NSC believes this approach is more appropriate than a focus on rebuilding by arbitrary timelines, which are entirely reliant upon long term projections now known to be highly uncertain and unreliable.

In 2005 NSC stated (NSC 2005),

> NSC strongly favors a consistent fishing mortality rate-based policy for both long-term management and shorter-term rebuilding. This policy should be both precautionary and linked to the scientific reality that fishing at a rate of Fmsy prevents overfishing and will on average and over the long term rebuild overfished stocks to Bmsy. Stated otherwise, a strategy of fishing at (or somewhat below) a rate of F_{msy} will achieve the overarching conservation objectives of the Magnuson-Stevens Act to prevent overfishing and rebuild overfished stocks in a biologically meaningful way while providing managers with the flexibility to achieve other critical social and economic objectives of the Act.

In 2008 NSC stated (NSC 2008),

> Perhaps more than any other section of these proposed guidelines, the setting of rebuilding timeframes is the area where the Agency should provide fishery managers with the highest degree of flexibility. Again,

the truly critical goal of fishery conservation and management is to prevent overfishing, not to apply an artificial, overly ambitious and biologically meaningless timeframe to achieve rebuilding to what is often a highly-uncertain rebuilding biomass target. The process of setting and enforcing rigid rebuilding timeframes has repeatedly and unnecessarily confounded the efforts of fishery managers nationwide.

Most recently, in 2012, NSC stated (NSC 2012),

> The most limiting provision of the statute (Section 304(e)(4)(A)(ii)), states that a rebuilding plan "shall not exceed 10 years except in cases where the biology of stock of fish or other environmental conditions dictate otherwise." A more flexible interpretation and implementation of section 304(e)(4)(A)(ii) would enable rebuilding plans to be more consistent with the biological realities of a stock including recruitment, growth and natural mortality, as those population dynamics are affected by unpredictable changes in the environment and ecosystem. NSC believes the goal of the Agency in revising the current guidelines should be to put much less emphasis on strict, arbitrary rebuilding timeframes through a much broader interpretation and application of the statutory terms "biology of a stock of fish" and "other environmental conditions."

In the case of the groundfish fishery in the Northeast, it is clear more consideration must be centered on the environmental conditions and ecosystem dynamics. Developing an F_{MSY}-based strategy which takes into account environmental conditions is likely the most effective approach moving forward. Such an approach would meet the overarching conservation goals of Magnuson while fostering greater stability for the fleet.

Conclusion

The current interpretation and implementation of MSA rebuilding timelines does not adequately allow for uncertainty. The existing mandate pretends there is consistency and stability in stock assessments and certainty in long-term projections. In the Northeast, rebuilding timelines have not adequately taken into account the influence of natural cycles, ecosystem dynamics and environmental conditions on the performance of a stock. The changes in the science and the required responses by managers to stay on trajectory to rebuilding goals have resulted in significant swings in the allowable catch (high and low) which has negatively impacted fishing businesses and communities.

Additionally, rebuilding comes with a cost. NSC has noted in its public comments that once a stock is deemed overfished the current fishing mortality rate is reduced to a level which is projected at that time to rebuild the stock to that current estimate of B_{MSY} in the specified timeframe (i.e. F-rebuild). This fishing mortality rate, and the associated catch, implemented remain constrained until B_{MSY} is reached if ever. As noted by NSC, "this is a major commitment of management resources and often has a major, very long term impact on the fishery." (NSC 2012) Too often the prevailing biological conditions prevent stocks from performing to a level that will achieve the $B_{MSY.}$ The cost of being wrong are lost yield, markets and continued business failures.

Starting on May 1, 2013, in order to end overfishing and remain on trajectory for rebuilding plans, the allowable catch for many groundfish stocks has been set at levels so low very few fishing businesses will be able to survive. The U.S. Secretary of Commerce declared the Northeast groundfish fishery a disaster in September 2012. These reductions are occurring after years of stringent management measures, Amendment 9, Amendment 13, Amendment 16 and a host of Framework Adjustments—implemented to meet MSA rebuilding timelines.

Now, more than ever, is the time for change. MSA law needs to embrace common sense. The law needs to recognize what can and cannot be controlled by policy. In the case of the Northeast groundfish fishery, environmental conditions and ecosystem dynamics need to be taken into account when considering rebuilding goals. Additionally, a fishing mortality rate-based strategy should be applied for both long-term management and shorter-term rebuilding. F_{MSY} prevents overfishing and will on average and over the long term rebuild overfished stocks to B_{MSY}. An F_{MSY} strategy will achieve the overarching conservation objectives of the MSA to prevent overfishing and rebuild overfished stocks in a biologically meaningful way while providing managers with the flexibility to achieve other critical social and economic objectives of the Act (NSC 2005).

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A Perspective from the Scientific Community about the Strengths and Weaknesses of Rebuilding Time Estimates

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Abstract

Rebuilding plans must be developed for U.S. Federally-managed fish and invertebrate species that are declared to be below their minimum stock size thresholds (MSSTs). Rebuilding plans involve a number of steps, but key amongst those are that a rebuilding analysis needs to be conducted which estimates how long it will take to rebuild to the biomass at which maximum sustainable yield (or a proxy therefore) is achieved, and the impact of different times to rebuild on catches. Although the requirements of the Magnuson-Stevens Act (MSA) and the guidelines developed by the National Marine Fisheries Service (NMFS) provide a fairly well-defined framework within which to construct rebuilding plans, a number of changes to how rebuilding plans are developed appear warranted given scientific constraints, and the need to provide scientific advice to guide decision-making: (a) the current rule for determining the maximum time for rebuilding is discontinuous, and should be replaced by a rule which does not have a jump at 10 years; (b) models of by-catch in multispecies fisheries should be developed and formally integrated with rebuilding analyses to improve socioeconomic analyses; (c) management should avoid changing regulations so that the probability of rebuilding by the target level always remains 50 percent given that assessment results are by definition uncertain;(d) work should be undertaken to define an appropriate tolerance for how far the predicted year of rebuilding can differ from the expected value given unavoidable uncertainty in stock assessments; (e) adoption of the term "depleted" for stocks that are below their MSSTs will tend to avoid incorrectly assigning responsibility for being below MSST to excessive fishing; (f) stocks for which subsequent assessments suggest they were never overfished should not be subject to rebuilding provisions to avoid non-symmetric treatment of rebuilding provisions; and (g) the rules for conducting rebuilding analyses should be integrated with the harvest control rules used for healthy stocks to avoid large changes in management actions when, for example, stocks are declared overfished or they rebuild.

Keywords: Groundfish; North Pacific; rebuilding analysis; rebuilding plan; stock assessment; uncertainty

Introduction

The requirements for rebuilding plans arise from the 1996 Sustainable Fisheries Act (SFA), which, in the event a fishery is found to be overfished or approaching an overfished condition, require the relevant fishery management Councils to develop a fishery management plan to:

> "(A) to end overfishing in the fishery and to rebuild affected stocks of fish; or (B) to prevent overfishing from occurring in the fishery whenever such fishery is identified as approaching an overfished condition."

The SFA also requires that:

> "For a fishery that is overfished, any fishery management plan, amendment, or proposed regulations prepared ....shall— (A) specify a time period for ending overfishing and rebuilding the fishery that shall—
>
> i. be as short as possible, taking into account the status and biology of any overfished stocks of fish, the needs of fishing communities, recommendations by international organizations in which the United States participates, and the interaction of the overfished stock of fish within the marine ecosystem; and
>
> ii. not exceed 10 years, except in cases where the biology of the stock of fish, other environmental conditions, or management measures under an international agreement in which the United States participates dictate otherwise;...."

The Federal government issued National Standard 1 Guidelines in 1998 which facilitated implementation of the requirements of the SFA. The guidelines which were issued following the 2006 reauthorization of the MSA clarified the MSST, the level below which a stock would be considered to be overfished, and provided guidelines for cases when a stock fails to rebuild to B_{MSY} with the agreed timeframe:

> "If a stock or stock complex reached the end of its rebuilding plan period and has not yet been determined to be rebuilt, then the rebuilding F should not be increased until the stock or stock complex has been demonstrated to be rebuilt. If the rebuilding plan was based on a T_{target} that was less than T_{max}, and the stock or stock complex is not rebuilt by T_{target}, rebuilding measures should be revised, if necessary, such that the stock or stock complex will be rebuilt by T_{max}. If the stock or stock complex has not rebuilt by T_{max}, then the fishing mortality rate should be maintained at $F_{rebuild}$ or 75 percent of the [maximum fishing mortality threshold (MFMT)], whichever is less"

The requirements for rebuilding in the U.S. differ from those in countries whose fishery management acts also include the need for rebuilding of overfished stocks. For example, while the New Zealand Harvest Strategy Standard (Ministry of Fisheries, 2008, 2011) includes the requirement for a time-constrained rebuilding period between the hard and soft limits (generally 10 percent and 20 percent respectively of the unfished spawning biomass, B_0), the time to rebuild to the [minimum] target biomass of B_{MSY} (the biomass corresponding to maximum sustainable yield, MSY) is not specified.

Seventeen fish and invertebrate stocks managed by the Pacific and North Pacific Fishery Management Councils have been declared overfished (Table 1). Formal rebuilding plans were only developed for 13 of these stocks (Table 1) because the remaining stocks rebuilt to B_{MSY} before a plan could be adopted (or in the case of Eastern Bering Sea Tanner crab *Chionoecetes bairdi*, the value for the target biomass was changed so that the stock was no longer considered overfished; NPFMC [2012]).

This paper first outlines the process for conducting the rebuilding analyses which form the basis for rebuilding plans, and how those analyses are revised/updated given new information. It then provides a summary of the technical aspects of the rebuilding analyses conducted for the groundfish and crab stocks managed by the Pacific and North Pacific Councils, and identifies some general issues which have proven scientifically challenging when designing, implementing and reviewing rebuilding plans, and how they could be overcome. The focus of this paper is on the groundfish and crab stocks managed by these two Councils because the author is most familiar with those stocks.

Developing and Reviewing Rebuilding Analyses

Rebuilding analyses provide the basis to evaluate the tradeoff between yield during the rebuilding period and the (expected) length of the rebuilding period. Rebuilding analyses can be used to also provide other types of information which could inform the selection of a target year for rebuilding. For example, rebuilding analyses presented to the Pacific Council have explored (a) the probability that a stock will drop below its size when it was declared overfished, and (b) discounted catches. The results of rebuilding analyses also form the basis for the socioeconomic analyses which summarize the impact of rebuilding times on fishing communities.

Table 1. Overview of the stocks managed by the Pacific and North Pacific Fishery Management Councils which have been declared to be overfished.

Stock	Plan Developed	Current Status
North Pacific Fishery Management Council		
Crab		
Eastern Bering Sea snow crab	Yes	Rebuilt
St. Matthews Blue king crab	Yes	Rebuilt
Eastern Bering Sea Tanner crab	No	Rebuilt
Pribilof Islands blue king crab	Yes	Overfished
Pacific Fishery Management Council		
Groundfish		
Bocaccio (south of 40'10)	Yes	Rebuilding
Canary rockfish	Yes	Overfished
Cowcod (southern California)	Yes	Overfished
Darkblotched rockfish	Yes	Rebuilding
Lingcod	Yes	Rebuilt
Pacific hake	Yes	Rebuilt
Pacific ocean perch	Yes	Overfished
Petrale sole	Yes	Rebuilding
Widow rockfish	Yes	Rebuilt
Yelloweye rockfish	Yes	Overfished
Pacific coast salmon		
Chinook salmon (Klamath fall)	No	Rebuilt
Chinook salmon (Sacramento fall)	Yes	Overfished
Coho salmon (Queets)	No	Rebuilt
Coho salmon (Western Strait of Juan de Fuca)	No	Rebuilt

Rebuilding analyses fundamentally involve projecting the population forward under various harvest strategies. Potential harvest strategies include: (a) different levels for the constant fishing mortality rate by the target fishery [e.g., Turnock and Rugulo 2010)], (b) the constant fishing mortality which matches the catch for the most recent year or a pre-specified spawning potential ratio[1], and (c) fixed catches for a certain number of years followed by fishing mortality set to achieve a particular spawning potential ratio. Table 2 lists the (minimum) set of harvest strategies, the implications of which need to be routinely reported in the rebuilding analyses for groundfish stocks managed by the Pacific Council.

The outcomes from a rebuilding analysis are time-trajectories of population size relative to the B_{MSY} (or its proxy) (Figure 1). The results of these projections are used to determine:

- T_{MIN}, the time to rebuild to B_{MSY} in the absence of all future fishing (Fig. 1, top right box). This is operationally defined as the year in which recovery to B_{MSY} (or its proxy) occurs with 50 percent probability if all fishing stopped when the rebuilding plan was first implemented.

1 The Spawning Potential Ratio is a measure of the expected spawning output-per-recruit, given a particular fishing mortality rate and the stock's biological characteristics, i.e., there is a direct mapping of the spawning potential rate to *F* (and *vice versa*).

Table 2. The minimal set of harvest strategies which need to be routinely reported in the rebuilding analyses for groundfish stocks managed by the Pacific Fishery Management Council (PFMC, 2012a).

- eliminate all harvest beginning in the next management cycle,
- apply the harvest rate that would generate the annual catch limit specified for the current year (i.e., the latest year specified in regulations),
- apply the spawning potential ratio or relevant harvest control rule in the current rebuilding plan,
- apply the harvest rate that is estimated to lead to a 50 percent probability of recovery by the current T_{TARGET},
- apply the harvest rate that is estimated to lead to a 50 percent probability of recovery by the T_{MAX} from the current cycle,
- apply the harvest rate that is estimated to lead to a 50 percent probability of recovery by the T_{MAX} from the previous cycle,
- apply the default (e.g. 40-10 or 25-5) harvest policy, and
- apply the acceptable biological catch harvest rate (i.e., F_{MSY} less the uncertainty buffer).

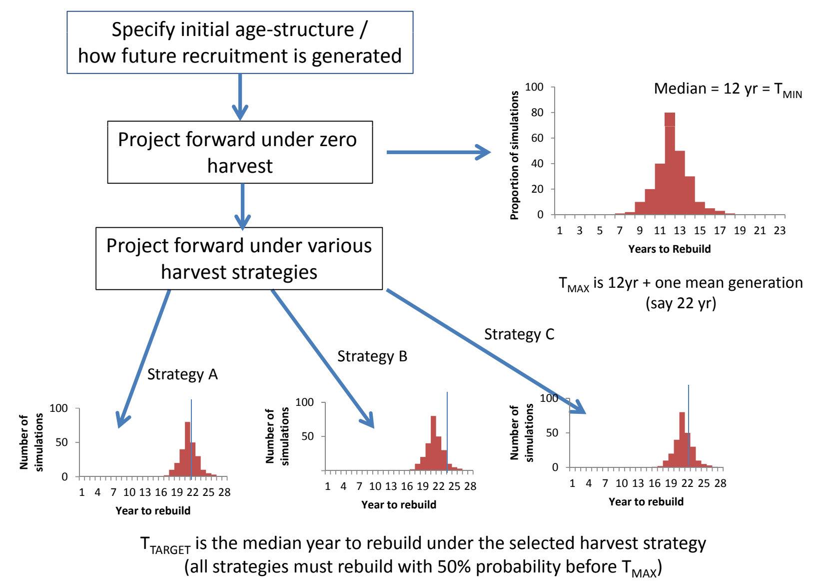

Figure 1. Graphical summary of how rebuilding analyses are conducted

- T_{MAX}, the maximum rebuilding time (Fig. 2a, page 110). T_{MAX} is 10 years[2] if the stock can rebuild in less than or equal to 10 years with 50 percent probability under zero fishing mortality. The rule which defines T_{MAX} leads to a discontinuity at 10 years because stocks which can be rebuilt within 10 years have to be rebuilt within 10 years, but the allowable rebuilding time can be substantially longer than 10 years even if T_{MIN} is slightly larger than 10 years.

- The tradeoff between yield and the target year for rebuilding, T_{TARGET}.

- The harvest strategy which leads to a 50 percent probability of rebuilding by T_{TARGET} (the year chosen as the target year for rebuilding by the Council) is then identified.

Rebuilding plans have to be reviewed every second year. There is wide range of interpretations for what constitutes a

2 A reviewer noted that 10 years was selected because it was noted when the rule was being developed that most stocks can rebuild within ten years. However, I could not find a record of this statement nor the analysis which underpinned it.

review of a rebuilding plan. This can range from comparing the catches expected under the rebuilding plan with those which were actually taken, to updated stock assessments which provide updated estimates of B_{MSY} (or its proxy), and of stock status relative to B_{MSY}. The factors considered by the Pacific Council Scientific and Statistical Committee (SSC) when they review rebuilding plans are (PFMC, 2011a): (a) whether cumulative catches during the period of rebuilding exceeded the cumulative total catch limit, (b) whether the proper data and software were used when conducting the rebuilding analysis and that the rebuilding analysis satisfied all of the agreed technical requirements (e.g., PFMC, 2012a), (c) whether the biological parameters in the stock assessment had been revised to such an extent as to warrant a change in T_{TARGET}, (d) whether progress towards rebuilding is deemed to be adequate, (e) whether there is a discrepancy between the current T_{TARGET} and the median time to rebuild under the currently-adopted rebuilding harvest rate ($T_{REBUILD}$), and if so, what a new maximum time to rebuild ($T_{MAX(NEW)}$) should be and, secondarily, if the currently adopted harvest strategy will likely rebuild the stock before this $T_{MAX(NEW)}$.

Overview of Recent Rebuilding Analyses for Pacific and North Pacific Fishery Management Council Stocks

Table 3 (next page) summarizes the factors considered in the most recent rebuilding analyses conducted for Pacific and North Pacific Council groundfish and crab stocks based on population projections (one for the North Pacific Council and nine for the Pacific Council). The assumptions underlying the rebuilding analyses can differ markedly among stocks, although this often reflects the amount of information available for the stock concerned, and how the stock assessment was originally conducted and reviewed. For example, only the rebuilding analysis for eastern Bering Sea snow crab *Chionoecetes opilio* (Turnock and Rugolo 2010) allowed for assessment error, and variation between the intended and actual harvest rate. Accounting for the fact that realized harvest rates are usually below their intended values for Pacific Council groundfish stocks has recently been identified as an issue to address in future rebuilding analyses (PFMC., 2012b), because this impacts the predicted rate of rebuilding.

Stock assessments, and hence population projections, are subject to several types of uncertainties: (a) estimation (or observation) uncertainty relates to how well the available data allow the parameters of the stock assessment model to be estimated, (b) process error relates to uncertainty in biological processes (such as how recruitment for one year differs from its expected value), and (c) model uncertainty relates to how mathematical models are able to capture reality. Rebuilding analyses differ in terms of how each of these sources of uncertainty is treated.

All but one of the rebuilding analyses (that for lingcod) were based on generating future recruitment using a stock-recruitment relationship. The lingcod rebuilding analysis generated future recruitment by sampling from past recruitments (essentially equivalent to a Beverton-Holt stock-recruitment relationship with a steepness[3] of 1). The lingcod rebuilding analysis was conducted in 2009; several other rebuilding analysis conducted for the Pacific Council at that time and earlier did not generate future recruitment using a stock-recruitment relationship, but this has become standard practice since assessments of West Coast groundfish became based on stock synthesis (Methot and Wetzel 2013), which has an integrated stock-recruitment relationship. The current way recruitment is generated for Pacific Council rebuilding analyses ensures consistency between how past and future recruitment is treated. Many of the rebuilding analyses for Pacific Council stocks include uncertainty in the parameter which determines the productivity of the population (steepness), usually based on the values chosen to bracket uncertainty in the stock assessment. Uncertainty in steepness is low for the rebuilding analysis for eastern Bering Sea snow crab because steepness was chosen so that $F_{35\%}$ was F_{MSY} (the fishing mortality corresponding to B_{MSY}) and $F_{35\%}$ is fairly robustly estimated.

3 Steepness is the proportion of unfished recruitment which is expected when a population is reduced to 20 percent of its unfished level.

Table 3. Overview of the factors considered in the rebuilding analyses conducted for groundfish stocks off the U.S. West Coast and crab stocks off Alaska. σ_R is a measure of the extent of variation in recruitment about the stock recruitment relationship. $F_{35\%}$ is the fishing mortality rate at which spawning biomass (or mature male biomass in the case of crab) is reduced to 35 percent of its unfished level and $B_{35\%}$ is corresponding biomass. B_0 is the average unfished biomass.

Stock	Year of most recent assessment	Treatment of recruitment	Parameters considered uncertain	Implementation error	Reference
Eastern Bering Sea snow crab	2010	Log-normal with auto-correlated residuals; steepness selected so that $F_{MSY} = F_{35\%}$; B_0 selected so that $B_{MSY}=B_{35\%}$.	Numbers-at-length; natural mortality; selectivity; growth	Log-normal with auto-correlated residuals; CV assumed to be 0.2	Turnoch and Rugolo (2010)
Bocaccio (south of 40'10)	2009 (full)	Log-normal; steepness=0.58; $\sigma_R = 1$	None	None	Field and He (2009)
Canary rockfish	2011 (update)	Log-normal; three values for steepness; $\sigma_R = 0.5$	All model parameters for three states of nature (weighted 25%: 50%; 25%)	None	Wallace (2011)
Cowcod (southern California)	2011 (status report)	Deterministic about a stock-recruitment relationship	All model parameters for 21 states of nature (weighted by a prior)	None	Dick and Ralston, (2009)
Darkblotched rockfish	2011 (full)	Log-normal; Steepness = 0.76; $\sigma_R = 0.8$	None	None	Stephens (2011)
Lingcod	2009 (full)	Resampled from historical recruitments	None	None	Jagielo (2009)
Pacific Ocean perch	2011 (full)	Log-normal; three values of steepness; $\sigma_R = 0.7$	All model parameters for three states of nature (weighted 25%: 50%; 25%)	None	Hamel (2011)
Petrale sole	2011 (full)	Log-normal; three values for steepness; $\sigma_R = 0.4$	All model parameters for three states of nature (weighted 25%: 50%; 25%)	None	Haltuch (2011)
Widow rockfish	2011 (full)	Log-normal; Steepness = 0.41; $\sigma_R = 0.6$	None	None	He et al. (2009)
Yelloweye rockfish	2011 (update)	Log-normal; three values for steepness; $\sigma_R = 0.5$	Nine states of nature (defined by steepness and historical catch); (weighting from 0.0625 – 0.25)	None	Taylor (2011)

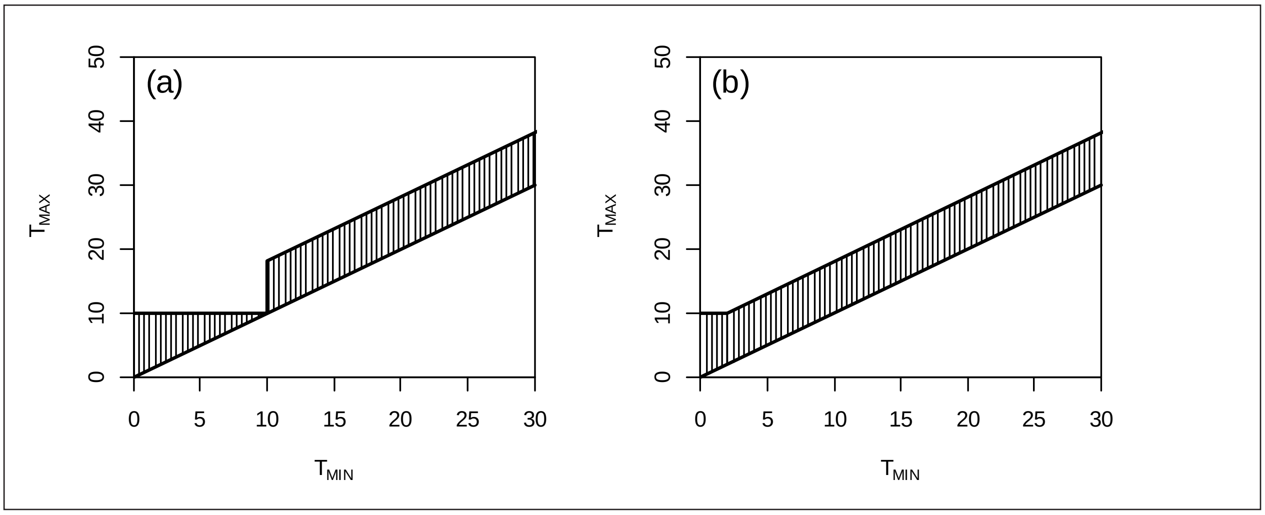

Figure 2. Relationship between T_{MIN}, and T_{MAX} for a stock with a generation time of 20 years given the current guidelines (a), and this relationship without the 10-year rule (b). T_{TARGET} has to be selected from within the shaded region. The vertical line at T_{MIN} = 10 years in (a) indicates the 10-year discontinuity.

Most, but not all, of the rebuilding analyses in Table 3 allowed for estimation uncertainty related to the current state of the population and to the parameters which define future recruitment. Only one of the rebuilding analyses (that for eastern Bering Sea snow crab) captured estimation uncertainty by sampling parameter vectors from a Bayesian posterior distribution. The remaining rebuilding analyses which accounted for estimation uncertainty conducted projections for a small (3-21) set of parameter vectors, where these vectors were selected based on the alternative model configurations (states of nature) identified during the review of the assessment. The sets of parameter vectors were then weighted based on the weights selected during those reviews.

A key issue for rebuilding analyses is that they are updated given new information (as well as due to changes to assessment methods and standard assumptions/ways to analyze input data). Figure 3 (next page) shows phase plots for Pacific ocean perch *Sebastes alutus* based on assessments conducted from 2005 to 2011, illustrating the sensitivity of the estimates of the time-series for B/B_{MSY} and F/F_{MSY} to changes and updates to the assessment. The results for the most recent (2011) assessment are shown separately from those for the early (2005-09) assessments because the metric used to express fishing mortality was changed. Qualitatively, the patterns are similar among assessments. However, the extent to which fishing mortality was higher than F_{MSY} has varied among assessments. More importantly, the most recent (2011) assessment led to a 68 percent increase to the estimate of B_{MSY} from that from the 2001 assessment. This, combined with the fact that the estimate of current spawning biomass only increased by 5 percent, led to a marked reduction in the estimate of how close the stock is to B_{MSY}. This change also led to a marked change to the estimate for T_{MIN} (from 2017 in the 2009 assessment to 2040 in the 2011 assessment; Figure 4e, next page). These changes led the Pacific Council SSC to note that a change to T_{TARGET} was warranted, but that continuing the current fishing mortality rate would still achieve rebuilding well before the value for T_{MAX} inferred by adding one generation time to 2040 (PFMC, 2011b).

Observations on Rebuilding Analyses and Their Use in Developing Rebuilding Plans

The 10-year Rule

The current guidelines for implementing the SFA lead to a discontinuity at 10 years in the relationship between T_{MIN} and T_{MAX} (Figure 2a). This means that stocks which can rebuild in the absence of exploitation in nine years are treated very differently from stocks which can only rebuild in 11 years (in the case of Fig. 2, the values for T_{MAX} would be 10 years and 21 years for these two situations). This problem is exacerbated by uncertainty. For example, Figure 5 shows the probability distribution for T_{MIN} (expressed as an actual year) for Pacific Ocean perch. A number of issues are evident from Figure 5 (page 112). First, the distribution for T_{MIN} is bimodal. This arises because the

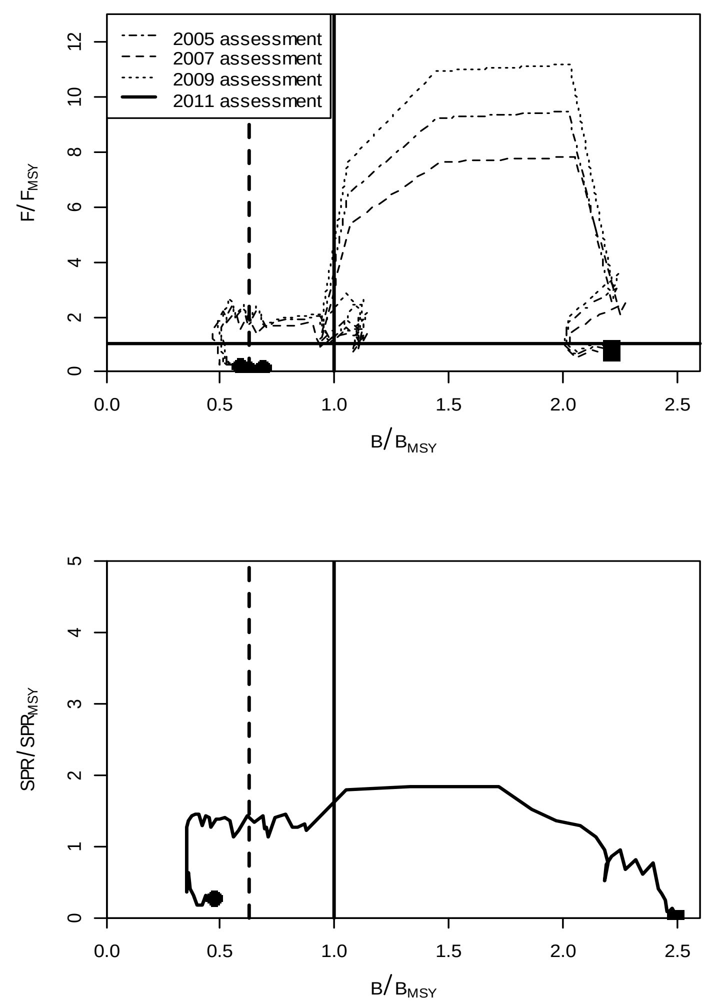

Figure 3. Phase plots for Pacific Ocean perch. The solid square indicates the first year included in the assessment, and the solid circle the last year included in the assessment.

projections are based on three states of nature (Table 3). The "high" state of nature (which was assigned a probability of 0.25) implies that the stock is less depleted compared to the target level and has higher productivity (as quantified through the steepness of the stock-recruitment relationship), and consequently can rebuild within 10 years of first being declared overfished, whereas the other two states of nature ("low" and "base") are unable to rebuild within 10 years. Second, the results in Figure 5 highlight the consequences of uncertainty. Were the weights assigned to the three states of nature to be changed, for example, if the "base" state of nature was assigned a weight of 0.25 and the "high" state of nature was assigned a weight of 0.5, T_{MIN} would drop from 40 to only 10 years. While a change of this nature is perhaps unlikely, Figure 5 illustrates the potential consequences of the 10-year discontinuity on the outcomes of rebuilding analyses and hence rebuilding plans.

The 10-year rule has two key consequences: (a) it imposes a minimum value of 10 years for T_{MAX}, and (b) it imposes a maximum value for T_{MAX} of 10 years if T_{MIN} is less than 10 years. Figure 2b shows an alternative to the current rule which retains a minimum value of 10 years for T_{MAX}, but does not impose the maximum value for T_{MAX} of 10 years if T_{MIN} is less than 10 years, but rather always sets T_{MAX} to T_{MIN} plus one mean generation time if T_{MIN} is larger than 10 years. While the choice of 10 years is necessarily arbitrary[1], Figure 2b does not lead to the discontinuity at 10 years, and is hence more robust to uncertainty. The rule in Figure 2b is only one of many rules which capture the spirit of the 10-year rule, but avoid the discontinuity at 10 years.

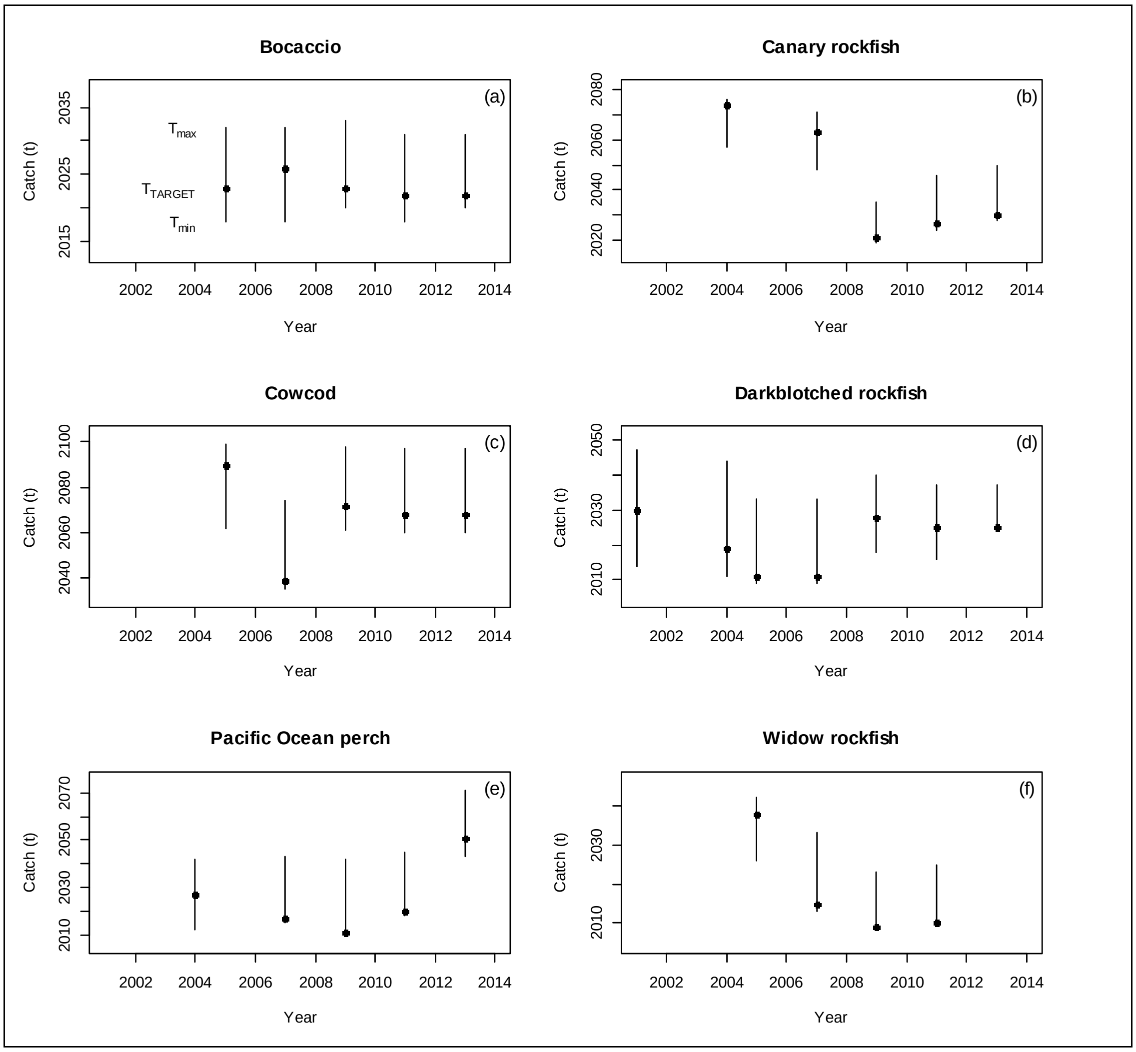

Figure 4. Values for T_{MIN}, T_{ARGET} and T_{MAX} for six selected groundfish stocks managed by the Pacific Fishery Management Council. Results are shown for each time the rebuilding analysis was updated or progress towards rebuilding was reviewed. The years on the x-axis relate to the first year for which management actions would be impacted by changes to the three parameters.

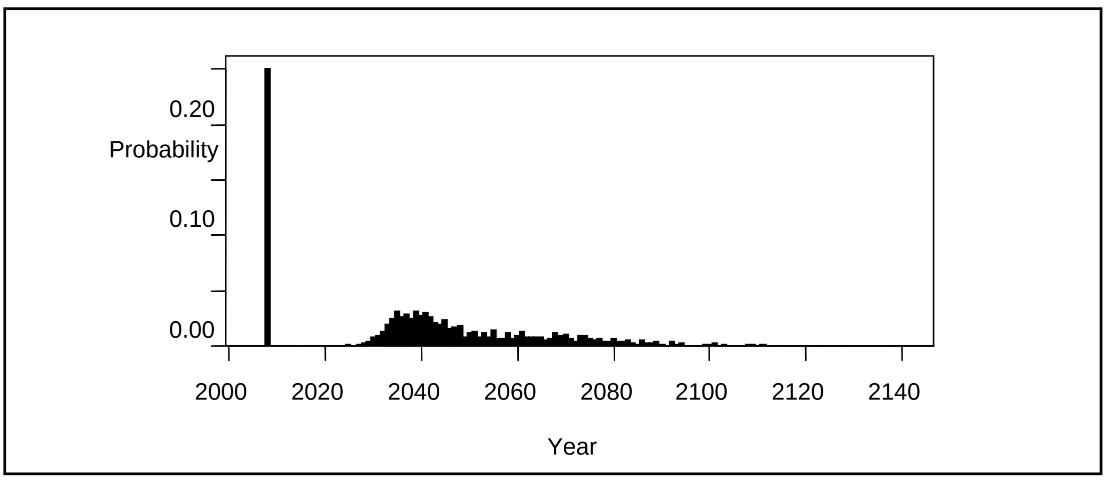

Figure 5. Distribution of time-to-rebuild to the proxy for B_{MSY} in the absence of exploitation for Pacific Ocean perch (reproduced from Hamel 2011).

Estimating B_{MSY}

The Pacific and North Pacific Councils have adopted different approaches for setting B_{MSY}, which provides the target biomass for rebuilding analyses. Both Councils encourage estimation of B_{MSY} (and F_{MSY}) directly (e.g., from the fits of stock-recruitment relationships), but only in a very few cases have directly-estimated values for B_{MSY} been accepted for management purposes (for example for groundfish in the northeast Pacific, management advice is based on a direct estimate of B_{MSY} for only eastern Bering Sea walleye pollock, [*Theragra chalcogramma*], Bering Sea and Aleutian Islands yellowfin sole [*Limanda aspera*], and Bering Sea and Aleutian Islands yellowfin sole [*Lepidopsetta polyxystra*]). B_{MSY} for the remaining stocks is estimated using "proxies."

The Pacific Council has adopted proxies for B_{MSY} for groundfish stocks based on the assumption that B_{MSY} occurs at a specified fraction of the unfished spawning biomass, B_0 (i.e., $B_{MSY} \sim x.B_0$) where x is 0.4 for rockfish and roundfish and 0.25 for flatfish (PFMC, 2011b). The basis for these choices is the work of Clark (1991, 2002), who noted that the loss in expected yield could be minimized when the fishing mortality rate is maintained at $\sim F_{30\%}$-$F_{40\%}$. Hilborn (2010) notes that adopting this range of target biomass levels will achieve "pretty good yield," i.e. the loss in yield targeting the wrong target biomass is relatively small because the yield curve is flat over a relatively wide range of target biomass levels. Application of this approach to estimating B_{MSY} requires that B_0 can be estimated. However, estimates of B_0 can be highly uncertain (often the fishery will have started tens of decades before the first index or composition data are available), and will depend on the ability to estimate the historical time-series of catches as well as, on the assumption that B_0 has not changed since the start of the fishery. Unfortunately, as was illustrated by Pacific ocean perch in Figure 5, changes to assessment methodology or data can lead to marked (in the case of Pacific ocean perch, ~68%) changes to B_0 and hence B_{MSY}.

In contrast to the Pacific Council, when F_{MSY} and B_{MSY} for crab and groundfish species cannot be estimated reliably, the North Pacific Council sets the proxy for B_{MSY} as either (a) the product of the spawner biomass-per-recruit corresponding to the proxy for F_{MSY} (usually $F_{35\%}$) and the mean recruitment corresponding to B_{MSY}, or (b) an average biomass when the stock was "at B_{MSY}" (e.g., NPFMC 2008). Calculation of the spawner biomass-per-recruit corresponding to the proxy for F_{MSY} is generally straightforward. However, the selection of a range of years to define the mean recruitment (or biomass) corresponding to B_{MSY} is not straightforward. There are many factors which relate to choosing this recruitment. Eastern Bering Sea Tanner crab provide an illustrative example of this. The proxy for B_{MSY} changed from 161,000t to 33,500t as a result of a change to the set of years used to define recruitment at B_{MSY} (NPFMC 2012). The North Pacific Council do not define B_{MSY} as a proportion of B_0 because it is generally recognized that productivity for many species in the Bering Sea and Gulf of Alaska changed substantially following the 1977 regime shift (e.g., Hare and Mantua 2000; Conners et al. 2002; Mueter et al. 2007), making pre-fishery reference points inappropriate measures of the current productivity of these species.

One advantage that U.S. West Coast and Alaska stocks have is that the B_{MSY} values estimated using the methods applied by the Pacific and North Pacific Council tend to lie within the range of historical observations of biomass, unlike the case for some stocks off the U.S. east coast. The approaches taken to define B_{MSY} by the two Councils reflect the nature of the data available and perceptions regarding long-term changes in productivity. For example, in the case of the West Coast, many groundfish stocks passed through the range of biomasses where B_{MSY} is likely to be very rapidly, making application of the North Pacific Council approaches particularly difficult. The ability to estimate B_{MSY} was examined using simulation by Haltuch et al. (2009) who found that biomass reference points should be based on average recruitment and/or "dynamic B_0" (MacCall et al. 2005) in the presence of low frequency autocorrelated forcing of recruitment, if catch and survey data are available for at least one full period of the environmental variable which forces recruitment. In contrast, Haltuch et al. (2008) suggested that biomass reference points should be based on the fit of the stock–recruitment relationship in the absence of autocorrelated environmental forcing of recruitment, and if the available catch and survey data do not span at least one full period of the environmental variable that is driving recruitment. Nevertheless, the simulations of Haltuch et al. (2008, 2009) confirm the expectation that it is much easier to estimate B_0 and relative biomass (biomass/B_0) than B_{MSY}.

Multispecies Interactions and Socioeconomic Evaluation

The analyses on which rebuilding plans are based include information on the socioeconomic consequences of alternative harvest strategies. These tend to focus on the impacts on recreational and commercial fisheries of reduced fishing opportunities for the stock which is being rebuilt. However, for many rebuilding stocks, the consequences of reduced fishing opportunities for overfished and rebuilding species can be substantial on healthy stocks which co-occur with the overfished and rebuilding species. For example, when developing a rebuilding plan for eastern Being Sea Tanner crab, the set of harvest strategies considered in the rebuilding analysis included potential restrictions on the fishery for eastern Bering Sea snow crab. No rebuilding plan was implemented for eastern Bering Sea Tanner crab so no additional restrictions have been imposed on the snow crab fishery. In contrast, the implications of the need to rebuild overfished West Coast groundfish have been substantial on fisheries for co-occurring species. Figure 6 shows the time-series of catches for yellowtail rockfish (*Sebastes flavidus*). This stock is assessed to be well above the target level of 40 percent of the estimate of B_0 (Wallace and Lai 2005). However, catches are substantially smaller than would be expected under an F_{MSY} strategy because of the need to avoid by-catch of canary and widow rockfish (*Sebastes pinniger* and *Sebastes entomelas*).

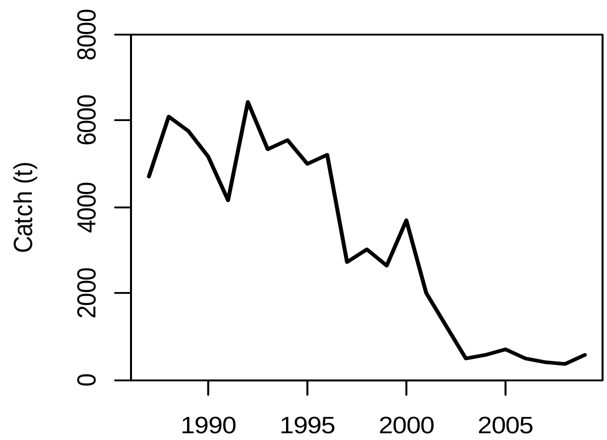

Figure 6. Time-trajectory of catch for yellowtail rockfish.

Generic approaches have been developed to conduct rebuilding analyses (e.g., Punt, 2003; Punt and Ralston, 2007; PFMC, 2012a), and these approaches have been used extensively on the West Coast to ensure consistency in how rebuilding analyses are conducted. However, these approaches are single-species and do not address the impact of rebuilding on co-occurring species. This is important because the revenue for some rebuilding species, even when rebuilt, will be low compared to that for the species for which fishing opportunities are restricted due to the need to rebuild the overfished species. Such impacts are estimated using various models. However, these models tend not to be dynamic, i.e. take account of the impact of changes over time to the biomasses of the various species. Work is currently being undertaken to develop a multispecies rebuilding tool (A.E. Punt, pers. obs), but a major factor constraining this development is the limited ability to predict the catch-rates of co-occurring species off the West Coast, especially given the recent change in the management of the groundfish fishery to being based on catch shares.

Sensitivity of Stock Assessment Updates and Progress to Rebuilding

As noted above, the requirement to evaluate progress to rebuilding has been implemented differently around the nation. Stock assessments for North Pacific crab and groundfish stocks are conducted annually, which means that the rebuilding projections for eastern Bering Sea snow crab were updated annually. In contrast, assessments of U.S. West Coast groundfish are conducted on a two-year cycle, and assessment updates can take one of three forms (Table 3): (a) a "full assessment" in which all of the assumptions of the assessment can be modified, (b) an "update assessment" in which the same model structure is used as that adopted during the last full assessment, but data streams are updated, and (c) a "status report" in which catch streams are updated, but no models are fitted. The level of review for the three types of assessment differ: full assessments are reviewed by a Stock Assessment Review Panel and the Pacific Council SSC, while update assessments and status reports are reviewed by the groundfish sub-committee of the SSC and then the full SSC. Rebuilding analyses are only updated when full or update assessments are available.

Table 4. Summary of the way rebuilding analyses were reviewed during 2011 by the Pacific Fishery Management Council Scientific and Statistical Committee (reproduced from PFMC (2011a)). SPR denoted spawning potential ratio (see footnote 1 for definition).

Species	Depletion		Total Catch/ Total limit During Rebuilding	Adopted SPR Harvest Rate	Current Council-selected T_{TARGET}	Time to Rebuild At Current SPR	$T_{MAX(NEW)}$
	2009	2011					
Pacific ocean perch	29%	19%	52%	86.4%	2020	2051	2071
Petrale sole	12%	18%	NA	30%	2016	2013	
Canary rockfish	24%	23%	119%	88.7%	2027	2030	2050
Yelloweye rockfish	20%	21%	64%	76%	2074	2067	
Bocaccio rockfish	28%	26%	35%	77.7%	2022	2021	
›arkblotched rockfish	28%	30%	94%	64.9%	2025	2017	

Table 4 provides a summary of the most recent review of rebuilding analyses and progress towards rebuilding by the Pacific Council SSC for its groundfish stocks. The depletion (biomass relative to unfished biomass) increased for three of the stocks, was basically unchanged for one stock, and declined for two of the stocks (Pacific ocean perch and bocaccio rockfish, *Sebastes paucispinis*). The catch during the rebuilding plan was substantially lower than the target catches specified by management based on previous stock assessments for the two stocks which were estimated to more depleted in 2011 than in 2009 (52 percent for Pacific ocean perch and 35 percent for bocaccio), highlighting that a stock may not rebuild at the expected rate even if annual catch limits are implemented correctly. The change in depletion was due to changes to the stock assessment (the 2011 assessment for canary rockfish was an update assessment while that for Pacific ocean perch was a full assessment). Two of the stocks (canary rockfish and Pacific ocean perch were considered to be behind schedule because they were predicted not to be able to rebuild to B_{MSY} by the current Council-selected T_{TARGET} (even though depletion of bocaccio declined between the 2009 and 2011 assessment, this stock is still predicted to rebuild before the current Council-selected T_{TARGET}). The Pacific Council SSC noted that canary rockfish and Pacific ocean perch would rebuild by the T_{MAX} implied by the latest assessment (2050 and 2071 respectively for the two stocks). The Pacific Council subsequently changed the target years for both of these stocks (Figure 4b,e).

The Pacific Council SSC recommended that the current harvest rates be a starting point for management decision-making for the 2013-14 fisheries. In part, this decision reflects a desire to avoid "following noise" whereby catch limits are changed in response to small changes to data sets. Punt and Ralston (2007) showed by simulation that modifying the target exploitation rate to maintain a 50 percent probability of rebuilding by T_{TARGET} would lead to considerable inter-annual variation in catches, with little gain in terms of time to rebuild. Management should therefore avoid changing regulations so that the probability of rebuilding by the target level always remains exactly 50 percent, and work should be undertaken to define an appropriate tolerance for how far the predicted year of rebuilding can differ from the expected value given unavoidable uncertainty in stock assessments.

Selecting and Evaluating Harvest Strategies

The harvest strategy during rebuilding is selected based on the results of rebuilding analyses. These are generally constant fishing mortality rate (or equivalently constant spawning potential ratio) strategies, although at least one stock off the U.S. West Coast (yelloweye rockfish, *Sebastes ruberrimus*) was managed using a harvest strategy which involved phasing in reductions in catches followed by the constant spawning potential rate strategy (Taylor 2011). However, the actual harvest strategy (or catch control rule) could be considered to be the combination of how rebuilding analyses are conducted, in combination with the choice of values for parameters such as T_{TARGET} and B_{MSY}. As has been shown by simulation (Punt 2003; Punt and Ralston 2007), this strategy can lead to management decisions following noise in the data, and is one reason why the Pacific Council SSC recommended that management decision-making start with staying at the current harvest rates rather than adjusting them so the probability of rebuilding by T_{TARGET} is exactly 50 percent.

Although Punt (2003) and Punt and Ralston (2007) have evaluated some aspects of how management decisions are made for rebuilding stocks off the U.S. West Coast, much work still remains. In particular, the simulations conducted to date do not capture "black swan" events (sensu Taleb [2007],) where causibility, explainability and predictability are overestimated and there is a disproportionate number of major, hard-to-predict events, such as major changes to quantities such as B_0 and B_{MSY} (the changes to these quantities from one assessment to the next can fall well outside of their 95% [or even 99.99%] confidence intervals from earlier assessment). Unfortunately, some of the major problems associated with rebuilding pertain to such events (such as the recent change to the estimate of B_0 for Pacific ocean perch).

Final Remarks and Future Work

The current way that rebuilding analyses are conducted provides a well-structured approach to implementing time-constrained rebuilding of overfished stocks. However, experience with rebuilding of Pacific and North Pacific Council fish and invertebrate stocks suggests that the current approach to technical analysis fails to fully and adequately address uncertainty. It is generally recognized within the scientific community that the projections on which rebuilding analyses are based make assumptions which are likely to be violated, but this is seldom fully quantified (and often it is not possible to quantify the full range of uncertainty). A better understanding of the behavior of management systems which include rebuilding provisions can be obtained using management strategy evaluation (Punt 2006; Butterworth 2007; Rademeyer et al. 2007). Management strategy evaluation is a useful way to evaluate candidate revisions to the current approach, but any additional management strategy evaluation work needs to more fully account for "black swan" events such as major retrospective patterns, and changes to rebuilding parameters caused by the addition of new data sources or changes to methods, because these are the factors which most substantially impact the success of rebuilding.

Rebuilding analyses are currently single-species exercises. There is clearly an urgent need to develop methods which analytically determine the impacts on healthy stocks of harvest strategies for overfished and rebuilding stocks. However, the ability to model fleet dynamics accurately means that any predictions of impacts of rebuilding on fishing communities will necessarily be subject to considerable uncertainty.

The current management structure for rebuilding overfished stocks is fundamentally based on the assumption that uncertainty is low and "black swan" events do not occur. Management strategy evaluations should, therefore, be used not only to evaluate the current approach to rebuilding overfished stocks, but also to explore how well other approaches (which may not involve fixed times to rebuild to B_{MSY}) can perform. In particular, strategies which avoid discontinuities in management actions are likely to better achieve management objectives. There are currently four major discontinuities in the system: (a) the 10-year rule, (b) the change in fishing mortality which takes place when a stock is initially declared overfished, (c) the change in fishing mortality which takes place when a stock is declared rebuilt to B_{MSY}, and (d) rebuilding plans must be developed for stocks which are declared overfished (i.e., B < MSST) even if it is subsequently shown that due to additional assessments that the stock was never below MSST (even if it was below B_{MSY}). All of these discontinuities can be triggered by a slight change in data or methods rather than a change to the dynamics or status of the stock itself. The adoption of a system of harvest control rules for overfished species which better integrate with those used for healthy species will tend to reduce the impact of factors such as changes in productivity regime for species for which rebuilding times are likely to be very long.

Another cause for (potential) major changes in management actions pertains to what to do at the end of a rebuilding period. If, for example, the rebuilding period was ten years and in year nine, the stock could rebuild to B_{MSY} with 50 percent probability if the fishery is closed, but would take an additional year to rebuild if fishing mortality rates were kept at current levels, a strict interpretation of a T_{TARGET} would lead to a huge impact on the fishery in one year followed by (if the stock does rebuild) a marked increase in fishing mortality. A more realistic approach would be keep fishing mortality at its current level and accept a slight delay in rebuilding. In general, sticking to an agreed fishing mortality rate even if it means differences in rebuilding times from those initially envisaged would seem to be consistent with the intent of requiring rebuilding for overfished stocks, particularly given how rebuilding is understood outside of the U.S. Changes along the lines suggested above may, however, lead to a different interpretation of "rebuilding in xx years with 50 percent probability" to that if a large number of stocks are under Rebuilding plans that have a T_{TARGET} of xx years that half of them will rebuild within xx years and half of them will not rebuild within the time.

There is also a need to better communicate that although the science on which rebuilding analyses are based is the best available (and often world's best), prediction of the consequences of management actions into the future (and sometimes well into the future; e.g. until 2074 for yelloweye rockfish) is subject to considerable uncertainty and should be better be considered to be indications of expected change than predictions. Moreover, major changes to the outcomes from rebuilding analyses for stocks for which rebuilding times are very long should be considered to be the norm.

Finally, the use of the term "overfished" while appropriate in many cases, can be misleading in others (e.g. a stock may become "overfished" even if fishing mortality has been at or below target levels owing to sequence of poor recruitments, or simply due to a change to how B_{MSY} is defined). Adoption of a term such as "depleted" for stocks which are below their MSSTs will tend avoid incorrectly assigning responsibility for being below MSST due to excessive fishing.

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A RADIO-TAGGED SOCKEYE SALMON BEING RELEASED INTO REDFISH LAKE, IDAHO IN AN EFFORT TO REBUILD THE STOCK. PHOTO: JENNIFER GILDEN

DISCUSSION SUMMARY AND FINDINGS
Session 1 Topic 2

Rebuilding Program Requirements and Timelines

Speakers

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Moderator

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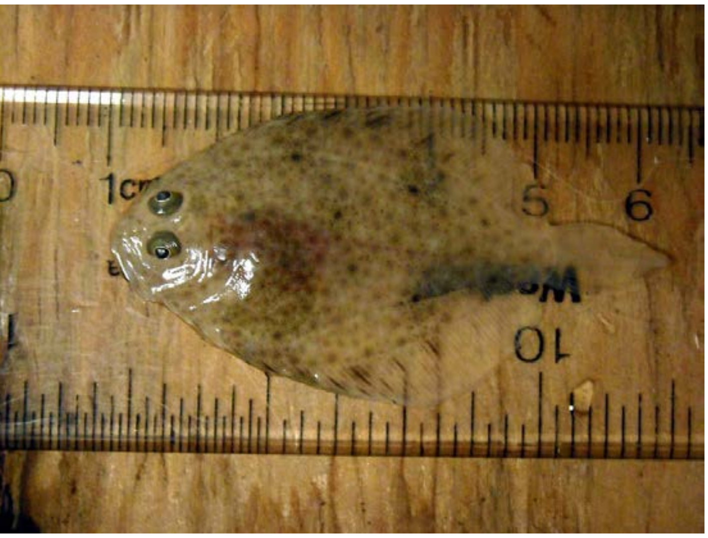
Discussion Summary: Rebuilding Program Requirements and Timelines

The Magnuson-Stevens Act (MSA) requires rebuilding of overfished stocks in as short a time as possible while taking into account the status and biology of the stock, the needs of fishing communities, recommendations by international organizations in which the United States participates, and the interaction of the overfished stock within the marine ecosystem. Further, the MSA stipulates that rebuilding shall not exceed 10 years, except in cases where the biology of the stock, other environmental conditions, or management measures under an international agreement in which the United States participates dictate otherwise. For longer-lived stocks that cannot rebuild in 10 years, National Standard 1 (NS1) guidelines state that rebuilding must occur in the time to rebuild in the absence of fishing plus the time equivalent to one mean generation.[1] Management restrictions under a rebuilding plan and recovery benefits are also mandated to be allocated fairly and equitably among sectors of the fishery.



NS1 guidelines further advise that the minimum time to rebuild (T_{MIN}) should be equal to the amount of time that a stock or complex is expected to rebuild to its maximum sustainable yield biomass level (B_{MSY}) in the absence of any fishing mortality (i.e., both directed and incidental), with a 50 percent probability. If T_{MIN} is 10 years or less, the guidelines stipulate that the maximum allowable time for rebuilding (T_{MAX}) is 10 years. When the T_{MIN} is greater than 10 years, the maximum time for rebuilding must be equal to T_{MIN} plus one mean generation.

The discussion among the speakers, panelists, and public attending this session explored the challenges associated with the rebuilding mandates which resulted in recommendations to modify either the MSA, NS1 guidelines, or the science and process that supports decision-making. Discussions were focused on the available science, time-constrained rebuilding requirements, reference points that inform harvest policies, and the ability of the mandate to achieve recovery benefits to the stock and fishing communities.

Potential Legislative Changes: Are Changes Needed to Provide Greater Benefits to Stocks and Fishing Communities?

The 10-year rebuilding timeline was imposed based on general understanding that many stocks could build in that amount of time or less, but cannot accommodate all situations in which stocks need rebuilding. The 10-year rebuilding timeline is not supported by any documentation, analysis, or supporting rationale. In the scenarios presented in Figure 2 (a), a stock that can rebuild in the absence of fishing mortality in nine years is treated very differently from a stock which can rebuild in 11 years. Such a discontinuity can occur between two stocks that have different times to rebuild or for one stock when rebuilding analyses result in changes to T_{MAX}. The discontinuity combined with the uncertainties inherent in assessment and rebuilding trajectories results in an unstable management platform. The

1 One mean generation time is how long it takes, on average, for a sexually mature female fish to be replaced by offspring with the same spawning capacity.

proposal to invoke a continuous rebuilding policy where the 10-year rule is replaced with T_{MAX} equal to T_{MIN} plus one mean generation time gained recognition (Figure 2(b)), yet consensus was not reached among the speakers and panelists that a change within MSA was necessary.

The MSA requirement to rebuild in 10 years, if possible, is problematic for species with annual life cycles and other short-lived species. The NS1 guidelines provide an exemption to the annual catch limit (ACL) requirements for species with annual life cycles and also provide for flexibility in applying the guidelines for species with unusual life history characteristics. For example, few butterfish live to more than three years of age, so by the time a stock assessment is completed, all of the fish that were assessed are already dead. Consequently, any catch limit based on an assessment of the population may be meaningless. There was some support for providing an exception to the 10-year rebuilding mandate for species with annual life cycles and other short-lived species in MSA.

Some participants recommended removing the time-constrained rebuilding requirements. Rebuilding could then be achieved by setting the stock exploitation rates at values less than the fishing mortality rate that produces maximum sustainable yield (F_{MSY}). The rationale is that fishing at a rate of F_{MSY} prevents overfishing and, on average and over the long term, will rebuild stocks to B_{MSY}. Further, such a strategy would be expected to provide stability for fishing communities consistent with MSA mandates. This was hotly debated, with some suggesting such a policy may be ineffective at rebuilding stocks in a timely manner.

Some attendees said the existing MSA mandates provide sufficient flexibility for incorporating social and economic needs during rebuilding. They contend that the significant progress made in rebuilding overfished stocks is directly related to the strength of the MSA provisions, specifically the finite rebuilding time scales, and implementation by managers and harvesters. A recommendation was made to increase the minimum stock size threshold (MSST, aka the overfished threshold) to avoid lengthy rebuilding times, which would provide for a stronger economic climate. Further, some recommended establishing a target biomass, developed with ecosystem considerations, at a level higher than that expected to produce maximum sustainable yield (B_{MSY}). These attendees believe the key features of a successful rebuilding plan include finite rebuilding time scales, reducing F well below F_{MSY} especially early in the rebuilding program, an open and transparent process in establishing rebuilding plans, and a robust monitoring of rebuilding progress.

Several participants requested further clarification on the rebuilding requirement to rebuild as quickly as possible while taking into account social and economic factors. Application of this mandate has become particularly challenging in the West Coast, given a court decision that required the Pacific Council to avoid "disastrous short-term consequences for fishing communities" in applying the MSA rebuilding calculus. Some maintain that Congress did not intend to destroy communities in order to rebuild fish stocks, and further clarification of Congressional intent through the reauthorization process is necessary.

Discussions highlighted the challenge of achieving the optimum yield from the fishery when a stock in that fishery is managed under a restrictive rebuilding plan. That is, when an overfished species occurs in a mixed-stock fishery, access to target species may be constrained by the management measures necessary to rebuild an overfished stock. The NS1 guidelines provide an exception to the requirement to prevent overfishing under certain limited circumstances, which is known as the mixed-stock exception. The exception allows the harvesting of one stock at its optimum level to potentially result in limited overfishing of another stock when the two stocks are caught together. The interactions between the two stocks may occur when the stocks are targeted in the same fishery or when one stock is a bycatch species that is unavoidably caught. The mixed-stock exception could provide greater access to target species, especially for those fisheries already constrained by management restrictions under a rebuilding plan. Some felt, however, the NS1 criteria for applying the mixed-stock exception were too rigid and thus never applicable. Several individuals recommended refining and including a viable mixed-stock exception in the MSA.

Transboundary stocks, which are stocks that occur in the Exclusive Economic Zone (EEZ) of at least two countries, present further rebuilding challenges since Councils can only recommend measures that promote rebuilding in their jurisdiction. Similarly, the ability to invoke management measures necessary to rebuild a stock may be limited when the majority of the stock distribution occurs outside a Council's jurisdiction. For example, Pacific ocean perch (POP) has a wide distribution in the North Pacific from the Mexican state of Baja California around the Pacific rim to northern Japan, including the Bering Sea. The stock is most abundant in the Gulf of Alaska and in northern British Columbia, Canada. The portion of the POP stock that exists within the jurisdiction of the Pacific Council was declared overfished in 1999 and despite severe fishery restrictions the stock has not reached target biomass. Some believe the reductions in removals required by the rebuilding plan will never influence the stock status since the West Coast is the terminus of the population. In these instances, consideration for a rebuilding exception may be warranted.

There was general agreement that stocks which are later determined to have never been overfished should no longer be subject to the MSA rebuilding requirements. For example, in 2000, a stock assessment indicated that the widow rockfish biomass on the West Coast was below the MSST. Accordingly, the stock was declared overfished and a rebuilding plan implemented. However, subsequent assessments in 2005 and 2007 estimated that the biomass had never dropped below the MSST and thus the stock had never been overfished. Despite the best available science, MSA provisions required the fishery to remain under the restrictive rebuilding plan until 2011 when the stock reached target biomass.

Some recommended that the term "overfished" in MSA be replaced with "depleted," since stock status may not be due to excessive fishing. That is, changing environmental conditions may be responsible for a stock dropping below the MSST. The example provided was the Pribilof Islands blue king crab, where the stock has not been subject to fishing mortality (other than minor amounts as bycatch) or habitat impacts for nearly 20 years, and the stock continues to decline.

Recommendations were also made to redesign or remove the maximum sustainable yield (MSY) concept in MSA. Some thought changes were necessary to align with the ecological principle of competitive exclusion, which recognizes that not all stocks can be at B_{MSY} at the same time. Further, some commented that the concept of MSY is unrealistic and alternative harvest targets should be explored (e.g., "pretty good yield" or a sustainable yield ≤ 80% of MSY).

The MSA currently requires a secretarial review every two years to determine whether adequate progress is being achieved to end overfishing and rebuild affected stocks. Dr. Punt demonstrated the wide range of interpretations regarding the review requirements in the North Pacific and Pacific Councils. Some believed a standardized review process, developed through changes to the NS1 guidelines, would be beneficial. Others believed each Council should be responsible for developing their own review processes. Participants also reviewed the challenge that occurs when new science results in minor changes in the estimated probability (to below 50 percent) to rebuild a stock by the estimated target rebuilding year. Some believed that under these circumstances, the MSA should provide a mechanism for maintaining the existing rebuilding plan.

Additional Findings: Are Changes to the Science and Process Necessary?

The speakers, panelists, and other attendees acknowledged the wide range of funding and support necessary to implement MSA provisions across the United States. There was overarching agreement to increase data quality, as well as the frequency and number of stock assessments and rebuilding analyses. More frequent assessments and better understanding of stock abundance leads to a faster management response and long-term stability for harvesters. Timeliness of information is particularly important because of the uncertainty inherent in predicting recruitment.

Incorporating ecosystem dynamics into stock assessment and rebuilding platforms was also recommended, recognizing the limitations of science. The choice of management reference points should be informed by the dynamics of the ecosystem.

A management strategy evaluation should also be used to evaluate various harvest control rules and rebuilding approaches to help inform the MSA calculus of shortest time to rebuild while taking into account the various socioeconomic and ecological factors. Such evaluations should also include mixed stock analyses to inform how the rebuilding species limits access to target species.

Further, by their nature, assessments and rebuilding projections will always be uncertain. Some felt strongly that Councils should refrain from adjusting policies in response to modest changes in stock status. Many supported the concept of managing to the rebuilding signal instead of chasing the noise resulting from the variance in estimated parameters. Scientists should also be encouraged to develop smoothing strategies to accommodate such variance and provide stability for harvesters.

Several participants noted that preventing a stock from reaching the MSST was the preferred approach. To that end, it was recommended that harvest control rules be developed that incorporate rebuilding provisions. In other words, when a stock declines below target levels, there is a proportional reduction in the harvest rate applied. Early reductions in catch necessary to maintain or rebuild stock size should increase the probability of success.

Finally, some requested a periodic review of allocations to evaluate whether rebuilding restrictions and recovery benefits are fairly and equally shared among sectors of a fishery. In particular, representatives from the recreational sector believe they are unfairly burdened by rebuilding requirements and request the Councils conduct a formal review of the existing allocations. Further, they thought the review should occur expeditiously given the increase of commercial catch share programs which require formal allocations between sectors.

SHARK FIN FISHING BOAT, GALAPAGOS, ECUADOR. PHOTO: PAUL STEIN, FLICKR CREATIVE COMMONS.

PAPERS

Session 1
Improving Fishery Management Essentials

Topic 3
International Fisheries Management: Leveling the Playing Field

LEVELING THE PLAYING FIELD? IT'S (TOO) COMPLICATED: SEAN MARTIN AND SVEIN FOUGNER

GOVERNMENT PERSPECTIVE ON ACHIEVING CONSERVATION GOALS IN REGIONAL FISHERIES MANAGEMENT ORGANIZATION FORUMS WHILE ALSO ACHIEVING EQUITY BETWEEN U.S. AND FOREIGN SEAFOOD PRODUCTION SECTORS: RUSSELL SMITH AND ELIZABETH MCLANAHAN

Leveling the Playing Field? It's (Too) Complicated

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Abstract

The Hawaii Longline Association view is that the dream of a "level playing field" is just that—a dream. It sounds good, but at least in the western Pacific, it will not happen (at least, not soon), and it probably does not make a lot of sense to spend a lot of resources trying to achieve it. It's simply too complicated. The variability of the Western and Central Pacific Fisheries Commission membership (size, economic conditions, fishery development priorities and aspirations, values, laws, management resources, etc.) is such that it is impossible to bring everyone up to the same level; and it is not reasonable to expect that we could. The intersection of international and domestic management also results in complications. This paper identifies several things that can be done to help minimize or mitigate the difficulties from the lack of a level playing field and make conditions more favorable for U.S. fishing interests, which operate in an international multispecies fishery over a huge ocean.

Introduction

The theme of this session is "Leveling the Playing Field."

We would like to address three questions:

- What does "Leveling the Playing Field" really mean?
- Does it make sense to spend a lot of resources chasing a level playing field?
- What are likely the most useful approaches if it is concluded that a level playing field is not achievable?

My answers are "it's not clear," "no, not a lot," and "there are several things we can do to lessen the difficulty due to the uneven playing field." And one of the prime things in our view would be to shift from a "punitive" view (force full compliance or else) to a "positive view" (reward demonstrated good performance under management measures such as allocations of quota).

The Fisheries Context

The Hawaii longline fishery is the largest and most valuable fishery in Hawaii. Total fishery landings in 2011 were nearly 12,000 mt valued at about $76 million ex-vessel (NMFS 2012). Bigeye tuna is the most valuable component of the fishery, but the fishery also lands significant amounts of other tunas, mahimahi (dolphinfish), wahoo, and swordfish. The fishery accounts for almost all the fresh tuna (9,300 mt) and associated species available to the Hawaii market. The fishery only lands fresh fish; the vessels do not have freezer capacity. The vessels go out on relatively short trips—15-25 days depending on catches and markets. The fishery has been evaluated against the United Nations Food and Agriculture Organization Code of Conduct for Responsible Fisheries criteria for sustainability with a score of 94. It is also responsible for a large number of jobs in the fishery and in support industries as well as in local retail and tourism markets. All the fishing occurs either in the exclusive economic zone (EEZ) or the adjacent high seas. No fishing occurs in any other country's EEZ. It is an island-based domestic fishery, and we think it is representative of the kind of island-based domestic fisheries that the Pacific Island countries want to develop for their own people. However, in the Western and Central Pacific Fisheries Commission (WCPFC), the Hawaii fishery is looked at as a distant water fishery, like the Asian fleets, and is not supported as an island fishery, even if the fishery probably represents the kind of well-managed and fully monitored fishery that all should seek to achieve. Cutbacks in the Hawaii fishery mean very little in terms of conservation of bigeye tuna, a key species. The fishery is probably the most comprehensively regulated fishery in the Pacific including -

- limited entry (164 permits) with a maximum vessel size (101 ft)
- logbooks
- observers (20% on tuna trips, 100% on swordfish trips)
- automated vessel monitoring system (first in the U.S.)
- area closures to protect nearshore fisheries and false killer whales
- area closures to protect northwestern Hawaiian Island resources (e.g., Hawaiian monk seal)
- circle hook and mackerel style bait requirements to protect sea turtles (in addition to handling and release gear and procedural requirements)
- measures to mitigate interactions with seabirds
- "weak hook" requirement to mitigate interactions with false killer whales
- separate bigeye catch limits for the Inter-American Tropical Tuna Commission and WCPFC areas

The importance of the regional fisheries management organizations (RFMOs) is clear when you consider the overall size and value of the tuna fisheries in the Pacific. The Western Pacific catch of tuna in 2011 was about 2,250,000 mt (down from the record catch of almost 2,550,000 mt in 2009), with an estimated ex-vessel value of almost $5.5 billion. In the eastern Pacific, the catch of tuna was about 570,000 mt with an estimated value of more than $1 billion. This is big bucks! Converted to wholesale value of processed or semi-processed fish and fish products, the value is probably many times higher. Tuna are the principal resource of value to most of the Pacific Island countries. Most of them have few land and mineral resources. They have lots of ocean area in their respective EEZs, but they don't have significant domestic commercial fisheries, so they get funds from issuing licenses (such as under the U.S. tuna treaty and other arrangements with Japan, Korea, China and so on). Ironically, one or two nations (such as Papua New Guinea) actually have complained about having too many foreign vessels in their waters—and then proceed to issue more licenses for foreign vessels. At the same time, there was early agreement on the need to curtail the growth of the fleets—especially the purse seine fleet—but capacity has continued to grow, and purse seine effort reached an all time high in 2011. New vessels are still being built for the fishery. There is also a cultural aspect. Most industry watchers heard or read about the single bluefin tuna that sold for more than $1.5 million in Japan. While that is an outlier, it speaks to the particular importance that tuna play in some cultures.

In addition, there is a political element. In the western and central Pacific, many of the island nations are essentially saying that the tuna in their waters, even if part of a stock ranging across and migrating across many boundaries, are "their" fish when the fish are in their EEZ. The Convention states "Conservation and management measures under this Convention shall be applied throughout the range of the stocks, or to specific areas within the Convention Area, as determined by the Commission." However, some members assert that they are in charge of saying who can and can't fish and how much they may catch in those members' waters and that the measures adopted by the Commission must be compatible with the management measures of those islands, and not the other way around. They also exempt internal and archipelagic fisheries from the measures of the Commission. Further, the island countries have formed other organizations (Forum Fisheries Agency, Parties to the Nauru Agreement, etc.) that develop coordinated positions and maintain solid "voting" blocks (that is, all hold the same positions) on virtually all issues, even if their separate interests do not always coincide. In short, it's complicated.

Meanwhile, the U.S. (including its territories, American Samoa, Guam, and the Northern Mariana Islands) catch of tuna in the western Pacific is estimated to have been about 219,000 mt in 2011, most of which was by the U.S. distant water purse seine fishery; the U.S. tuna catch in the eastern Pacific was about 14,000 mt, primarily troll caught north Pacific albacore tuna. The total longline catch of bigeye tuna in the WCPFC was about 4,000 mt taken principally by the Hawaii longline fishery, and total U.S. longline bigeye catch in the Pacific was about 5,300 mt. These are not huge numbers, but they are very important to the U.S. The Pacific remains the biggest source of U.S. caught tuna, and without the U.S. fisheries' presence, it would be hard for the U.S. to be taken seriously in the discussions.

The Questions

Question 1: What is a "Level Playing Field"?

It is common to hear representatives of the U.S. tuna fishing industries express the view that the playing field is not level. The U.S. is almost always well out in front of other nations in carrying out regulatory measures agreed to by the RFMOs. The U.S. is exceptionally strong in implementing and enforcing regulations, whatever their origin. The U.S. wants to be a leader in the international arena, and this is commendable. On top of that, the U.S. fisheries regulated under the tuna RFMOs are also regulated under domestic law—the Magnuson Stevens Act, the Western Pacific Fisheries Commission Implementation Act, and other applicable law (Endangered Species Act [ESA], the Marine Mammal Protection Act [MMPA], National Environmental Policy Act [NEPA], Administrative Procedure Act [APA], Executive Orders)—and the scope and stringency of these regulations often go beyond the rules adopted in the international arena, and again, enforcement is very strong. Note that the U.S. laws apply not only in the U.S. EEZ but also on the high seas. However, this often puts the U.S. fisheries at a serious disadvantage relative to their international counterparts. If a U.S. vessel gets caught breaking the rules, it may be out of business. But in other countries, there may not even be an effort to get their vessels to follow the rules, much less any teeth in the enforcement or penalties for violating the rules. The WCPFC largely is unwilling to force its members to demonstrate full compliance with WCPFC decisions. There is no WCPFC sanction for failure to comply with the measures adopted by the RFMOs. U.S. fishermen are fully compliant at high costs, while others may be less than fully compliant with less cost and less risk of losses. In that context, leveling the playing field might mean getting all the players to achieve the same level of implementation and enforcement of comparable regulations so that the measures agreed to can be effective to the same degree for all fishermen and markets. That seems to be the primary theme of the National Marine Fisheries Service (NMFS) report on Section 403(a) of the Magnuson-Stevens Act (NMFS 2013). In principle, we support this goal, and we appreciate the diligence of the U.S. government. All should be held accountable to a common standard. It can be very frustrating to see that compliant folks rarely get rewarded, while non-compliant folks rarely get punished. It is definitely an uneven playing field in this regard.

But it's more complicated than just ensuring full compliance by all members of the RFMOs or even narrowing the differences in the scope of regulations between domestic and internationally agreed to measures. While the Hawaii Longline Association is firmly committed to the proposition that international management of highly migratory fish stocks (or more precisely the fisheries for them) is critical, it is not clear that a "level playing field" is anything other than a dream world in the international arena. In fact, it may not make much sense to try to clearly define the issue in these terms, much less try to resolve it. While we can imagine such a world, it is unlikely to become a reality, for many reasons.

What might be the characteristics of an "ideal" international system with a level playing field?

We would suggest the following as a start:

- All members of RFMOs have common goals, including such elements as target and limit reference points for tuna stocks, and are committed to abiding by them
- All members have solid information that is commonly agreed to represent the best information available and are committed to full consideration of the scientific advice they receive from staff or scientific advisors who have solid credentials and integrity
- All members share common principles or criteria for determining fair and equitable allocations and effective and efficient management
- All members have a common commitment to strong and effective monitoring, compliance and enforcement, have comparable capacity to carry out that commitment, and will fully evaluate and assess their compliance
- Bordering RFMOs would be committed to working together on common problems in open and collaborative ways and conflicts would not arise between international measures across RFMO boundaries

But even if these criteria were met, it doesn't solve the whole problem of "leveling the playing field" for U.S. tuna fisheries because U.S. fishers also face U.S. regulations under domestic law, regulations that often go beyond or may even somehow conflict with international measures (e.g., vessel marking rules). And the processes for developing and implementing actual regulations—even those arising from international agreements and commitments—are time consuming and loaded with paperwork. Between the Magnuson-Stevens Act, the ESA, the MMPA, NEPA, APA, and Executive Orders, we often seem stuck in a regulatory swamp. As we all know, the domestic fisheries management world is complicated.

Question 2: Can a Level Playing Field be Achieved?

THE INSTITUTIONAL CONTEXT

In the Pacific, the U.S. is a party to two tuna RFMOs and there are three fishery management Councils (Western Pacific, Pacific, and North Pacific) with actual or potential interests in highly migratory species.

THE RFMOS

One RFMO is the WCPFC, which has 25 members and eight "participating territories" (generally island territories with some degree of local authority for fisheries management, including Guam, American Samoa, and the Northern Mariana Islands). The other is the Inter-American Tropical Tuna Commission, the oldest of the tuna RFMOs, established in 1949. It has 21 members (including the European Union as a single member). The RFMOs have comparable conventions which contain various goals and objectives in their conventions and ostensibly are committed to maintaining tuna stocks at or above maximum sustainable yield levels. Several nations or fishing entities are members of both RFMOs, which suggests there should be a common basis for cooperation, but this is not always the case. For example, there is an overlap area which is in the area of competence of both commissions, and the members of the two commissions do not always see the management situation and alternatives the same way. As you can imagine, this causes complications as vessels may be subject to two different sets of regulations in the same waters. It is difficult to say who is in charge when both are in charge of the same waters.

The RFMOs share certain difficult challenges:

- the problem of obtaining agreement among numerous members with vastly different geographic and population levels (in the WCPFC, members are as large as the U.S. [9.8 million sq. km., population over 313 million] and as small as Tuvalu [area 28 sq. km., population about 10,000]) (CIA 2014), different degrees of economic development, different resource bases, different priorities for their fisheries, and different laws and cultures that may facilitate—or impede—development of their fisheries or implementation of fishery regulations or programs to protect non-fish species

- the problem of achieving fair and equitable apportionment of fishing rights or opportunities among a variety of fishing gears (in both cases the orientation is almost exclusively toward commercial fisheries), each of which has different fishing strategies and impacts but all of which seem to be competing in some degree for the available fish, and among coastal states and distant water fishing nations with differing goals and aspirations
- the problem of minimizing or mitigating bycatch of sharks and takes of non-fish species such as sea turtles, seabirds, and marine mammals

- the problem of obtaining and verifying fisheries data
- the problem of ensuring compliance through full monitoring, control and surveillance programs and true evaluations of compliance or sanctions for non-compliance

As if international negotiations weren't complex already, adding to this the difficulty is the occasional personality conflict that shows up between heads of delegation of two or more nations that prevents consensus even if there is strong overall support for a particular measure. The result is that conservation decisions are either deferred or weakened to achieve some compromise that saves face, and there is at best uneven compliance. It's complicated.

And as for implementation, consider the following: the WCPFC membership includes countries like Tuvalu, Samoa, the Marshall Islands, and Fiji. We can think of these countries in romantic terms like "beautiful South Pacific beaches" and "tropical islands," which might be correct in one sense. But it's a reality that they are also among the poorer places in the world (CIA 2014). Most of them have per capita gross domestic products (GDPs) that are less than 10 percent of the per capita GDP of the U.S. For example, Tuvalu (just a bit north of Fiji) has a per capita GDP of $3,300, and that is largely due to aid from foreign governments and its share of license revenues from foreign fishing access agreements. There are no substantial domestic fisheries. Yet, Tuvalu (like the other island countries) has the same decision power within the WCPFC and, at least on paper, has the same responsibilities as all other members to comply with all measures of the WCPFC. This includes collecting and providing data on the fisheries (not a significant problem with few tuna fisheries) and policing and enforcing the rules of the WCPFC in its EEZ, which is very large. Is it reasonable to expect Tuvalu to be doing the same degree of monitoring, control and surveillance in its EEZ and on the high seas as is achieved by major nations such as the U.S.? That's what a level playing field would suggest; but it's beyond the ability of many of these island nations to carry out. And it does not make sense to even try to push them; they simply can't do it. They need others to do it. It's complicated.

THE REGIONAL FISHERY MANAGEMENT COUNCILS

Of the three Regional Fishery Management Councils in the Pacific, two now have direct interests in the tuna fisheries: the Western Pacific Council, which manages not only the Hawaii longline fishery (targets bigeye tuna and swordfish) but also the longline fishery of American Samoa (targets South Pacific albacore); and the Pacific Council, where the U.S. troll albacore fishery is based and where there is still a gillnet fishery for swordfish and sharks. Neither Council exercises significant governance of the U.S. purse seine fishery for tuna, which largely operates in the western Pacific under a treaty with Pacific Island nations, though the Western Pacific Council has established certain large vessel area closures to protect local fisheries. Both the Western Pacific and Pacific Councils have fishery management plans for the fisheries for tuna and other highly migratory species (under the term pelagics in the Western Pacific Council). The North Pacific Council has minimal interest in highly migratory species to this point (though perhaps global warming will result in tuna moving ever farther north). The two fishery management plans (FMPs) are different, reflecting the different status of HMS fisheries in the two regions; but there are no overt conflicts between the measures that cause major problems between the respective Councils. NMFS and the Coast Guard have comparable resources in the two regions. However, the capabilities of the states and territories are very different—state programs in the Pacific Council area are relatively strong, while the program in the state of Hawaii is middle strength and the programs in Guam, American Samoa and the Northern Mariana Islands are very limited, in part because the U.S. has not seen fit to endow them with all the powers of a state. So even domestic management gets complicated.

The set of regulations that the Hawaii longline fishery is subject to was listed previously. Again, it probably is the most comprehensively regulated longline fishery in the Pacific if not the world. The U.S. purse seine fishery is not quite as comprehensively regulated, but there are fleet size limits under the South Pacific Tuna Treaty; 100 percent observer and vessel monitoring system requirements, sea turtle protection requirements, and a seasonal closure of the fish aggregating device purse seine fishery under the WCPFC; area closures around U.S. territories under the Western Pacific Council's FMP; and of course the long-standing controls on purse seine fishing on dolphins in the eastern Pacific. Again, the U.S. enforcement program is vigorous. The U.S. also has a troll fishery for north Pacific albacore, based on the West Coast. Most of the fishery occurs in the eastern Pacific Ocean (EPO), but both commissions have agreed to conservation measures for this fishery. However, there are no specific controls under those measures such as specific quantitative catch or effort limits. There are domestic permit and reporting requirements under the Pacific Council FMP and State laws.

The Hawaii Longline Association has worked closely with the Western Pacific Council for many years (the current longline fishery really only developed in Hawaii in the early 1990s). Several Association members have served as Council members and Council advisors. The Association has worked closely with the Council on a strong management and monitoring regime for the fishery, and the Council has actively sought our advice and information. The Hawaii Longline Association also has worked with NMFS in many ways, including providing vessels to support at-sea research, such as the trials that demonstrated the effectiveness of seabird avoidance techniques, and the "model fishery" (based on the Atlantic longline fishery trials) using circle hooks and mackerel-style bait to mitigate sea turtle interactions when fishing for swordfish. Implementing new gear and techniques have resulted in 98% reductions in estimated mortalities of sea turtles and seabirds. We are proud of our accomplishments in the domestic arena. We also are painfully aware of the challenges of dealing with Federal paperwork requirements for implementing regulations, and even more of trying to understand and deal with the vicious attacks of some environmental organizations even as we have achieved those fantastic reductions in sea turtle and seabird mortality. It makes us realize the frustration that the tuna industry must feel in the eastern Pacific, where a 98% reduction in dolphin mortality has not been enough to resolve the issue for some non-governmental organizations. And here is the crux of another aspect of the "uneven playing field." No matter how well we do in promoting "good" behavior by all members of the RFMOs, it won't deflect the attacks of those to whom any fishery that takes any non-fish species is a fishery that can't be tolerated. Unfortunately, there may even be some government employees who feel the same way.

So, again, even just working in the domestic arena: It's *complicated*.

For the U.S., an added complication arises in that the U.S. territories (American Samoa, Guam, Northern Mariana Islands) are designated as "Participating Territories" in the WCPFC. As such, they get seats at the commission table separate from the seat for the U.S. They don't have the power of a full member—they can't block a measure or vote in the rare event a vote were taken—but they have the full power to speak on behalf of their own interests. They are assigned separate fishing rights for bigeye tuna in longline fisheries from the allocation to the U.S. In the highly migratory species world, however, as bigeye tuna are within the management unit of the Pelagics FMP (now a Fishery Ecosystem Plan) of the Western Pacific Council, none of the territories has independent authority that is afforded to other full WCPFC members to enter into an arrangement that would allow some of that quota allocation to be made available to other U.S. interests in the event that territory fishers don't have the capability to catch the quota. Such an arrangement was in place in 2011 and 2012 under a special provision of U.S. law that has now expired. It was of benefit to both American Samoa and the members of the Hawaii Longline Association. However, now it will take an amendment to the FMP to allow that to happen. This is a real-world demonstration of the difficulty that can arise in the intersection of international and domestic fisheries management.

Which brings us to the conclusion regarding the feasibility of a "level playing field." Basically, it sounds good to profess that the U.S. is seeking a "level playing field," and we can't object to it, but in reality it can't be done. It is unrealistic to think that we can get all members of all RFMOs to the same point; the U.S. can't seem to force full and transparent implementation of measures and honest evaluations of compliance. The U.S. can't impose its values and laws and processes on other nations who have different values and laws, even if the RFMO conventions would seem to require it. We can't seem even to get the commissions to adopt strong tuna stock conservation measures that provide stability and predictability in management. This is compounded by the complexity of harmonizing in a time-effective and organizationally smooth manner international and domestic management.

Question 3: What are Likely the Most Useful Approaches if it is Concluded that a Level Playing Field is Not Achievable?

First, we think we need to take a more positive approach. We (that is, industry and others) could work with the Government and U.S. delegations to the RFMOs to push for management strategies that *reward* good behavior and that discourage bad behavior. The U.S. government is a model in implementation, and U.S. fisheries are largely models in compliance. The U.S. should promote actions by the RFMOs that provide greater fishing opportunity when there is a clear record of greater compliance. Effective fishery management is better served by developing a strong, robust, sustainable management regime that isn't looked at as another nail in the coffin of fishing but that supports economically healthy fisheries. This might provide a basis for RFMOs to strongly support their members in developing comprehensive regulatory programs with full monitoring and compliance elements so that members can demonstrate a high level of performance, and the commissions can have a basis for making decisions (such as allocations of fishing opportunities or catch quotas or otherwise) that recognize and reward good compliance. The carrot needs to be used more frequently than the stick. To this end, perhaps the U.S. Government could establish a special fund to support RFMOs in their efforts to develop such reward systems. This doesn't mean we don't endorse moving steadily closer to a fully level playing field; it is simply an acknowledgement that we recognize that all do not now have the same compliance and enforcement strengths and capabilities, that all do not now have the same ability to collect and provide fishery and scientific data, that all do not now have the same scope of measures to protect non-fish taken in the fisheries. We would hope that the positive examples shown by the U.S. and its fisheries would be recognized and promoted in the commissions. We also know that allocation decisions are very difficult when it comes to balancing different members' priorities and capabilities and different fishing gears and strategies. However, a greater focus on rewards could possibly result in a less confrontational atmosphere and better receptiveness for U.S. proposals. We know that U.S. negotiators support U.S. interests, but it would be encouraging if the U.S. would keep reminding RFMO members that the U.S. fishermen are responsible, law abiding and sincerely interested in making the RFMOs' management decisions work to conserve the stocks in perpetuity, and that their commitment and compliance warrants positive recognition by the commissions.

A second thought is to really focus on one of the driving forces that result in overall tension and animosity and distracts from possible common good outcomes. Too often, there are one or two members of the WCPFC that are directly confrontational and accusatory rather than being constructive. These members accuse the WCPFC of making decisions that actually violate the convention, though this accusation is rarely backed up by facts and logic. This kind of behavior needs to be put to the challenge: Put up or shut up! Right now, it seems as if the accusers get away with this "bullying" approach; as no other member overtly and publicly counters the charge, then it can take a life of its own. This has to stop. Diplomacy does not work when one party gets to bluster on and on with misstatements, while others silently sit by. It is not in the interest of the Commission or the member nations to let this bullying practice continue. The U.S. should challenge it.

Along the same lines, the U.S. and others should challenge those members who are almost certainly disregarding the controls of the WCPFC. There is a real lack of transparency in the reports and data being provided by one member in particular: China. Nobody really knows how many Chinese vessels are active in the WCPFC area, how much they fish and how much they catch of different species, how much bycatch they have, how many turtles or seabirds are killed, and so forth. We suspect that China has arrangements for access to other members' fishing grounds, but we never learn how much is caught under those arrangements and to whom the catch is attributable. The WCPFC has been trying to get clarity about charters and joint ventures and licensing agreements for years with no real success. Both the WCPFC and Inter-American Tropical Tuna Commission have large numbers of longline vessels on their registers with Asian names, but there is no ability to match those names with records of catch by species. At the same time, the Hawaii longline fishery is subject to virtually real-time monitoring and the fishery is closed before the end of the year if the quota is projected to be reached before the end of the year—sometimes even before the quota is reached. It appears that other countries do not even attempt to monitor their fleets in season. The U.S. knows this is a major problem. But the U.S. seems reluctant to ask the difficult questions that some members may not want to hear or discuss. There is no significant use or attempted use of "peer pressure" to try to force more complete and accurate reporting. The Hawaii Longline Association thinks the U.S. is simply too "nice" in this regard.

Another thought is that we must not lose sight of the "transfer effects" that may result from excessive control of one fishery or fleet. The Hawaii fishery faces stiff market competition from foreign sources, and when the fishery is closed down, the fishery may have a hard time regaining its place in the market. Hawaii Longline Association-funded or -supported research has demonstrated clearly that, if the Hawaii longline fishery were closed down to eliminate sea turtle takes, it would simply open the market to imports from nations with fleets that are *not* subject to the kinds of sea turtle protection measures that the U.S. fleet must follow. It simply is counterproductive to the resources of concern to impose regulations that close down a regulated and monitored fishery with minimal impacts if that opens the door to expanded fishing by fleets that are not regulated and monitored. This phenomenon is not limited to longline caught fish or even just fishing; it can arise in multiple industries. For example, if the U.S. effectively curtails an industry due to pollution controls, that industry may simply shift to a place with less stringent controls. The U.S. is increasingly stressing the need to consider "global warming" but this global context should be part of the calculus in the fisheries arena as well. This is a point that needs to be made in the RFMOs; if they want effective control, they must have effectively implemented measures that are applicable to all fishing in the range of the stocks.

On a less dramatic note, some other actions worth considering because they might reduce the difficulties of the uneven playing field are:

- Seek consistency between measures of different RFMOs dealing with common problems (it not clear at this point if the Kobe process has really made much progress in this regard)
- Seek consistency between RFMOs and U.S. Councils' FMPs with respect to management measures
- Achieve better cross-RFMO management planning and data collection/analysis
- Take administrative steps or amend the Magnuson-Stevens Act if necessary to provide fast-track rulemaking authority for RFMO actions and a smooth transition process to make rules consistent between FMPs and RFMOs
- Take action to provide U.S. Participating Territories with greater fishery management decisions in concert with FMPs and WCPFC actions
- Ensure strong constituency involvement in rulemaking for discretionary actions (some RFMO actions are not discretionary—once agreed to they must be implemented)

- Support strong NMFS science involvement in the RFMOs (including support for and participation in research and stock assessments) to ensure that the best scientific information is being used in an appropriate manner and to provide advice to the U.S. delegations and advisory groups about the strengths and weaknesses of that scientific information in advance of advisory committee meetings

- Undertake proactive efforts by Government to engage industry in developing and evaluating alternative management approaches that provide greater flexibility as well as stability and predictability in management at the RFMO level as well as domestically

- Start earlier in development of draft Government positions in the periods between meetings of RFMOs so that advisory committees are not simply relegated to a last minute review/reaction mode (assuming that even draft U.S. positions have been worked out by the time advisors meet)

- Make a stronger push for RFMO adoption of non-fish stock protective measures comparable to U.S. measures, or acceptance by Government that RFMO controls are sufficient so that U.S. fisheries are not at a competitive disadvantage (e.g., observers—U.S. accepts five percent in RFMOs for longline, why not accept five percent for U.S. domestic controls?)[1]

At this point, it is not clear if legislation is needed; it may be that internal administrative actions could be taken that would focus on making the regulatory process less burdensome and more efficient. We recognize the need for science-based and logical decisions; we recognize the need for clear documentation to support decisions where there are substantial choices to be made between options; we recognize that there is "other applicable law" that needs to be followed. But let's get out of the trap of thinking that more paper is better paper. At some point, more paper is simply more paper.

In closing, we say again "it's not clear" what a level playing field is, but if it means all parties and fishers playing by the same rules in all waters, then "no," it is not reasonable to spend a lot of energy pursuing it, but that "there are several things we can do to lessen the difficulty due to the uneven playing field." And we should start with shifting from a "punitive" view (force full compliance or else) to a "positive view" (recognize and reward demonstrated good performance under management measures such as allocations of quota).

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1 It is encouraging that NMFS is so interested in taking the lead internationally with respect to IUU and takes of Protected Living Marine Resources—though it is not clear that there has been great progress in the RFMOs or that it would make much difference to them.

Government Perspective on Achieving Conservation Goals in Regional Fisheries Management Organization Forums While Also Achieving Equity Between U.S. and Foreign Seafood Production Sectors

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Overview: Importance of International Fisheries Management

Ensuring the sustainable management of both domestic and global fisheries is very important to the United States. Seafood is increasingly recognized as an important component of a healthy diet and is a significant source of protein for many Americans. Fishing is a vital source of employment for our coastal communities. Fishing does not just support fishermen; fishing supports many related industries including fish auctions, fish processors, fish exporters, and fishing equipment repair and sales. However, our fisheries cannot and will not provide an endless bounty. We have an obligation, to consumers, the fishing industry, coastal communities and our future generations to manage our fisheries sustainably so that our oceans will continue to be a reliable source of food, employment and important ecosystem services. We have an obligation to ensure that the oceans support healthy, functioning ecosystems.

Sustainable fisheries management begins by developing a foundation of science and then managing based on that science. We must collect information about the fishery and its ecosystem, and then use that information to create scientific advice about how to manage the fishery with the goal of long-term sustainability. That advice must then be translated into ecosystem-based management measures, including provisions for education and enforcement. Management measures must be fully implemented. Finally, continuous monitoring of the fishery is necessary to evaluate the success of the adopted management program so that it can be revised, if necessary.

The United States has been successful in implementing this management cycle domestically. Under Magnuson-Stevens we have turned the corner on overfishing in U.S. fisheries. While we have more work to do, we are on the right path. We are working assiduously to ensure global fisheries are also on the same path. America's reliance on the global trade of seafood gives us a strong interest in ensuring the sustainable management of all global fisheries. In 2011, the United States imported more than 90 percent of our seafood. Our consumer demand for seafood is dependent on the health of global stocks. Not only do we have a strong interest in the sustainable management of global fisheries, but also in the effective enforcement of those management measures. The United States exported a total of $5.13 billion dollars in edible seafood in 2011. This trade depends on fair access for our fishermen, processors and exporters to the global market. Competing against seafood that has been harvested illegally undermines fair access for U.S.

caught and processed product to the global market.

Role of Regional Fisheries Management Organizations in Managing International Fisheries

Regional fisheries management organizations (RFMOs) are the primary regulatory bodies for international fisheries management and are responsible for the long-term conservation and sustainable management of a large portion of global fishery resources. Bringing together flag States of distant water fishing fleets and coastal States, RFMOs govern fisheries that target straddling or shared stocks between zones of national jurisdiction, between these zones and the high seas, or exclusively on the high seas.

Each of the RFMOs generally takes the same approach to the management of the fisheries for which they are responsible. That approach is very similar to the domestic process outlined above. They collect data about the fisheries under their jurisdiction. That data is provided to one or more scientific bodies for the purpose of scientific analysis and the development of recommendations on how the fishery should be managed to obtain maximum sustainable yield. Scientific analysis may include stock, bycatch and ecological risk assessments. These recommendations are, in turn, provided to a management body that is responsible for adopting and implementing, among other things, conservation and management measures that will ensure the sustainable management of the fishery.

Typically, RFMOs adopt three types of measures:

- Fishing limits, such as total allowable catches, capacity limits, and the location of fishing activities;
- Technical measures, including gear restrictions and catch documentation requirements; and
- Monitoring, control, and surveillance measures.

All navigable high seas areas of the ocean are covered by an RFMO- from the Northern reaches of the Atlantic and the Pacific to the Antarctic. RFMOs are often broken down into two categories, those that manage tuna and tuna-like species, and those managing demersal fisheries. All high seas tuna fisheries are managed internationally. For demersal stocks, two new RFMOs were recently formed in the Pacific, leaving only high seas areas within the Southwest Atlantic and Indian Oceans without an international management scheme. Most areas of the ocean are managed by more than one RFMO (for example, one that focuses on tuna and another that focuses on demersal stocks), but there are instances where the same stock is managed by more than one RFMO. Both situations create challenges for effective management, particularly with regard to ecosystem and bycatch issues.

There was a time when RFMOs saw their role as narrowly focused on the regulation of a particular species or group of species. However, more and more RFMOs are recognizing that in order to fulfill their mandate they must also manage impacts from fisheries on non-target stocks, protected species and the surrounding ecosystems. As the mandates of RFMOs expand, so does the need for more comprehensive and ecosystem-based scientific knowledge. In some RFMOs, the institutional changes necessary to support revised mandates have been slow. Nevertheless, over the past few years RFMOs have begun to adopt management measures to address ecosystem impacts of fishing, such as measures to protect sea turtles, sea birds, and vulnerable habitats.

The greatest challenge to the success of these RFMOs, however, is not updating their conventions or overlapping jurisdictions. The greatest challenge is overcoming political inaction. Member States often have dueling goals when they attend RFMO meetings: ensuring their fishermen obtain their greatest allocation for their fishermen while balancing the need for long term sustainability of fisheries resources. For far too long, some nations have focused on their short term gains, deferring their long-term needs. The United States has and continues to play a key role in the evolution towards sustainable management for our global fisheries.

U.S. Engagement in Regional Fisheries Management Organizations

The United States is a member of ten RFMOs, as well as numerous regional advisory and scientific bodies. U.S. membership in these organizations reflects a strong U.S. economic and conservation interests in the management of each of these fisheries. The United States is a member of the International Commission for the Conservation of Atlantic Tuna, the Inter-American Tropical Tuna Commission and the Western and Central Pacific Fisheries Commission all of which manage tunas. The United States is also a member of the North West Atlantic Fisheries Organization, the Convention for the Conservation of Antarctic Marine Living Resources, the North Pacific Anadromous Fish Commission, the Pacific Salmon Commission, the International Pacific Halibut Commission and the regime created under the Convention on the conservation and Management of Pollock Resources in the Central Bering Sea which manage demersal stocks. Finally, the United States is a member of the Agreement on the International Dolphin Conservation Program which focuses on dolphin conservation and ecosystem management in the Eastern Tropical Pacific Ocean. The United States recently signed the agreements creating the new RFMOs in the North and South Pacific and is awaiting Senate ratification and the passage of implementing legislation in order to become a full member of these organizations.

Industry and other stakeholder engagement are integral to U.S. participation in the RFMO process. For almost every RFMO in which we participate, the United States works with stakeholders on the development of U.S. positions. Industry cooperation is vital to the full implementation of management measures within RFMOs. More importantly, U.S. industry serves as an example for other nations on how they can participate in the successful management of their fisheries. At these RFMO meetings, the United States speaks to the effectiveness of our fisheries regulations, as well as the importance of collaboration between industry and environmental groups, all leading to a sustainable future for U.S. fisheries.

Domestically, U.S. fishermen operate in some of the most sustainably managed and heavily regulated fisheries in the world, requiring significant investment. Promoting RFMOs measures that are based on strong scientific foundations and reflect U.S. management requirements, levels the playing field for the U.S. fishers.

Illegal, Unregulated and Unreported Fishing

Illegal, unregulated and unreported (IUU) fishing includes activities that do not comply with national, regional, or global fisheries conservation and management obligations. In some cases, that is because no management requirements exist, although in the most notorious of cases, IUU activities intentionally violate existing requirements. Experts estimate that the global value of economic losses from IUU fishing range between $10 billion and $23.5 billion dollars annually, representing between 11 and 26 million tons of seafood. Sales of IUU fish and fish products provide a financial incentive for the illegal harvests and also create unfair competition for our legal fishers in the marketplace. The United Nations Food and Agriculture Organization (FAO) considers IUU fishing a serious threat to fisheries' worldwide.

IUU fishing undermines efforts of nations and international organizations to manage fisheries in a responsible manner. IUU fishing does not comply with the management measures put in place to sustainably manage fisheries. As a result, it can lead to harvests that exceed scientific advice. IUU vessels are likely to engage in unsustainable fishing practices, such as using non-selective gear, exacerbating problems of discards and bycatch. Furthermore, because these activities are not reported, scientists are deprived of information critical to accurate stock assessments. IUU fishing also undermines the efforts of various nations to achieve food security.

IUU fishing activity can be found in and negatively impacts fisheries of all types—from small scale to industrial. Some vessels, including some that are U.S.-flagged, engage in illegal fishing but are detected and punished through effective enforcement efforts. Other vessels are able to escape detection, or are flagged to countries that are unable or refuse to effectively manage their fleets. One outstanding problem is the presence of large numbers of vessels engaged in IUU fishing in the exclusive economic zones (EEZs) of developing coastal States. These States are often unable to effectively monitor and enforce their fishery rules in their EEZs and the high seas areas adjacent to those EEZs. The ability of vessels to reflag in order to disguise their identity and to avoid detection has also made combating IUU difficult.

IUU fishing activities tend to be highly mobile and increasingly sophisticated as IUU fisheries continue to find and exploit weak links in the international fisheries regulatory system. The use of flags of convenience, as well as ports of convenience, facilitates the scope and extent of IUU fishing activities. Since IUU fishing activities are complex, a broad range of governments and entities must be involved to combat them. RFMOs play a key role in bringing these groups together to address IUU fishing. RFMOs combat IUU fishing through activities such as adoption of IUU vessel lists; strengthening port State controls; improving monitoring, control, and surveillance; implementing market-related measures to help ensure compliance; and supporting capacity-building assistance.

Domestic Actions to Combat IUU Fishing

NOAA has taken strong actions against illegal fishing to protect U.S. fishing industry interests and ensure sustainable global fisheries. The Fisheries Office of Law Enforcement, together with the NOAA Office of the General Counsel, and their Federal, state and local partners, works tirelessly to ensure that domestic Federal fisheries laws are adequately enforced. U.S. law enforcement officials also have tools to take action against IUU products from other countries. For example, domestic measures restrict port entry and access to port services by vessels included on the IUU lists of the RFMOs of which the United States is member. Another domestic measure, the Lacey Act, makes it unlawful for any person to import, buy or sell fish that was harvested, taken, sold or possessed in violation of the laws of another nation. We are working to improve our authorities so that we can do an even better job of keeping IUU product out of the U.S. and global markets.

Under the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006 Congress directed the Executive Branch to strengthen its leadership in international fisheries management and enforcement, particularly with respect to combating IUU. Among other things, NOAA is required to biennially identify countries that have fishing vessels engaged in IUU activities. Once a nation has been identified, NOAA consults with the nation on its fisheries management and enforcement practices in order to encourage appropriate corrective action. NOAA uses this consultation as an opportunity to encourage the identified nation to take effective action against the specific IUU fishing activities, including by improving the relevant laws, or through direct sanctions on vessels, captains or owners. If NOAA determines that effective action has been taken, the nation is positively certified to Congress in the next report. If, instead, the identified nation receives a negative certification, Congress directs the United States to impose trade restrictions or other penalties on that nation.

NOAA has completed two full rounds of the MSRA process and begun the third. Thus far, all nations that have been identified for IUU activities have taken the appropriate corrective action and have been positively certified. We consider this a success that United States has been able to get nations to take the steps necessary to address IUU activities by their flagged vessels. This process acknowledges that while combating IUU can be a difficult and slow challenge, these efforts can make a real and measurable impact.

A nation's ability to effectively manage its fisheries depends on its ability to collect scientific information, to use that information to develop plans to effectively manage its fisheries, and to ensure compliance with those management plans. To that end, the U.S. Government has focused on helping developing states, especially developing coastal states, to build their domestic institutional capacity to effectively manage their fisheries. As it would be impossible for the United States to unilaterally monitor global compliance, it is important that we work with other nations to ensure that they can effectively manage their own fisheries. Our capacity building efforts have included some bilateral activities, but we are increasingly looking to work within the RFMOs, in other multilateral fora, and in collaboration or coordination with other partners. Our efforts span management issues broadly: from helping to build capacity for fisheries biology and sampling, to implementing port state controls, to improving enforcement.

NOAA's Priority Areas to Address IUU Fishing in 2013 and Beyond

Reducing IUU fishing globally helps to level the playing field for U.S. fishermen, while ensuring sustainable fisheries management globally. As such, in 2013, NOAA will continue to engage in significant efforts to combat the threat of IUU fishing. Working in partnership with other U.S. Federal and non-Federal Government agencies, foreign governments and entities, intergovernmental organizations, and private sector entities is crucial to combating IUU fishing effectively. NOAA will undertake its efforts in 2013 in close collaboration with these partners. NOAA will also work with interested constituent groups to keep them engaged in these ongoing efforts. Below we identify some of the activities that we intend to undertake. However, the current budgetary environment is dynamic, and the activities described below are dependent on available funding.

Supporting U.S. Ratification of the Port State Measures Agreement

The Port State Measures Agreement is the first binding global instrument focused specifically on combating IUU fishing. It establishes minimum standards for dockside inspections and training of inspectors and, most significantly, requires parties to restrict port entry and port services for vessels known or reasonably suspected of having been involved in IUU fishing. In 2011, the Obama Administration sent the Port State Measures Agreement to the Senate, seeking advice and consent for its ratification. It also prepared draft implementing legislation that was shared with both the House and the Senate. It has been introduced in the Senate as the Pirate Fishing Elimination Act (S.267). Senate approval for U.S. ratification of the Agreement and Congressional passage of the implementing legislation will bring the Agreement closer to entry into force. When in force, the Agreement will benefit U.S. fishermen, seafood buyers, and consumers by preventing vessels carrying illegally harvested fish from entering ports around the world and polluting the market with illegal product. By ratifying the Agreement, the United States will demonstrate strong leadership in the global battle against IUU fishing and will be well-positioned to encourage broad ratification of the Agreement by other countries.

In addition, the United States has entered into agreements creating the North Pacific Fisheries Management Organization and the South Pacific Regional Fisheries Management Organization, and modifying the conventions under which the Inter-American Tropical Tuna Convention and the North Atlantic Fisheries Organizations were created. Each of these agreements will improve fishery management and provide tools for combating IUU fishing. NOAA will work with the Department of State, the Coast Guard, other relevant agencies, and with Congress to seek ratification of all of these agreements and to seek the enactment of necessary implementing legislation.

Development or Improvement of RFMO Compliance Monitoring Schemes

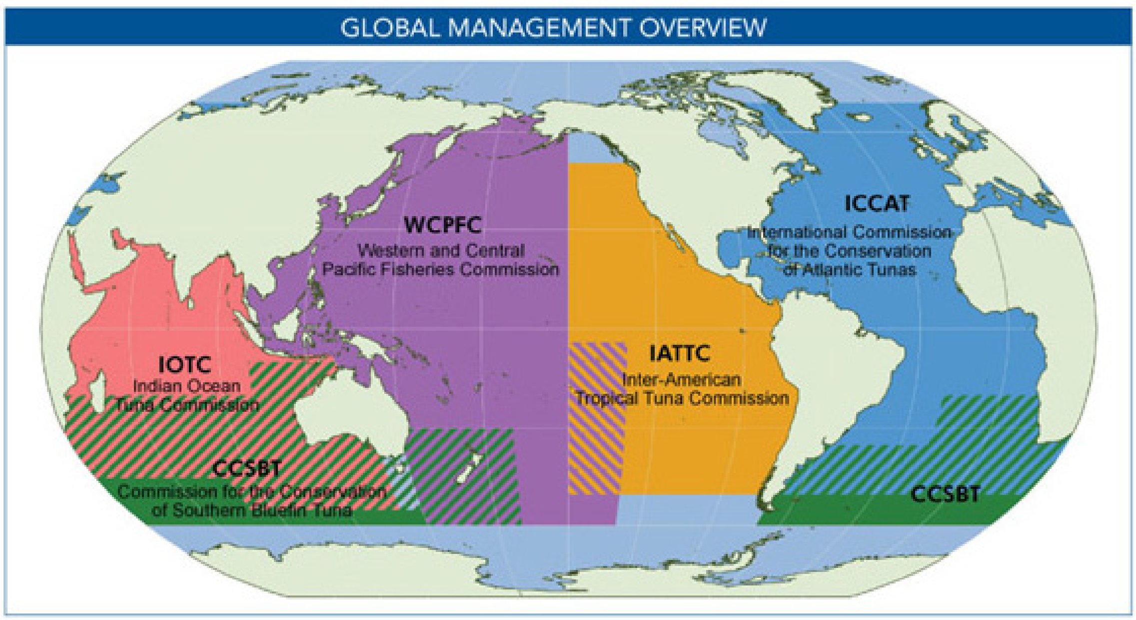
Effective, transparent and meaningful compliance monitoring schemes are critical for assessing the level of compliance by RFMO members in the implementation of management measures and ensuring that the requirements of RFMOs are effectively enforced. Understanding the levels of compliance is also key information for evaluating the effectiveness of those conservation and management measures. Failure by members of RFMOs to implement and enforce agreed conservation and management measures can significantly undermine the effectiveness of those measures and the ability of RFMOs to carry out their mandates. It also disadvantages the vessels flagged by RFMO members that do fully implement the measures. Identifying and addressing areas where members fail to act either willfully or as a result of a lack of capacity is critical to preventing and eliminating IUU fishing.

Most RFMOs have undergone performance review exercises in recent years. These reviews included efforts to address compliance monitoring. Based on the RFMO performance reviews, NOAA, in coordination with the Department of State, will examine the effectiveness of these existing mechanisms. Based on that analysis and as appropriate, NOAA will work with Department of State and other members of the relevant RFMO to promote the development and adoption of appropriate measures within RFMOs at 2013 Annual Meetings and beyond. Potential measures may include mechanisms to identify non-compliant RFMO members, improvements to reporting and transparency schemes, mechanisms for building capacity, where appropriate, and development of appropriate penalties for IUU activities

Establishment of Unique Vessel Identifiers for Fishing Vessels

One problem encountered by those combating IUU fishing is that even after vessels have been identified as being engaged in IUU fishing they continue to operate by changing their name and/or registering under a different nation's flag. One way to reduce their ability to do this would be through the assignment of globally unique, permanent numbers to fishing vessels. This step would greatly improve the ability of authorities to quickly and accurately identify vessels, trace their history, and link them to specific fishing activities. It would also support the related efforts of the United Nations FAO to establish a successful Global Record of Fishing Vessels, Refrigerated Transport Vessels, and Supply Vessels which would further strengthen efforts to monitor the activity of vessels involved in or supporting IUU fishing. The FAO has identified the implementation of unique vessel identifiers (UVIs) for fishing vessels as an essential prerequisite to the development of a Global Record.

International progress with respect to requiring the use of UVIs on fishing vessels has been slow. In 2013, NOAA, in collaboration with the Department of State and U.S. Coast Guard, as well as relevant stakeholders, will review the state of play on the development of UVIs within global and regional fora, in particular actions taken at the International Maritime Organization, FAO and tuna RFMOs, and develop approaches to advance the application of UVIs with a view towards global application in line with the recommendation of FAO.



Ensuring Successful Development and Implementation of IUU Enforcement Mechanisms by Coastal and Flag States

Flag and coastal States need effective legal and enforcement institutions to fully implement measures to combat IUU fishing. Without these mechanisms, IUU-related measures adopted by RFMOs will not have a meaningful impact on illegal fishing activities, which in turn undermines the effectiveness of management measures adopted at both the domestic and RFMO level. NOAA works with domestic and regional partners to support and improve fisheries management and enforcement efforts globally. Past cooperative efforts have included assessing levels of IUU fishing, training of fisheries managers and enforcement agents, and development of regional capacity for fisheries monitoring, control, and surveillance. By supporting countries' development and enforcement of domestic laws that prosecute IUU acts, NOAA is leveling the playing field for our fishermen.

In 2013, NOAA, in coordination with the Department of State, the U.S. Agency for International Development, U.S. Coast Guard, and interested stakeholders, intends to expand upon past capacity building efforts in West Africa, the wider Caribbean and Latin America, and Southeast Asia. As the situation in each region is unique, partners will develop courses of action specific to each of those regions.

Conclusion

Ensuring the sustainable management of domestic and global fisheries is important to American food security, to American jobs and to the health of the oceans upon which both of these depend. In order to sustainably manage fish stocks, we need to collect fisheries and ecosystem data, provide advice on how to sustainably manage our fisheries based on that data, translate that advice into management measures, and implement and enforce those measures. With respect to U.S. domestic fisheries, we have made good progress on achieving these goals and turned the corner on ending overfishing. Nevertheless, there is still much work to do. We have also made progress on some of these objectives in various RFMOs, but much more work needs to be done. Further, the United States also needs to work with a number of developing coastal states to improve the sustainable management of their domestic fish stocks. However, all of this work will be for naught unless the global community is able to reduce IUU fishing and its impacts. IUU fishing undermines efforts to sustainably manage fisheries and introduces unfair competition into the markets for seafood, directly harming the interests of the United States and others.

The United States will continue to be a leader in promoting the sustainable management of global fisheries and combating IUU fishing. Among other things, these efforts will involve working to obtain advice and consent for ratification of the treaties creating the new South Pacific and North Pacific regional fisheries management organizations, for the amendments to the Northwest Atlantic Fisheries Organization Convention, and for the Port State Measures Agreement. We will also need to obtain legislation implementing those commitments.

We will continue to lead efforts within the RFMOs to improve scientific, management and enforcement processes. In addition, we will work within RFMOs and bilaterally to help developing coastal states improve the sustainable management of their fisheries, including by improving their ability to combat IUU fishing in their waters. Together these actions should take us closer to the long-term sustainability of our global fisheries resources.

WESTERN AND CENTRAL PACIFIC FISHERIES COMMISSION MEETING, 2008. PHOTO: DONALD MCISAAC.

DISCUSSION SUMMARY AND FINDINGS
Session 1 Topic 3

International Fisheries Management: Leveling the Playing Field

Speakers

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ELIZABETH MCLANAHAN, ACTING DIRECTOR, NMFS OFFICE OF INTERNATIONAL AFFAIRS

Panelists

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Moderator

DAVID WITHERELL, DEPUTY DIRECTOR, NORTH PACIFIC FISHERY MANAGEMENT COUNCIL

Discussion Summary:

International Fisheries Management: Leveling the Playing Field

Regional fisheries management organizations (RFMOs) are the principal forum for managing trans-boundary stocks like highly migratory species (HMS) and generally function consistent with international treaties such as the UN Law of the Sea Convention and UN Fish Stocks Agreement. The United States, and by extension Regional Fishery Management Councils that manage HMS domestically, must participate in RFMOs to promote management objectives consistent with the Magnuson-Stevens Act and other Federal laws governing the Nation's fisheries. Because RFMOs usually feature decision-making by consensus, international cooperation is a key commodity that the United States and other members must continually cultivate.

Achieving consensus requires the balancing of interests between RFMO members and fisheries, which is often difficult. However, once RFMOs are agreed to, there remains concern about possible discrepancies in the implementation of RFMO conservation measures by participating countries, as opposed to the prompt implementation and enforcement of measures by the United States. In this regard, U.S. HMS harvesters talk about "leveling the playing field," because they perceive that a higher standard is applied to them compared to fishery participants from other countries. To achieve conservation goals and level the playing field, the United States must promote the application at the international level of the kind of science-based, precautionary fisheries management found domestically. This involves efforts to make RFMOs more effective through technical assistance and other types of support to developing nations to increase their fishery monitoring and data reporting capacity. RFMOs measures and other multilateral efforts must also address ocean commons issues such as overfishing; overcapacity; bycatch; and illegal, unregulated, and unreported (IUU) fishing.

Based on the presentations, panelists' reactions, and audience comments, session participants developed findings covering 1) international cooperation and assistance, 2) combating IUU fishing, 3) promoting U.S. competitiveness internationally, and 4) improving communication and stakeholder involvement in U.S. RFMO delegations.

Foster International Cooperation and Assistance

Capacity building is an important tool in furthering the goal of applying international management measures fairly and equitably ("leveling the playing field"). For this reason the U.S. is helping to build fishery management and enforcement capacity internationally. This involves bilateral cooperation to increase management capacity globally, and especially for developing countries, recognizing that many developing countries have limited management capacity, which makes it difficult for them to comply with conservation measures. An example of the need for capacity building is in the Caribbean, where U.S. affiliated entities share boundaries with five nations and indirectly deal with many more. Most of these countries have limited management capacity, making cooperation difficult. Across many contexts, the United States can play an important role, because it has an effective domestic management system and has leverage as a major seafood consuming nation.

While speakers and panelists were generally supportive of capacity building efforts, it would require a commitment of significant resources to get countries to mirror U.S. laws. Capacity building will not address the challenge of forging measures consistent with U.S. standards, because of the consensus-based decision-making format in RFMOs. While the U.S. shouldn't compromise the conservation standards embedded in domestic law, neither can it impose these on other countries in international forums. Overall, leveling the playing field will involve the incentive of technical assistance coupled with a continued commitment to international measures that achieve conservation goals and are effectively enforced. Incentives could also take the form of RFMO conservation measures that reward compliance such as adjusting national quota allocations based on the outcome of compliance monitoring schemes.

Participants also advocated immediate adoption of appropriate target and limit reference points by RFMOs. The U.S. can promote sustainable management by setting an example with science-based measures like biological reference points. Currently, U.S. domestic laws and regulations impose a higher standard of management on U.S. fleets compared to other nations' fishing fleets. Universal adoption of biological reference points could force other fishery participants to comply with comparably strong international conservation measures. However, it was noted that there is a need to examine the stock-recruit relationship for tunas. In tuna stock assessments, the relationship between spawning biomass and recruitment is often unknown, which can result in specifying limits that allow overfishing to occur. One participant advocated for a more risk-averse science-based strategy within the tuna RFMOs.

After hearing about an initiative to improve RFMO performance through market-based partnerships, participants agreed that environmental nongovernmental organizations should continue to leverage compliance with RFMO conservation measures. For example, the International Sustainable Seafood Foundation (ISSF), focuses on a market transformation strategy at the supply chain level that involves partnerships between conservation and industry groups. Currently, 21 tuna processing companies are members of ISSF. ISSF is also involved in the RFMO process through advocacy; it also binds its members to conservation measures beyond those implemented by RFMOs. This represents another approach to fostering international cooperation by leveraging supply chains.

Increase Efforts to Combat Illegal, Unreported and Unregulated Fishing

To combat IUU fishing, both U.S. measures (e.g., MSRA IUU identification) and international cooperation (e.g., FAO Port States Agreement) are necessary. Ensuring effective compliance with RFMOs measures by all fishery participants will require increased support for at-sea and in port monitoring and enforcement. This should include more U.S. investment in monitoring and enforcement on the high seas. Alternatively, another potential avenue for the U.S. to pursue is to develop RFMO measures that reward compliance. For example, while RFMOs should develop the capacity to impose sanctions for noncompliance, incentives for compliance (e.g., increased catch allocations) should also be explored. Another avenue supported by panelists was to broaden trade sanctions domestically and within RFMOs to address non-compliance. It was also agreed that the U.S. should ratify the 2009 FAO Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing, which identifies procedures the port states must follow when admitting foreign fishing vessels.

The U.S. market is vulnerable to products from IUU vessels, so the U.S. should implement stricter imported seafood labeling requirements in the U.S. market. Mislabeled seafood products are a major challenge and poorly enforced labeling regulations have a huge impact in the seafood industry. Connelly also argued that measures implemented by the European Union to combat IUU fishing may not be appropriate in the U.S. market. There is no one size fits all solution, because different fisheries have different levels of traceability. Nonetheless, product traceability coupled with better labeling requirements is an important tool in combating IUU fishing.

A very specific recommendation was brought up in discussion: the current interpretation of the statutory language in MSA section 609 requires a country to have two or more documented IUU vessels to be included in the biennial report to Congress required by MSA section 607. Therefore, it was recommended to amend MSA section 609, Illegal, Unreported, and Unregulated Fishing, to change "vessels" to "vessel." A recent case was noted where a single vessel from a country was cited for IUU fishing but was not included in the report required under MSA section

607, because of the NOAA's interpretation that section 609 only applies to instances where more than one IUU vessel from a country is identified.

Promote the Competitiveness of U.S. Fisheries Internationally

Several panelists and participants noted the rapid expansion of foreign purse seine and longline fleets in the Pacific, often supported by government subsidies. The U.S. should promote measures to reduce overcapacity internationally, which would not only enhance U.S. fishing industry competitiveness, but also the industry's strength in employing environmentally responsible fishing practices. As a specific example, it was argued that overcapacity in tuna purse seine fisheries in the Pacific is harming tuna longline fisheries. Purse seine vessels fishing on fish aggregating devices (FADs) catch juvenile tuna such as bigeye tuna and yellowfin tuna that are targeted as adults in the longline fishery. Furthermore, this may be exacerbated by the allocation scheme implicit in the Western and Central Pacific Fisheries Commission's tropical tuna conservation measure, which manages purse seine bigeye tuna fishing mortality with a seasonal FAD closure and longline bigeye tuna mortality through catch quotas. It was noted that increasing tuna catch in the Western and Central Pacific Ocean, spurred by significant increases in longline and purse seine capacity, is impacting Guam's artisanal fisheries and other U.S. Pacific Islands. This is an example of the need for the U.S. to promote the immediate adoption of capacity controls within the Western and Central Pacific Fisheries Commission. More directly, it was recommended that RFMOs limit vessel numbers of member states. Capacity can also be controlled indirectly by measures that restrict national subsidies for fuel and vessel construction, which reduce operational costs. In addition to uneven compliance and enforcement, subsidies of foreign fleets that compete with U.S. fishing vessels for the same HMS stocks promote an uneven playing field.

A participant pointed out that some European countries actively assist their domestic fisheries in acquiring eco-labeling (certification) in order to promote their competitiveness among increasingly environmentally aware consumers. In the United States, no such assistance is currently provided and this fact sparked discussion of a national sustainable seafood certification program. A certification program embedded in the MSA could be an alternative to third party certification schemes. While some panelists advocated a more active role for NOAA in developing an eco-labeling scheme based on the standards found in the MSA, others cautioned that the government would face challenges in identifying a comprehensive set of standards and effectively promoting such a scheme. Although the balance of participants supported the concept of national sustainable seafood certification program, there were reservations about this as an alternative to current third-party programs.

Another aspect of international fisheries is direct allocations of international total allowable catches to U.S. fisheries. While participants didn't discuss international allocations at length, it was agreed that catch share programs are an effective way of boosting competitiveness, because they induce economic rationalization of fisheries. Some form of quota tradability could be an element of international schemes. Rights-based management schemes could also address overcapacity issues and improve compliance, however, the complexity and lack of administrative capacity in some developing countries make these measures difficult to implement across RFMO members.

"Transfer effects" were also discussed in relation to U.S. competitiveness in the international arena. Environmental compliance by U.S. harvesters can favor foreign competitors subject to lower compliance standards, who can therefore sell into the U.S. market at lower cost than U.S. producers. Participants found no easy solution to this problem but, at a minimum, RFMOs should consider transfer effects when developing conservation and management measures. Improving RFMO monitoring schemes that include mechanisms for sanctioning non-compliance is one way to address transfer effects.

Increase Communication With and Stakeholder Engagement in Regional Fisheries Management Organization Delegations

Participants with experience with U.S. RFMO delegations urged the U.S. government to better facilitate communication among U.S. delegations to tuna RFMOs in both the Pacific (Western and Central Pacific Fisheries Commission, Inter-American Tropical Tuna Commission) and Atlantic (International Commission for the Conservation of Atlantic Tunas). There is a need for consistency in management measures among RFMOs, which could be facilitated by such communication. This is particularly important in the Pacific, where two RFMOs, the Inter-American Tropical Tuna Commission and Western and Central Pacific Fisheries Commission, have jurisdiction. Participants felt there was a need to improve government-stakeholder engagement when developing positions by maximizing participation of fishermen and other stakeholders in U.S. RFMO delegations. While NMFS is committed to stakeholder participation in the RFMO process, it was noted that the U.S.-affiliated Pacific islands have difficulties in getting their voices heard within U.S. delegations to RFMOs.

Conclusions

U.S. fisheries that target straddling and HMS stocks are highly monitored and managed under comprehensive regulations stemming from domestic and international measures and environmental laws, all which are strictly enforced by the U.S. Coast Guard and NOAA's Office of Law Enforcement. Many other countries do not manage or monitor their fleets to the same standards, thus resulting in an uneven playing field between U.S. fleets and foreign fleets targeting the same stocks. Furthermore, national subsidies of foreign fleets further exacerbate the eneven playing field.

In addressing the uneven playing field, the U.S. needs to be realistic in what is achievable. In this regard, enhancing compliance monitoring in RFMOs and mechanisms to address non-compliance at the RFMO level as well as restricting access to U.S. markets will likely be the most effective in addressing these problems. To achieve these objectives, the U.S. must continue to involve U.S. harvesters and other stakeholders in developing U.S. positions and proposals for internationally managed transboundary stocks.

SCHOOLMASTER (*LUTJANUS APODUS*) WITH BLUE TANG, ST. CROIX, USVI. PHOTO: NOAA CCMA BIOGEOGRAPHY TEAM

INTRODUCTION

Session 2
Advancing Ecosystem-Based Decision-Making

TOPIC 1 ASSESSING ECOSYSTEM EFFECTS AND ADAPTING TO CLIMATE CHANGE

TOPIC 2 FORAGE FISH MANAGEMENT

TOPIC 3 INTEGRATING HABITAT CONSIDERATIONS

SESSION CHAIR: JOHN HENDERSCHEDT
EXECUTIVE DIRECTOR, FISHERIES LEADERSHIP & SUSTAINABILITY FORUM

Fisheries affect, and are affected by, an ever-changing ocean ecosystem; and decision-makers must consider the relationships between managed species and their environment when setting policy and developing management strategies. Despite general acknowledgment of the concept and relevance of ecosystem-based management, the investment of hundreds of millions of dollars over the past decade, and notable progress in many arenas, agreement over exactly how to implement ecosystem-based management principles remains elusive. However, there is a strong agreement that more active consideration of ecosystem effects will advance the sophistication of fishery management decision-making, and thus the sustainability of fisheries and their attendant benefits to the nation.

Just as ecosystems are a whole comprised of many interacting parts, an exploration of ecosystem-based management should begin with an examination of its parts. This session addressed three of many possible topics that might be most effectively woven into the fabric of ecosystem-based fisheries management. The first topic focused on an emerging adaptive management tool, the Integrated Ecosystem Assessment (IEA), which is designed to help fishery managers recognize, understand, and respond to ocean ecosystem changes. While this tool is presented in the context of dealing with climate change adaptation, it applies to all three focus topics. The second focus topic covered the role of forage fish and directed forage fisheries in the ecosystem. The third focus topic discussed the integration of healthy habitat as an essential component of successful fishery management.

The three focus topics proved to be interrelated, with discussions of the other focus topics emerging naturally in each session. The climate change discussion recognized that the influence of changing water temperature, currents and chemistry affect the productivity and distribution of forage fish and habitat. The forage discussion raised the question of protecting habitat as a way to increase forage fish populations instead of simply focusing on reductions in catch. These are just a few examples of the intersections between discussions.

Many cross-cutting themes emerged from the discussions of climate, forage, and habitat. These common findings link the focus topics and provide overarching insight into ecosystem-based decision-making.

Consider a Broad Range of Ecosystem Processes

Fish populations influence and are influenced by their surrounding environment and ecosystem. Scientists and managers must shift from the single-species approach to consider a broad range of ecosystem processes and effects of harvesting fish species.

Evaluate Ecosystem Productivity Change

Fisheries managers must consider the productivity of our nation's fisheries and how that productivity is changing. Climate change is impacting fish populations, their productivity and distribution, and therefore impacting fisheries and fishing communities. Scientists should consider ways to incorporate this change into evaluations and stock assessments, while managers should include considerations of changing productivity in the decision-making process.

Evaluate the Effectiveness and Utility of Closed and Fixed Areas

The topic of fixed and closed areas arose in each of the three focus topics, both in terms of evaluating existing area-based protections as well as looking at the expanded use of this management tool. As the climate changes, scientists and managers need to think about the effectiveness of static closed areas amid changing ocean conditions and species distributions, as well as the value of closures for maintaining wider age structure to reduce vulnerability of certain stocks. Finally, many areas of the ocean have been protected for habitat, and scientists and managers should evaluate the efficacy of those closures as ocean conditions change.

Engage Across Disciplines and Increase Coordination

Ecosystem-based decision-making demands integration across disciplines, including ecology, biology, physical oceanography, climate science, economics, and social science. Fisheries management must find ways to break down the barriers between these disciplines. Similarly, ecosystem-based decision-making requires enhanced coordination across jurisdictions and between agencies. Participants noted the need to increase coordination between National Marine Fisheries Service (NMFS), Councils, states, science centers, stakeholders, and other Federal agencies, as well as internationally.

Leverage Opportunities for Industry Collaboration

All three of the focus topics touched on the need to increase the use of information generated by the fishing industry in response to a changing environment. In the climate session, participants suggested that a lack of flexibility in the Federal rule-making process may lead to a shift in roles of the Councils and industry. Industry may be called upon to develop and implement measures to meet management goals and performance criteria set by Councils. Additionally, industry may be able to help understand emerging trends and collect data to leverage limited resources. In some forage fisheries, fishermen want access to higher catches during years of high abundance. Industry-supported real-time data collection and dissemination may allow more precise and more adaptive management that would allow higher catches while ensuring the sustainability of the forage stocks. Finally, industry could expand data collection efforts to identify and classify habitat. Allowing greater flexibility for adaptation by fishers may require changes in management frameworks and will place a premium on sharing industry-provided data to evaluate the effectiveness of such strategies. In a time of budget constraints, a robust industry role in cooperative research may allow management to continue or expand research needs under limited resources.

Build Capacity to Advance Ecosystem-Based Decision-Making

Participants recognized the need to invest in ecosystem-based management. New tools and scientific models will be needed to continue advancements in our understanding and management capabilities. Analysts will be need training in applying the new models and integrating data across disciplines. Existing staff must be trained on the new capabilities and appropriate application of the new information emerging on ecosystem-based decision-making.

Participants recognized the need to integrate multi-species and ecosystem considerations into the decision-making process. Some Regional Fishery Management Councils have established Ecosystem Scientific and Statistical Committees (SSCs) or similar advisory bodies that have the expertise and mandate to evaluate ecosystem considerations and provide management advice. An Ecosystem SSC represents a forum to engage scientists across disciplines and jurisdictions to evaluate new ecosystem science and inform management.

Identify and Overcome Impediments to Ecosystem-Based Management

The transition to ecosystem-based decision-making is underway in the U.S., and in some regions and for some fisheries the implementation of ecosystem-based management is already advanced. Participants suggested that a next step for transitioning from single-species to ecosystem-based management is to learn from these examples by identifying and overcoming impediments.

Session 2 Topic 1

Assessing Ecosystem Effects and Integrating Climate Change

The relationships between marine resources and their habitat, fisheries, other ocean uses, and the ocean environment are characterized by change. In an ever-changing system, fisheries managers must continuously improve their understanding of the marine ecosystem and integrate current information in their decision-making. The deeper our understanding and the more developed our analytical tools, the better we are prepared to recognize ecosystem changes and adapt our management of fisheries resources in response. There is currently a great need to assess ecosystem change if sustainable fishery management is to be advanced to the next level, including the need for management systems to be able to adapt to climate-based changes in the ecosystem as they occur.

National Marine Fisheries Service is developing an adaptive analytical tool, known as an Integrated Ecosystem Assessment (IEA), which provides information about ecosystem relationships and interactions for use in fishery management decision-making (NOAA 2008). The IEA approach is a decision-support system that uses data and ecosystem models to forecast future conditions; evaluates alternative management scenarios; and assesses economic and ecological tradeoffs to guide decisions, implement, and evaluate management actions relative to objectives. IEAs hold significant promise. For example, an IEA for the California Current ecosystem could describe the effects of fishing Pacific anchovy on salmon stocks or marine mammal populations, and consequent effects on humans (NMFS 2011). Notably, the FY2013 President's requested budget proposed a significant investment for additional IEA development.[1] However, questions remain about how IEAs might be integrated in the Regional Fishery Management Council process.

While there is debate about the causes and parameters of climate change, no one claims ecosystems to be absolutely

1 Fiscal Year 2013 President's Request Budget, NMFS budget presentation and comparison to FY 2012. http://tinyurl.com/bafmvhy

stable. Climate-based ecosystem change has the potential to affect fish stock distribution, population size, productivity, and fishery yield. Informative and predictive indicators of natural variability, combined with an understanding of their effects on fish stocks, could improve fishery management and minimize harvest as a contributor to stock declines. With modern oceanographic observing systems, changes in parameters such as sea temperatures, ocean chemistry, and sea levels can be identified and measured; current data processing technology also allows for enormous amounts of information to be available for analysis. However, it is not clear what information fishery managers need to improve decision-making, or how they can best adapt regulatory approaches when presented with specific information about ecosystem change.

Discussion under this focus topic allowed participants to examine the emerging IEA analytical tool and consider findings about its application in fishery management decision-making. Participants also discussed climate-based ecosystem changes, the current status of scientific information available for use, ways to integrate large volumes of scientific data and projections into the management process, and uses of the IEA tool as it applies to the forage fish and habitat focus topics within this session.

Trigger Questions

1. What are IEAs capable of doing to enhance fishery management decision-making towards improved sustainability?
2. How could IEAs be integrated into the Council process?
3. How can fisheries management prepare and adapt to shifts associated with climate change, including distribution shifts of fish stocks across Council and international boundaries and changes in fish stock productivity?
4. What are successful examples of the utilization of climate information in decision-making processes, and what is necessary for wider application of these successful approaches?

Session 2 Topic 2

Forage Fish Management

Forage fish clearly play an important role in marine ecosystems. Scientists generally agree on the basic characteristics that define forage species: they are small in size, comprise a considerable portion of total ecosystem biomass, are found in the diet of other predators throughout their lifespan, mature early and have high inherent productivity potential, exhibit schooling behavior and can show high variation in inter-annual recruitment. Forage fish are an important linkage of energy and biomass between primary production and higher trophic levels. They are also the target of valuable and regionally important directed fisheries. As ecosystem-based management concepts have evolved in recent years, there has been a growing public focus on proper management of forage fish.

The competing interests of stakeholders result in widely diverging perspectives among environmental groups, recreational anglers, and those involved in the commercial fishing industry on what proper forage fish management means. Forage fish have traditionally represented an important resource for commercial fisheries, both for direct consumption and for the production of bait, fishmeal, and other valuable products. Many recreational anglers view forage fish as a food source for larger game species, arguing for greater protection of forage species to ensure more large fish to improve the angling experience. Some environmental groups believe that current forage fish fisheries, and the chance that these fisheries could expand, create a high risk of undesirable ecosystem effects.

Forage fishery conflicts have emerged on both coasts. On the East Coast, NMFS is considering a petition to list river herring under the Endangered Species Act as environmentalists fear that incidental bycatch is contributing to declining populations. Also on the East Coast, anglers and environmental groups argue that localized depletion of menhaden by large factory trawlers limits food available to predatory fish populations such as recreationally-important striped bass, sea birds, and marine mammals. Menhaden is the second largest fishery in the United States by volume and its products are used for aquaculture, livestock, and health supplements. Commercial fishermen argue that the removals are so small compared to the overall population biomass that they cannot cause a significant ecological impact, and note that it is ecologically safer to fish lower on the food chain than for predatory fish at higher trophic levels.

On the Pacific coast, some environmental groups worry that fishing levels for sardines do not adequately account for forage needs within the ecosystem. At the same time, there are those in the fishing industry who feel that ecosystem "set-asides" and low fishing rates represent more than sufficient protection. The many questions posed in various Council arenas around these complex considerations illustrate the importance of forage fishery conflicts.

In addition to concerns about existing fisheries, there are concerns about developing new fisheries for forage species. There are fears that the rising demand for aquaculture or terrestrial animal feed, or other markets, may result in initiation of new fisheries for species low on the food chain. There has been some action in this regard, such as the Pacific Council ban on krill fishing and consideration of additional forage species protections, and the North Pacific Council's Arctic Fishery Management Plan bans harvesting a variety of unfished species in the arctic area. Currently, regulations at 50 CFR § 600.747 define a process for Councils to consider new fisheries, but these regulations have not been updated for several decades and may not have sufficient flexibility for regionally-specific application.

All of these uses and interests require careful consideration of forage fish management options, as management policies and goals are ultimately a reflection of the values placed on forage fish populations and their predators.

Trigger Questions

1. Do current characteristics of forage fish warrant a departure from the current management approaches, characterized by some as a traditional single-species approach?
2. Where on the trophic scale should we be harvesting and managing species? As societal targets change, is there a need to redefine optimum yield and what the Councils should be managing for?
3. Are current fishing rates for forage fish too high in U.S. fisheries?
4. How should management reconcile ecosystem services valuation and the economic value of forage fisheries? What are some of the tradeoffs?
5. How do inter-jurisdictional, including international situations, factors influence the protection and recovery of forage fish stock?
6. Are legislative changes necessary for Councils to best leverage their management objectives in the international processes (e.g. co-managed stocks, incidental catch)?
7. Do Councils have the flexibility to address emerging forage issues under the current law and regulations? Are MSA Section 305 and Administrative Rules § 600.747 obsolete?

Session 2 Topic 3

Integrating Habitat Considerations: Opportunities and Impediments

In 1996 when the Fishery Conservation and Management Act of 1976 was amended as the Sustainable Fisheries Act (also known as the MSA), the requirements for habitat conservation as a component of managing ocean fisheries were widely considered as one of the major accomplishments of the new legislation. In 2006, the MSA was reauthorized and further amended to include deep sea coral protection and research provisions in recognition of the special contribution deep corals play in ocean ecosystems. Councils and NMFS have made great strides to conserve important habitats since 1996. Councils have designated "essential fish habitat" for more than 1,000 managed species and have designated over 100 Habitat Areas of Particular Concern; review and update of these essential fish habitat designations occurs on a routine, periodic basis. Since 2004, NMFS and the Councils have protected over 700 million acres of ocean habitat essential to marine fisheries from damaging fishing practices, and NMFS conducts thousands of consultations with other Federal agencies on non-fishing impacts to habitat.

Despite the volume of important habitat conservation activity over the past two decades, there is a general consensus that additional habitat protection is necessary. Some fish stocks continue to show signs of distress even after substantial reductions in fishing intensity; and for some of these stocks, this distress may be due to a shortage of healthy habitat. As fishing is only one impact on habitats, Councils need to collaborate with non-fishing ocean users to protect and conserve important fish habitat. One impediment is a lack of shared understanding about how best and where to focus conservation efforts for the benefit of fisheries and ecosystems; without this focus, it can be very difficult for NMFS and the Councils to convince other ocean users to reduce their impacts on habitats. Without a stated habitat conservation objective, it also becomes challenging for the Councils to frame the value of their own habitat conservation efforts to minimize fishing impacts on the ecosystem. Some of these impediments are exacerbated by a shortage of habitat science and information. One might also question whether all of the necessary habitat policy and management pieces are in place within the MSA mandates and guidance.

These challenges and impediments are reflected in the NOAA Habitat Blueprint, a strategy to better align NOAA's habitat-related programs, use habitat as a fisheries tool more prominently within NOAA, and demonstrate the impact and value of these programs. The National Ocean Policy also highlights, among other things, the opportunities and challenges that fisheries managers face in protecting fish habitat from non-fishing ocean uses. Additionally, there is debate about whether artificial habitat structures, such as off-shore gas and oil platforms, represent an opportunity or an impediment to habitat protection for sustainable fishery management.

This session explored regulatory and legislative measures to improve integration of habitat considerations into fishery management, through examining real-world examples. The discussion included how Councils might better engage and consult on the permitting of non-fishing ocean uses that impact fisheries habitat.

Trigger Questions

1. How effective are current consultations regarding non-fishing habitat impacts, and how can they be improved?
2. How can regulatory and legislative provisions support Council engagement in non-fishing ocean uses and minimize impacts on fisheries and habitat?
3. Is there a need for National Standards on habitat quality, productivity, or allowable degradation? Should a maximum sustainable yield-equivalent standard be established for habitat "removal"?
4. What is the proper role of non-natural habitat structures, such as off-shore petroleum platforms and artificial reefs, in optimizing habitat for sustainable fisheries?
5. Should habitat protection and improvements have a designated role in fish rebuilding programs? If so, what are meaningful alternatives?

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MANGROVE ROOTS PROVIDE HABITAT FOR NUMEROUS MARINE ANIMALS. HAWAII. PHOTO: CLAIRE FACKLER, CINMS, NOAA

PAPERS

Session 2
Advancing Ecosystem-Based Decision-Making

Topic 1
Assessing Ecosystem Effects and Adapting to Climate Change

Implications of Changing Ecosystems for Fishery Managers

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Abstract

Changing ecosystems are increasingly recognized as a driver in fishery trends and considered by policy makers in annual and long-term management decisions. Regional Fishery Management Councils and fishery scientists have made strides in developing methods for incorporating climate change information into stock assessments and decision documents, but comprehensive strategies for giving climate related issues full consideration remain to be developed. The actions taken thus far by managers in the North Pacific to respond to changing climate trends, both through long-term management actions and incorporation of ecosystem information into annual decision-making, can serve as a basis for discussion of similar action in other regions. In particular, attention should be paid to responsible management of rapidly changing eco-regions, the challenges a changing ecosystem poses to designing catch share programs and protections for vulnerable species or habitat, recent trends in climate related Endangered Species Act listings, and the value of long-term planning for climate change.

Discussion

Recent Climate Trends

Although many states are facing implications from a changing climate, Alaska is often described as being on the front lines of climate change. The Arctic climate is changing more rapidly than any other region of the United States, and the changing ecosystem is driving coastal erosion, increased storm activity, loss of seasonal sea ice cover, and dramatically increased interest in Arctic access and development by many nations. Open waters for several months in the summer have led to increased vessel activity in the area; commercial, recreational, and research vessels are all transiting an area with no port of refuge, no permanent Coast Guard base, and limited assets for either search and rescue or environmental mitigation should an incident occur. Much of coastal Western Alaska and the Arctic lack sufficient baseline data and infrastructure to adequately address these challenges, and not nearly enough is known about current conditions or what the future holds for this vast, remote area.

The State of Alaska has consistently recommended increased investment in the Arctic region in the form of additional ice breaking capability, greater Coast Guard resources, development of ports and harbors, adequate mapping, and increased research on both baseline environmental conditions and fish and wildlife in the area. Among the many priorities for an open Arctic, the State of Alaska and Federal managers have been carefully considering potential impacts on fish stocks that may currently, or in the future, be found in Arctic waters. Given the incomplete information on the complex interactions among ecosystem components, the state has been strongly supportive of research efforts to guide future development.

Currently, university, Federal and state scientists are collaborating to gather baseline data on all major components of the marine ecosystem through the first comprehensive oceanographic and fisheries survey of its kind in the Arctic. This ongoing project spans three years and will provide a comprehensive assessment of the northeastern Bering Sea and Chukchi Sea ecosystems, from the physical environment, through the primary and secondary producers that support Arctic marine food webs, to the numerous fish species utilizing the area. The study will provide an unprecedented baseline for understanding Arctic marine and coastal communities and for assessing the potential effects of future development and climate changes on fisheries resources and the marine environment in the region.[1]

Precautionary Management for a Changing Climate

In the North Pacific Ocean, an ecosystem-based fishery management approach has been adopted for managing Alaska groundfish fisheries by the North Pacific Fishery Management Council (Council). The stated management policy is to apply judicious and responsible fisheries management practices, based on sound scientific research and analysis, proactively rather than reactively, to ensure the sustainability of fishery resources and associated ecosystems for the benefit of future, as well as current, generations (Heltzel et al. 2011). This policy has been implemented through a variety of measures to achieve specified goals, but one of the best examples is the Council's management action in the Arctic.

The Council was early to recognize that a changing Arctic, if left unregulated, had the potential to allow exploratory fishing and commercial exploitation of stocks about which very little is known. In 2009, the Council adopted and the Secretary of Commerce approved the Arctic Fishery Management Plan (FMP), which took proactive and precautionary action to close U.S. Federal waters of the Arctic Ocean to commercial fishing until such time that sufficient data has been accumulated to allow for responsible management and exploitation of fish stocks in the area. This management policy directly recognizes the need to balance competing uses of marine resources and different social and economic goals for sustainable fishery management, the complex interactions among ecosystem components, and the need to base future management measures on the best scientific information available (NPFMC 2009).

The protection of the Arctic FMP, however, stretches only out to 200 miles. Beyond are international waters that are outside the exclusive economic zone (EEZ) of any Arctic nation. It is likely that Arctic stocks straddle the boundary between the U.S. EEZ and the "donut hole" that is currently unregulated. The precautionary approach taken in U.S. Arctic waters should be extended through treaty negotiations to international waters, similar to the treaty that protects international waters, and the stocks therein, in the Bering Sea and provides a mechanism for international cooperation on research, enforcement, and management actions.[2] In addition, the U.S. should use diplomatic measures to encourage other Arctic nations to take a similar approach within their own EEZs, thereby guaranteeing continued protection for transboundary stocks.

In 2008, at the recommendation of the Council, the Northern Bering Sea Research Area (NBSRA) was established, prohibiting bottom trawling in the northern part of the Bering Sea. It was part of a larger package of precautionary Bering Sea habitat conservation measures recommended by the Council in 2007 that included freezing the footprint of bottom trawling in the Bering Sea, with the understanding that the ranges of specific fish species may be shifting northward due to changing climate and ocean temperatures. The measures prohibit bottom trawling in the deep slope and basin area as well as shelf waters north of St. Matthew Island, over 132,000 nm^2 overall (NOAA AFSC 2012a).

In setting aside the NBSRA, the Council's goal was to allow development of a research plan that would provide information on the impacts of bottom trawling and catalog sub-areas that may be of interest for future fisheries by learning more about stock distribution and benthic habitats within the area. The closure identifies areas that will remain closed to bottom trawling regardless of research design or outcomes, in order to protect crab habitat and

1 State of Alaska Coastal Impact Assistance Program, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, Arctic Ecosystem Integrated Survey project description, Dr. Franz Meuter.

2 Convention on the Conservation and Management of Pollock Resources in the Central Bering Sea, June 16, 1994.

subsistence fishing and hunting in the area.

By freezing the footprint of the fleet to areas previously subject to bottom trawling, the Council has considerably constrained the ability of the fleet to react to changing patterns in fish distributions or reductions in sea ice without substantial further research into the effects of bottom trawling on previously untrawled areas and the distribution of fish stocks and marine mammals in this region.

There is high uncertainty in predicting ecosystem trends, and the potential changes in fish stock distributions and biomass that may result. The Arctic and Northern Bering Sea present one type of management challenge, where previously unexploited stocks and areas were thought likely to become available to and sought after by an existing, highly capable fleet of vessels due to an ecosystem that is changing very rapidly. This approach represents a tradeoff between allowing for continuation or expansion of commercial fisheries in a changing climate and a more precautionary approach that favors conservation measures in the face of uncertainty and requires a significant investment in new research before allowing fishery expansion.

Adaptive Management for a Changing Climate

In other scenarios, potential shifts in fish stocks, fishing areas, and ecosystems are more gradual, or affect stocks that already support established fisheries. In these cases, a blanket moratorium or establishment of extensive closures to allow for increased research and data gathering would likely not be considered a responsible or desirable response to climate change. Therefore, consideration of other methods is necessary.

In many areas, Regional Fishery Management Councils have relied on a system of fixed closure areas to protect important habitat and core distributions of sensitive species. As a changing climate influences stock health and distribution and fleet behavior, these fixed closures can diminish in effectiveness and must either be constantly reexamined or replaced with a more flexible system of protection.

In the North Pacific, both the Council and the Alaska Board of Fisheries have relied heavily on fixed area closures to provide additional protections to areas thought to be especially important or vulnerable. In total, more than 665,000 square nautical miles off Alaska are closed to some or all fishing.[3] However, fixed area closures may or may not continue to be appropriate in changing conditions, depending on the species or habitat being protected. For example, fixed area closures to protect salmon in the Bering Sea have been limited in their effectiveness over time, given the annual variability of salmon distribution.

In order to facilitate moving toward a more adaptive management approach for crab, National Marine Fisheries Service (NMFS) scientists are researching how oceanographic currents and the extent of the Bering Sea cold pool affect distribution of female red king crab and therefore location of larval release. As this research progresses, the North Pacific Council is monitoring the results to evaluate whether the existing crab protection closure areas effectively protect the stock in all temperature regimes. Although there is interest in development of adaptive management triggers tied to environmental variables, further work is needed to determine how such a trigger might be incorporated into NMFS' regulatory framework.

As conditions continue to change, it is likely that other fixed area closures may need reevaluation and modification to remain centered on core areas of stock distribution. For salmon, the North Pacific Council allows for a "rolling hot-spot" system of short-term, flexible closures that respond to bycatch rates over a given period of time. This type of flexible closure system, although effective, may challenge the ability of the Federal regulatory system to be responsive within a season or fishing year, and managers may need to consider implementation through industry agreements, with the Council's role shifting to evaluation of effectiveness and requiring accountability.

Harvest limits on prohibited species that are not indexed to population abundance may also need to be reevaluated

3 NMFS GIS data, 2012.

as ecosystem conditions change, and if possible, be established at a level that is appropriate for the current distribution and abundance of the stock. Rapidly changing conditions challenge the slow-moving and deliberative Federal regulatory process, and flexibility is needed to respond to newly available scientific information about species distribution, abundance, and reaction to climatic variables.

Designing Flexible Management Systems

Climate change, although currently the topic of much discussion, is not a new phenomenon. The climate has been changing throughout recorded history and will continue to change in the future. In the past, when fish stocks shifted across areas or when one stock became more abundant and another declined, the reaction of the industry varied. In general, when markets, economics, and regulations allowed, the fleet often either moved to a new area or learned to exploit more abundant species, allowing the fleet and fishery dependent communities to continue to thrive.

For example, the community of Kodiak once relied heavily on a red king crab fishery in the Central Gulf of Alaska that supported a local fleet of crabbers. In the early 1970s crab stocks declined in abundance. The reasons for the decline are not fully understood, but it is thought that one of the primary drivers was a regime shift in the North Pacific Ocean that resulted in more favorable conditions for groundfish and less favorable conditions for shellfish. In response, many in the Kodiak crab fleet either shifted efforts to participate in Bering Sea fisheries, which remained relatively abundant, or shifted to participating in local groundfish fisheries. By adapting to changing conditions, much of the fleet was able to survive in the face of a changing climate regime.

In that era, entry requirements were rare and investment in a vessel and gear was often all that was required for a fisherman to move to a new area or target a new species. In a similar scenario today, the displaced fleet would see significantly increased costs of entry into both the Bering Sea groundfish and crab fisheries and the groundfish fisheries in the Gulf of Alaska, as a result of license limitation and catch share programs that, while valuable in meeting certain objectives, have significantly reduced the fleets' flexibility to adapt to changing conditions.

Since the advent of limited entry in Alaska's state managed fisheries in the 1970s and various catch share programs in Federal fisheries beginning in the 1990s, entry into new areas and fisheries has become significantly more expensive. Other regions have also developed and implemented catch share programs. To change one's fishing operation may require purchase of a permit or catch share privilege, which many times is specific to one species and area. Despite these limitations, it is likely that catch share programs will continue to be considered for their potential benefits to stability, bycatch reduction, conservation, management, and safety.

The halibut and sablefish individual fishing quota (IFQ) program in the North Pacific is a good example of a catch share program which provides many economic and conservation benefits, but has limited the ability of the fleet to respond to changing conditions. In 1995, this program awarded fishermen the privilege of catching a certain share of the quota in one of the International Pacific Halibut Commission regulatory areas off Alaska. The structure of the program is fairly rigid, not only in specifying the area to be fished, but also in designating quota by vessel size and dividing it into blocks to limit consolidation (Fina 2011). The program allowed for delivery of halibut throughout much of the year, slowing processing and allowing for additional fresh shipments and improved product forms. The result has been a substantial increase in the price paid to harvesters and a related increase in the price of catch shares for these fisheries (NPFMC 2010).

When the International Pacific Halibut Commission shifted from a closed area assessment to a coastwide assessment of halibut biomass, the percentage of harvest allocated to each regulatory area shifted substantially. This shift coincided with decreased estimates of exploitable biomass partially driven by observations of reduced size at age in the halibut stock, a phenomenon thought to be related to changing environmental conditions.

As quotas shift and decline, fishermen who once would have had little investment beyond a vessel and gear now find themselves with hundreds of thousands of dollars invested in catch shares that represent far fewer pounds of harvest than in previous years. They are unable to move among areas in the Gulf to respond to changes in distribution without engaging in a complex purchase and sale of quota share.

As Councils consider future catch share programs, consideration should be given to possible future impacts of climate change. Flexible program design that will reduce the cost of entry and allow the fleet to adapt to climate-driven changes in the ecosystem should be a paramount consideration. The benefits of programs that significantly increase the cost of entry and limit fishermen to a single species and area must be weighed against the likelihood that such a program will continue to be beneficial in the future if ecosystem factors change significantly. Similar consideration should be given when other management measures are designed, such as prohibited species catch reduction programs, and Councils should realize that frequent reexamination of such programs may be required to respond to changing environmental conditions.

Incorporating Climate Data into Management Decisions

Given the current attention to a changing climate and the development of a more advanced understanding of the interactions between climate and stock health, managers are faced with the challenge of how best to incorporate uncertainty related to future climate variables into today's actions. For example, in the North Pacific, significant research has been done on the relationship of productivity of certain species with ocean temperature, and stock assessment scientists incorporate environmental information into annual stock assessment and fishery evaluation documents, which are used to establish allowable catches.

In the North Pacific pollock fishery, much thought has been given to how a reduction in sea ice and a corresponding increase in ocean temperature might affect the spatial distribution of the pollock stock. The pollock fishery is one of the world's largest, and the stock straddles the international boundary between Alaska and Russia. Concern that changing conditions would shift more of the stock into Russian waters led to initial research that revealed the cold pool in the Bering Sea in some years limits the Northwestward movement of the stock. In 2012 however, stock movement appeared to be less inhibited by the existence of the cold pool (NOAA ASFSC 2012b).

Fishery managers carefully consider these dynamics when setting annual catch allowances, but have not yet had to reduce pollock catches in the U.S. fishery as a result of stock movement. Careful monitoring continues, and managers will need to react if stock distribution shows a notable change that could increase the vulnerability of the stock to exploitation in Russian fisheries.

The mechanisms for coordination and cooperation in management of transboundary stocks will be tested as climate change continues to drive changes in species abundance and distribution across jurisdictional lines. Attention should be paid to mechanisms for cooperation between state managers, between state and Federal managers, and between neighboring nations to ensure that assessment programs are coordinated and harvest levels are appropriate as stocks shift.

In both the North Pacific and other jurisdictions, efforts have been made to develop stand alone ecosystem plans or assessments. Although these are useful as reference documents and for long-term strategy and coordination, they are somewhat removed from the day-to-day actions of fishery managers, and further effort is needed to fully incorporate ecosystem and climate change information into decision-making documents rather than stand alone documents.

Within the decision-making process, managers should be careful not to unnecessarily forego available sustained yield opportunities in the short term based solely on precautionary principles. For some species, impacts from climate change are distant and in the proximate timeframe the species are expected to remain abundant and robust. Allowing harvest opportunities in the short term provides essential economic benefits to fishermen and local communities that should not be foregone unless sacrificing short term yield will benefit the long-term viability of the stock.

Climate Change and the Endangered Species Act

The section above discusses how climate science and environmental variability are incorporated into stock assessment to allow for continued responsible management. However, some stakeholders are pushing for an approach to future uncertainty that would have far greater impacts on fishery managers' ability to optimize yield and on fishery dependent communities' ability to thrive. For example, in the North Pacific, the National Marine Fisheries Service recently received a petition to list 44 species of corals under the Endangered Species Act (ESA). Unlike most traditional ESA listings, the petition does not allege that the coral species are unhealthy, or point to a trend of decline. Instead, the petition points to possible future impacts of climate change and ocean acidification as a justification to list the species now and provide additional protections (Center for Biological Diversity 2012).

Surely, it was never the intent of the ESA to be used to protect a healthy and abundant species that might face a threat in the distant future. If so, the other management frameworks that are intended to apply to most known species would have no place. However, the coral petition is not a new approach to ESA listings in Alaska. Already, the stable and healthy polar bear population has been listed as threatened based solely on untested models of future sea ice loss, despite evidence that the species has survived prior warming periods.[4] And last December, NMFS announced their intention to list ringed and bearded seals, which have populations that number in the millions and hundreds of thousands, respectively, based solely on speculation about future sea ice loss and despite the fact that the agency itself acknowledges there is no immediate threat to these abundant animals.[5]

Given precedents such as these, it is questionable which species would not qualify for an ESA listing. If indeed a healthy population, in some cases numbering in the millions of animals, is subject to listing without any evidence of a declining trend, what role remains for fishery managers, fishery Councils, and state fish and wildlife agencies in determining appropriate protections for species under their traditional authorities?

The Magnuson-Stevens Fishery Conservation and Management Act and the very constitution of the State of Alaska require that species be managed for sustained yield and that appropriate protections be provided. In the North Pacific, the Council and the State of Alaska have mechanisms in place to protect species and manage in a precautionary fashion using the best scientific information available, but these traditional management authorities will be irreversibly eroded if Federal agencies continue to use speculative future impacts from climate change as a justification to bring healthy and abundant species under the daunting and burdensome umbrella of the ESA.

Federal agencies should instead respond to such concerns with detailed and rigorous plans for both individual species and ecosystem monitoring, and research to ensure early detection of any real world change to the health of the species. Planning processes could be put in place to ensure that more precautionary measures are readily available should they become necessary. Avoiding this potentially more challenging task and instead moving directly to burdensome regulatory requirements will only serve to remove management authority from existing bodies with the necessary expertise; it is a mistake with grave implications for the future of fisheries in a changing climate.

Alaska Department of Fish and Game Strategy

In 2010, the Alaska Department of Fish and Game adopted a strategy for responding to climate change and its impacts on fish and wildlife species under our jurisdiction (ADFG 2010). The strategy includes identified expected climate impacts to fish and wildlife and their uses across Alaska, focusing on those impacts that are expected to occur within the next 20-25 years. Identified key impacts include altered hydrologic conditions; altered sea ice conditions; ocean acidification; changing species distributions, abundances, and phenologies; invasive species; impacts on existing harvest opportunities; impacts on existing regulatory structures; and impacts of development of "clean" energy alternatives. For each identified key impact, key strategies were identified to address the impacts.

4 73 FR 28212, May 15, 2008. http://tinyurl.com/6hjjda

5 NOAA Fisheries Alaska Regional Office, Endangered Species Act Listings for Bearded and Ringed Seals, (website), http://tinyurl.com/mdtzmcw.

The strategy also identified research as a key element towards understanding and predicting impacts and assessing strategy implementation. Identified areas of needed research include improved downscaled (local) climate models, need for research and monitoring to define the baseline, improved baseline mapping, improved research infrastructure, improved data integration and sharing, need for adaptable legal and policy frameworks, and education and outreach. Finally the strategy identifies management principles, key strategies, and key initial actions.

Key strategies the department is now implementing include filling information gaps related to climate change on Alaska fish and wildlife populations, working with the University of Alaska to develop scaled down climate change scenarios, and establishing partnerships with other agencies evaluating climate change impacts.

Other resource agencies and governments have undergone similar planning processes and developed strategies and recommendations for responding to climate change. Further planning of this type is recommended to embrace the reality of climate changes, identify reasonably foreseeable impacts, and prioritize research that will assist in identifying and responding to changing conditions.

Conclusions

Throughout this paper, it has been noted that the most pressing need to effectively respond to a changing climate is better information for managers. Recommendations include infrastructure and research in the Arctic, increased research into interactions between climate variables and fishery stocks, and research and planning for protection of species that are the target of ESA petitions. However, concern exists that the current Federal fiscal climate is a barrier to implementation of these recommendations. Our Federal managers struggle to maintain funding for core stock assessment work, even as dollars are expended on new initiatives such as aquaculture development or national oceans policy. In order to equip managers with the information needed to respond responsibly to the threats and opportunities brought about by a changing climate, it is paramount that the appropriators fully understand the resource needs of Federal agencies and that the agencies themselves are disciplined in allocating funding to core responsibilities and research priorities rather than funding new initiatives that do not address these pressing needs.

Recommendations

- Additional investment in the Arctic, particularly for additional fishery research and stock assessment science and research infrastructure.
- Precautionary management should be extended to the Arctic donut hole and other Arctic nations' EEZs. Generally, precautionary management is a recommended approach when rapidly changing conditions expose new areas or stocks to significant commercial effort.
- Consideration of climate-driven ecosystem changes in designing catch share programs, habitat and species protections, and annual quota setting.
- Increased coordination between jurisdictions to ensure transboundary stocks are adequately managed and protected when distributional shifts occur.
- Do not unnecessarily forego available sustained yield opportunities that provide essential economic benefits to fishermen and local communities in the short term in the absence of evidence that such actions will benefit the stock in the future.
- Consistency in ESA listings based on present stock status and conditions. Potential future climate-driven impacts should be a key focus of research and management but should not serve as criteria for listing.
- Jurisdictions should develop strategies for responding to climate change that identify critical needs and prioritize research and resources.
- Federal agencies must focus on core stock assessment responsibilities in times of reduced Fed-

eral budgets as these services are critical sources of information needed to manage responsibly in a changing ecosystem.

Acknowledgments

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Assessment and Maintenance of Ecosystem Health in the Face of a Changing Climate

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Abstract

Integrated Ecosystem Assessments (IEAs) provide a structured approach to ecosystem evaluation that serves as an integrative complement to single-species and single-sector assessments now applied in resource management. IEAs provide assessments of status and trends of key ecosystem components as well as the environmental, social, and economic causes and consequences of these trends. They forecast the likely status of key ecosystem components under a range of policy and/or management actions, and identify knowledge gaps that will guide future research and data acquisition efforts. In this paper, I highlight how the IEAs can be brought be used to inform fisheries management in an era of rapidly changing climate. Using examples from the U.S. Pacific Coast, I illustrate how ecosystem indicators, risk assessments and scenario analysis can be used to develop fisheries management that is robust to climate change. Importantly, IEAs not only provide information about fisheries, but analyze the full breadth of ocean uses. Thus, they consider sectoral trade-offs that may emerge or be amplified as a consequence of climate change. The challenge for IEAs to inform the multitude of ocean uses against a backdrop global change is great; however, sustainable resource management requires that we bring science to the fore to confront this challenge.

Introduction

The need for a more holistic and integrated approach to management of ocean resources is now widely appreciated, and in recent years, NOAA has been developing scientifically-based ecosystem management strategies by advancing, integrating, and expanding our science to enable an ecosystem-based approach to management (EBM). The objective of EBM is to make management of natural resources more effective. It takes a step beyond traditional management that considers single issues, species, or functions independently, and instead takes into account the richness and complexity of the interactions between them. Additionally, EBM considers the inherent links between human activity and wellbeing and the condition of the ecosystem and its parts. Importantly, rather than replacing existing management structures, and the science that informs that management, EBM builds on these and develops them further. Finally EBM cannot be realized without a solid science core—one that provides an understanding of the ecological systems, including individual components within a system, as well as the social elements.

Implementing EBM requires a framework to assess the status of marine ecosystems in relation to specific management goals and objectives and to evaluate the probable outcomes of alternative management strategies. IEAs are intended to provide just such a framework. IEAs provide a structured approach to ecosystem evaluation that serves as an integrative counterpart to single-species and single-sector assessments now applied in resource management.

The fundamental structural elements of NOAA's IEA framework have been previously described (Levin et al 2008, 2009). Here, we briefly outline NOAA's IEA approach and describe how IEAs can assist fisheries managers as they prepare for ecosystem changes associated with climate change and ocean acidification.

What is an Integrated Ecosystem Assessment?

An IEA is a formal synthesis and quantitative analysis of existing information on relevant natural and socioeconomic factors in relation to specified ecosystem management objectives. It brings together citizens, industry representatives, scientists, and policy makers through established processes to evaluate a range of policy and/or management actions that are relevant to a diversity of environmental objectives.

An IEA results in the following products:

- Identification of key management or policy questions and specification of ecosystem goals and objectives
- Assessments of status and trends of the ecosystem
- Assessments of the environmental, social, and economic causes and consequences of these trends
- Forecasts of likely status of key ecosystem components under a range of policy and/or management actions
- Identification of crucial gaps in the knowledge of the ecosystem that will guide future research and data acquisition efforts.

A Step-Wise Process for Developing an Integrated Ecosystem Assessment

Step 1: Define Ecosystem Goals and Targets

IEAs are driven by clearly defined management objectives; consequently, the IEA approach purposefully begins with the scoping step to clearly identify priority management objectives to be addressed. Scoping the IEA requires that scientists, managers and stakeholders work together to define the broad vision and objectives of the IEA, the spatial scale of the IEA, and the ecosystem components and ecosystem threats that will be included in the effort.

Step 2: Develop Ecosystem Indicators, Reference Levels, and Assess Ecosystem Status

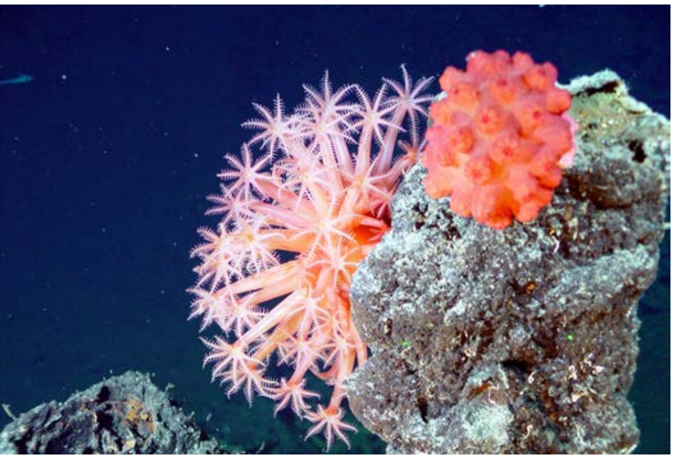
A critical step in the IEA process is to select indicators that capture the key ecosystem states and processes that underlie healthy ecosystems. Effective indicators serve as measures of the many of the ecosystem services that concern policy makers and stakeholders (Link 2005), and are one of the primary contact points between policy and science.

Establishing a set of indicator values that reflect progress towards specific management objectives is critical for successful EBM. Reference levels provide context for evaluating performance and progress towards EBM goals. They can be diverse and include both ecosystem state variables of interest (e.g., habitat area, measures of diversity, etc.) as well as metrics of ecosystem pressures (e.g., shoreline development, nutrient or contaminant input, etc.). These levels can be drawn from the underlying properties of the natural and human systems or they can be designated as part of the process of setting management goals. Establishing a reference level is informed by science, but ultimately reference levels are set to achieve a desired policy outcome.

With ecosystem indicators and reference levels in hand, it is possible to assess the state of the ecosystem. In general, this can be expressed as the value of the indicator relative to a desired future state.

Step 3: Risk Analysis—Impacts of Natural Perturbations and Human Activities on Ecosystem Status

Once ecosystem indicators and reference levels are selected, IEAs evaluate the risk to the indicators posed by human



activities and natural processes. The goal of these risk analyses is to qualitatively or quantitatively determine the probability that an ecosystem indicator will reach or remain in an undesirable state (i.e., breach a reference limit). Risk analysis must explicitly consider the inevitable uncertainties involved in understanding and quantifying ecosystem dynamics and their positive and negative impacts on social systems. An ecosystem risk analysis requires an understanding of the distribution and intensity of land-, air- and sea-based pressures, as well as their impacts on ecosystem components.

Step 4: Evaluation of Management Strategies for Protection or Restoration of Ecosystem Status

The next step in the IEA process uses simulation, analytical or conceptual modeling to evaluate the potential of different management strategies to influence the status of natural and human system indicators, and to achieve our stated ecosystem objectives.

Systematic scenario analysis is increasing being used as an approach to evaluate management options. Scenario analysis generates multiple alternative descriptions of potential outcomes, including processes of change, thresholds and uncertainties (Alcamo 2008). Scenarios explore alternative perspectives about underlying system processes and can illuminate key issues, by using a consistent set of assumptions about the system state to broaden perspectives (Raskin 2005, Refsgaard et al. 2007). They generate alternative, internally consistent, logical descriptions of the future. Scenarios can be qualitative, in which "storylines" are developed, or quantitative, in which the outcomes of numerical models are explored (Refsgaard et al. 2007). Scenarios typically include assessments of the ecosystem state variables and driving forces, descriptions of critical uncertainties, and approaches for resolving them (Swart et al. 2004). One unique attribute of scenarios is that they acknowledge the interdependencies of system components. The advantages of qualitative scenarios include more flexibility to incorporate multiple stakeholder perspectives and greater capacity for creative thinking. Quantitative scenarios can provide geographical and numerical specificity to the concepts provided by qualitative scenarios (Alcamo et al. 2005).

Step 5: Monitoring and Evaluation

Monitoring and evaluation of chosen indicators and management strategies is an integral part of the IEA process. Monitoring and evaluation is necessary to determine whether management strategies improve ecosystem services and sustainability, and quantifies the trade-offs that have occurred since implementation of the management strategy.

At its core, monitoring is straightforward; it is the collection of biotic, abiotic and human dimension data. In the context of IEAs, monitoring is the systematic collection of data to reliably answer clearly articulated management questions (Katz 2013). In the case of IEA indicators, monitoring must directly address the operational objectives developed as part of the scoping process. Successful monitoring depends on developing efficient sampling programs that allow a cost-effective determination of the state of the ecosystem and the effectiveness of management actions. Importantly, monitoring includes not only measurements of the biophysical environment, but also includes social and economic systems.

A status evaluation is focused on giving an interpretation of where an ecosystem component is at a particular time. Impact evaluations are generally one-time assessments frequently performed at the conclusion of a management project is complete. The goal of impact evaluations is to determine how well a particular project performed. Adaptive management is an iterative process that integrates the design of management strategies and monitoring to systematically evaluate management actions, and is obviously related to evaluation. The goal of adaptive management is to learn and then adapt ongoing management. Adaptive management thus can be viewed as a way of "learning by implementing."

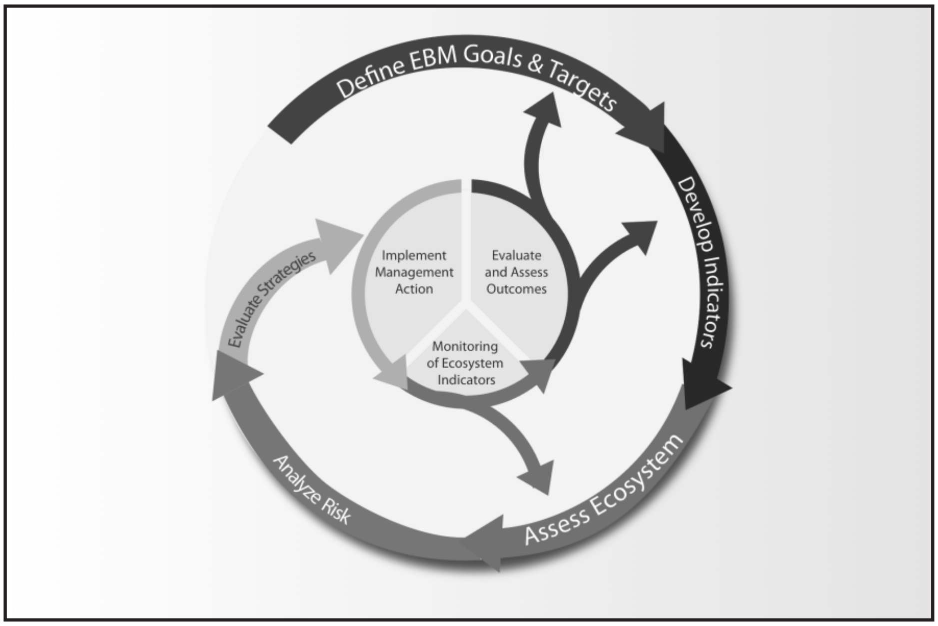


Figure 1. A schematic view of the Integrated Ecosystem Assessment process that begins with scoping the goals and targets of Ecosystem-Based Management, and continues to the development of indicators, an assessment of ecosystem status and risk. It then forecasts likely status of key ecosystem components under a range of policy and/or management strategies.

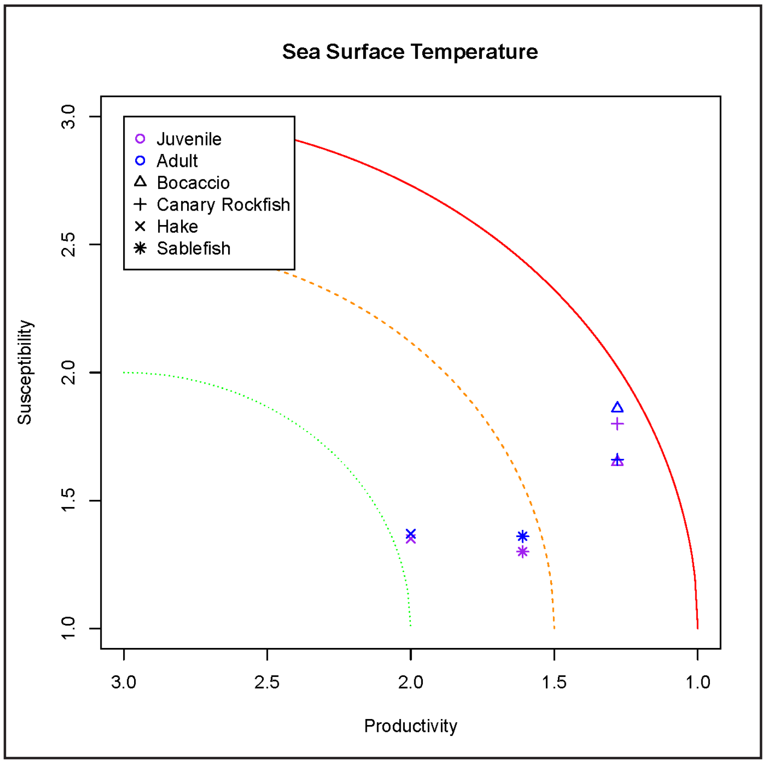


Figure 2. Productivity-susceptibility analysis plot for the eight species/life stages relative to sea surface temperature as a threat. The susceptibility axis represents a relative score among species and stages but not among threats, though values near one indicate little to no impact in all cases. Where the adult and juvenile Susceptibility scores are identical, the symbols are on top of each other and only the adult values are visible. Reprinted from Levin and Wells (2013).

Integrated Ecosystem Assessments, Climate Change, and Ocean Acidification

In the oceans, global warming may lead to a 1.8–4°C (3–6°F) increase in sea surface temperature this century. This may cause northward shifts in species ranges and migration patterns, changes in growth and reproductive rates, and 1–7 percent reductions in the oxygen content of water, particularly in nearshore areas. These hypoxic areas may lead to local die-offs of crabs or other species with limited mobility. Primary production (phytoplankton) may increase, but smaller phytoplankton may be favored, leading to less food availability for large zooplankton (e.g. krill) but more for smaller zooplankton (e.g. copepods).

Increasing fossil fuel emissions and the resulting increase in atmospheric CO_2 levels will likely lead to a decline in seawater pH of 0.3 by the year 2100. Changes to seawater pH and the saturation state of aragonite and calcite (the minerals many organisms use to build protective structures) could lead to reduced populations of marine species including corals, crabs, shellfish, benthic invertebrates, and plankton groups such as krill. There is considerable uncertainty regarding which species will be impacted, and to what extent.

IEAs have the potential to inform fisheries management in the face of a changing environment. Below we provide examples from the California Current IEA to illustrate the way IEAs can inform fisheries management in a changing climate.

Indicators

Low dissolved oxygen concentrations in coastal and shelf waters of the California Current ecosystem is a relatively recent issue and is dependent on a number of climate-mediated processes. Monitoring of indicators of dissolved oxygen has revealed that increased low dissolved oxygen events in the northern California Current, with impacts on fish and benthic invertebrate communities off Oregon (Keller et al. 2010). For example, during a severe anoxic event in August 2006, surveys found an absence of rockfish on rocky reefs and a large mortality event of large benthic invertebrates (Chan et al. 2008).

Risk Assessment

Quantitative risk assessment is a general analytical approach for describing the likelihood and magnitude of adverse consequences due to exposure to particular threats (and, if possible, cumulative impacts of multiple threats. A recent development in the use of risk assessment in fisheries management is the productivity-susceptibility analyses that have been used as an evaluation of the vulnerability of fish stocks to current fisheries management practices, based upon their susceptibility to the fishery and a suite of life history traits that indicate productivity.

Figure 2 shows the relative risk faced by four species of groundfish to changing sea surface temperature. Such analyses reveal that adult bocaccio and juvenile canary rockfish are at higher risk to changing climate relative to adult or juvenile hake or sablefish. Given overfished status of bocaccio and canary rockfish, this added risk is of concern.

Scenario Analysis

As part of the California Current IEA (Levin and Schwing 2011), Ainsworth et al. (2011) attempted to reproduce ecosystem changes associated with climate change using Ecopath with Ecosim models. They examined changes in fisheries landings as a function of climate-induced changes in primary production; range shifts, size structure of zooplankton, ocean acidification, and dissolved oxygen. Model simulations predicted that the performance of fisheries and the relative abundance of species in the northern California Current are expected to change, but not in a uniform way. Despite the implementation of mainly negative forcing functions (that reduce productivity), many fisheries and species benefited because of indirect feeding relationships. However, the cumulative impacts of all climate effects reduced landings by 40 percent (Figure 3). The impacts were even more severe when range shifts were included in the cumulative impacts scenario.

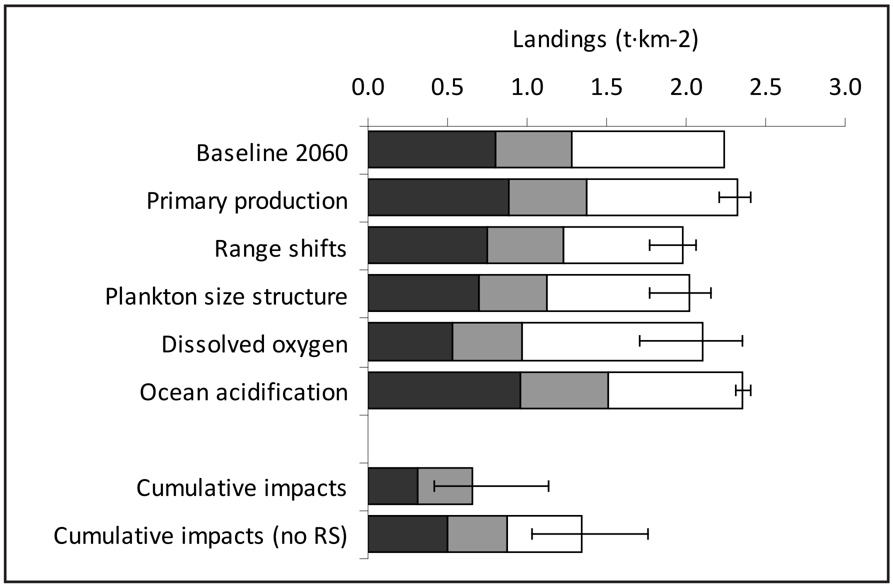


Figure 3. Projected fisheries landings in the northern California Current (2060). Baseline shows projected landings without climate change. Error bars show the range of outputs predicted using three effect sizes (nominal, moderate and substantial); bar shows median. Dark grey: demersal fish; light grey: pelagic fish; white: invertebrates. Based on Ainsworth et al. (2011); reprinted from Levin and Schwing (2011).

Integrated Ecosystem Assessments Link Ecosystem Science to Fisheries Management in a Changing Climate

The rate of climate change in the last 100 years is greater than any other change experienced over the last 10,000 years (Marcott et al. 2013). There is no question that Regional Fishery Management Councils will be challenged to implement policies that are robust to the combined effects of fisheries extraction and climate change. The aim of IEAs is to synthesize the best available science about climate and harvest impacts on fish stocks, and to project the efficacy of different management approaches for achieving management goals. It is clear that climate change will affect the distribution, abundance, growth and species composition of our Nation's fisheries (Ainsworth et al. 2011), and that management that does not consider such changes will fail (Kaplan et al. 2010).

The situation becomes more complex because we, of course, manage the ocean for many uses and these may conflict with fisheries. The impetus for alternative energy including wind, wave and hydropower that impact fisheries will increase as human populations grow, and society seeks energy that does not emit green house gases. Conservation concerns may increase as climate change affects habitat, prey and risks facing protected species. IEAs can provide the information needed to carefully consider trade-offs between fisheries and other ocean uses, and they can assist policy makers to develop plans that attempt to meet society's cross-sectoral objectives. The challenge for IEAs to inform the multitude of ocean uses against a backdrop global change is great; however, sustainable resource management requires us to confront this challenge.

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Effects of Climate Velocity on Fish and Fisheries

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Abstract

By 2100, global temperatures are projected to be 2–4°C warmer and ocean waters are expected to be substantially more acidic than they are today, with profound effects on natural ecosystems and human societies. Climate drives clear changes in fish populations and communities, including alterations in abundance, productivity, distribution, and species composition. Both in the U.S. and around the world, clear indications can be found of population shifting to follow changes in temperature. Fisheries respond to these changes in the ecosystem, including by following fish poleward and by changing the mix of species caught in any particular location. Despite the clear impacts, climate is not explicitly considered in traditional fisheries management and a range of opportunities exist for fostering "climate-ready" fisheries in the future. Adapting fisheries management will likely require two parallel and complementary approaches: 1) anticipating climate impacts where possible to guide preparations, monitoring, and long-term planning, and 2) maintaining management flexibility, ecosystem monitoring, and rapid-response capabilities to adapt quickly when ecosystems change unexpectedly. One useful approach is to test alternative fisheries management methods and choose the strategy that performs the best under a range of possible future conditions. Preparing climate impact assessments (including online interfaces and regular reports to fishery management Councils) that summarize existing climate states, predicted future conditions, and their regional impacts on fish and fisheries will provide resources for managers to make informed decisions and help to educate stakeholders. Shifts in species distributions that affect international agreements appear particularly difficult to negotiate. Given the clear signals from past climate impacts and the strong importance of fisheries to our coastal economies, efforts to adapt fisheries to climate impacts will be most effective if they begin as soon as possible.

The Pace of Climate Change in the Oceans

By 2100, global temperatures are projected to be 2–4°C warmer and ocean waters are expected to be substantially more acidic than they are today, with profound effects on natural ecosystems and human societies (Caley et al. 1996; IPCC 2007). The world is now committed to at least a substantial portion of these changes even if rapid mitigation measures are taken, and society must consider not only what impacts to expect, but also how to adapt to those impacts.

Climate velocity measures the speed and direction that species would have to shift to maintain a constant temperature (Fig. 1). Climate velocities are as fast, and sometimes faster, in the ocean than they are on land (Burrows et al. 2011). Median velocities from 1960-2009 in the ocean have been 21.7 km/decade, but reached 200 km/decade near the tropics and in the sub-Arctic (Burrows et al. 2011). Velocities in the ocean are 2-7 times faster than on land in the topics and the sub-Arctic, but similar to those on land at most other latitudes (Burrows et al. 2011).

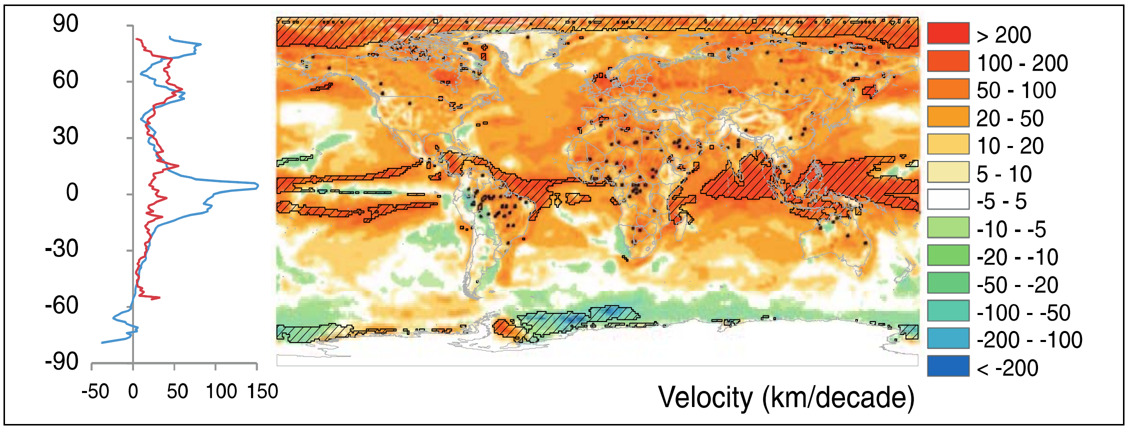

Figure 1. *The velocity of climate change represents that pace at which species would have to move to maintain a constant temperature (i.e., it does not consider the ability of species to move). Rates on the map are expressed in km/decade and are for 1960-2009. Velocity is positive in areas of warming and negative in cooling areas (e.g., Southern Ocean). The graph on the left shows averages for land (red) and ocean (blue) by latitude. Figure reproduced from Burrows et al. 2011.*

It is important to recognize that there is much variation in climate velocity from region to region and through time. For example, though the global ocean has been, on average, warming rapidly for the past three decades, the California and Humboldt Current ecosystems have been cooling (Belkin 2009). This appears to result from climate variability (e.g., Pacific Decadal Oscillation and El Niño), and so may reverse in the future (Chavez et al. 2011). Other regions, such as the northeast U.S., have been warming rapidly in recent decades (Belkin 2009). Over multiple decades, however, the impacts of climate variability average out, leaving the long-term warming signal from climate change clearer.

Observed Responses of Marine Fish and Invertebrates

Fish appear to respond quickly and often quite predictably to changes in water temperature. There are physiological reasons to expect this effect, including the concept of a "thermal envelope" within which fish have sufficient oxygen for growth and survival (Pörtner & Knust 2007). These envelopes vary among species, and marine species distributions match closely to their physiological limits, including more closely than on land (Sunday et al. 2012).

Observed changes over the past few decades support this view of strong temperature effects on marine species. For example, from 1980-2008, southern species increased in abundance and northern species declined throughout the northern European shelf as temperatures warmed (Simpson et al. 2011). Elsewhere, many new species are appearing in ecosystems and becoming available to fisheries in ways that appear linked to changes in temperature. In the United Kingdom, sea bass (*Dicentrarchus labrax*), red mullet (*Mullus barbatus*), John dory (*Zeus faber*), anchovy (*Engraulis encrasicolus*) and squid are now sparking new fisheries (Cheung et al. 2012). There have been a wide range of similar observations around the world, with species generally shifting poleward (Murawski 1993; Nye et al. 2009; Perry et al. 2005; Sorte et al. 2010).

Predicted Responses

A direct consequence of shifting species distributions is that many traditional fisheries will decline, while new opportunities for fisheries will emerge. In the northeast U.S., for example, cod, pollock, and haddock appear unlikely to be available to fisheries by the end of the 21st century (Lenoir et al. 2010), but Atlantic croaker and blue crab are predicted to become more abundant (Hare et al. 2010; Najjar et al. 2000). Globally, fish are projected to shift 45-49 km/decade poleward under a moderate climate-warming (A1B) scenario (Cheung et al. 2009).

Basic population ecology suggests that fish populations are particularly vulnerable when they colonize new territory. Delaying the start of new fisheries (e.g., NPFMC 2009; Stram & Evans 2009) until newly colonizing species fully establish a population appears to be a strategy that will allow species to adapt more smoothly to climate change.

Aside from specific changes in distribution, an important question is which species are likely to survive well under future climates and which will do poorly. Research from species invasions predicts that species with lower dispersal abilities and slower population growth rates (usually those species with longer lifespans) will have more difficulty keeping up with rapid climate velocities (Hastings et al. 2005; Zhou & Kot 2010). Species with lower dispersal abilities are also more likely to be out-competed by those that disperse further, since the former tend to lag behind their optimal thermal environments (Urban et al. 2012).

Finally, those species facing the fewest additional stressors will have the greatest capacity for adapting to climate change. Fishing, for example, typically truncates the age structure of exploited species, reduces their within-species diversity (life history, geographic, and genetic diversity), and causes their geographic range to contract. All of these factors reduce resilience to climate impacts and can increase the magnitude of population fluctuations (Brander 2007; Hsieh et al. 2006; Rouyer et al. 2011). For example, the high geographic and habitat diversity of Bristol Bay salmon appears to have reduced the risk of a fishery closure in any given year to less than 4 percent, a ten-fold reduction in risk compared to a less diverse set of populations (Schindler et al. 2010).

While all predictions about the future have uncertainty, scientists are more confident in some predictions. For example, climate-driven shifts in species distributions tend to be more predictable than changes in abundance, recruitment, and productivity (Walters & Collie 1988). This effect may occur because climate is a dominant factor in population dynamics at range edges, while fishing and other impacts are stronger elsewhere in fish ranges. Compared to patterns on land, it appears that range shifts will be more predictable in the ocean because there are fewer microclimates and fewer barriers to dispersal in the ocean, two key factors that complicate predictions on land (Robinson et al. 2011). In addition, marine species' ranges generally conform to species' physiological thermal limits more closely than do terrestrial species, again implying that climate impacts will be more predictable in the ocean (Sunday et al. 2012).

Effects on Fisheries and Fisheries Management

Range shifts have important implications for fisheries and fisheries management. As species in the northeast U.S. have shifted to higher latitudes, fisheries have shifted poleward as well except where regulations or other economic and social factors have impeded these shifts (Pinsky & Fogarty 2012). Shifts in stocks require re-evaluation of stock boundaries, population productivity, and allowable catches (Link et al. 2011). As discussed above, range shifts can lead to newly emerging fisheries in new areas. If not considered explicitly in fisheries management, shifts can lead to the over- or under-estimation of population biomass or the rate at which a population can be harvested (e.g., maximum sustainable yield). Shifts can also reduce the effectiveness of existing management measures. For example, offshore shifts in North Sea plaice (*Pleuronectes platessa*) have made a closed area (the "Plaice Box") largely ineffective (van Keeken et al. 2007). Permanent closed areas may be warranted in other cases to protect previously de facto refugia. The North Pacific Fishery Management Council set up Marine Protected Areas for blue king crab in the Bering Sea to protect habitat from shifts in the location of bottom trawling (Stram & Evans 2009).

Even for individual populations, shifts in climate and species ranges can complicate basic fisheries monitoring, and therefore management. In the Aleutian Islands, the bottom trawl survey has a harder time catching yellowfin sole in cold temperatures, and so survey abundance indices are now adjusted to account for temperature (the Plan Team for the Groundfish Fisheries of the Bering Sea and Aleutian Islands 2012). In the northeast U.S., survey indices for butterfish populations fluctuate widely, but much of this variation appears to result from migration of the butterfish population into and out of the survey extent from year to year (J. Manderson, personal communication).

Shifts of species across national or management boundaries raise complex issues of coordination and equity. If populations shift enough to straddle management boundaries, fishing in both regions can create a situation of "double jeopardy" that is not sustainable. For example, both Iceland and the U.K. want to fish mackerel stocks that have shifted into Icelandic waters, and the combined harvest threatens to cause overfishing (Anonymous 2010; Cheung et al. 2012). The disagreement among the two countries has been dubbed the "Mackerel Wars" (Anonymous 2010). Pacific salmon harvest in the U.S. and Canada may become a similar case (Miller & Munro 2004), and cross-boundary groundfish populations in the northeast U.S. and eastern Canada raise similar issues. Pre-agreements, perhaps involving side payments, are one method for avoiding destructive conflicts that would otherwise arise without proactive negotiations (Miller & Munro 2004).

Climate change also has important implications for stock rebuilding plans, since these have the long time horizons over which climate effects are most likely to accumulate (MacCall 2002). For example, even lower fishing rates than currently considered would be needed to achieve rebuilding goals for depleted west coast U.S. rockfish if spring transition dates are delayed by climate change (Holt & Punt 2009). Climate change may also mean that rebuilding goals for cod are simply unachievable and that new, lower rebuilding goals will be needed (Mieszkowska et al. 2009). However, managers will have to be very careful not to use climate change as an excuse to avoid the hard work of rebuilding or managing fisheries sustainably. Coupling projections of climate to observations and monitoring will be critical for deciding when and if to initiate action.

The climate-driven shift of populations out of a management zone can actually alter the fundamental incentive structure of fisheries. While individual transferable quotas and other secure rights systems normally increase the incentives for stewardship, this incentive may evaporate when a stock is expected to shift to another region. In that case, the incentive can instead become the exact opposite: one rational response is to harvest as hard as possible before the population leaves (Silvert 1977). This course of action would clearly have negative consequences for the harvested species and for stakeholders on the receiving end of the shifting population.

Detecting Changes

A range of tools exists for detecting changes in climate and subsequent impacts on fish populations. Fishery-independent surveys, for example, have already been used in many regions of the U.S. for detecting changes in fish distributions (Mueter & Litzow 2008; Murawski 1993; Nye et al. 2009). The wide spatial extent and long history of bottom trawl surveys have made these surveys in particular quite useful, but other surveys can also be analyzed to detect changes in spatial distribution. Fishery-dependent surveys may also be useful when other information is lacking, though care must be taken to consider other impacts on where fishermen fish (e.g., changes in closed areas).

Other tools can be very useful for detecting changes in the marine environment, but are only beginning to be used in fisheries management. Remote sensing of temperature, primary productivity, and sea ice cover can all provide evidence of current environmental conditions, including the amount of habitat available for different species. Regional hubs for the U.S. Integrated Ocean Observing Systems initiative (http://www.ioos.gov) provide remotely sensed data, as well as temperature and other data from buoys, robots, and sensors in the coastal ocean to management bodies and to the public. Dynamic ocean models are increasingly being used to fill in data gaps in real time, such as subsurface ocean conditions.

One key tool for detecting climate impacts is regional calculations of expected climate impacts. When and how much is temperature expected to change? Will primary production, ocean currents, and oxygen concentrations change? Which species are expected to appear, or disappear? Rapid progress in being made on downscaling global climate models to the regional scale of fisheries management and linking these projections to consequences for fisheries (Ainsworth et al. 2011; Hare et al. 2010; Hare et al. 2012; Kaplan et al. 2010), but such efforts need to be scaled up substantially. By knowing which physical and ecological factors are most likely to change, monitoring efforts can be tuned to detect these impacts earlier and with more certainty.

Potential Adaptation Options

As described above, global climate change is expected to strongly affect the distribution, abundance, and persistence of marine fishes and of the fisheries that rely upon them. Such impacts can be subtle in any particular year, but these impacts will accumulate over time to threaten the sustainability and effectiveness of current fisheries management. The traditional approach to fisheries management focuses strongly on the impacts of fishing, largely or even entirely ignoring the impacts of climate. While this is starting to change in a few jurisdictions and for a few fisheries, much more widespread adaptation will be needed in the coming years and decades. Below are a series of approaches for adapting fisheries management to the impacts of climate change. The approaches are not mutually exclusive, and in fact, many, if not most, of them may be needed.

Integrate Climate-Relevant Monitoring into Fisheries Management

To guide climate adaptation in fisheries, a wider range of ecosystem monitoring tools can be integrated into fisheries management, including biophysical information (temperature, acidification, phytoplankton, etc.), remote sensing, oceanographic models, and climate-focused biological monitoring. For example, changes in spatial distribution are a common climate impact and yet not a routine part of fisheries monitoring. Spatial distribution can be extracted from existing bottom trawl, mid-water trawl, hydroacoustic, and aerial spotter surveys (Azarovitz 1981; Mueter & Litzow 2008; Nye et al. 2009). Where these surveys exist, an important step is to summarize range shift information for fisheries managers and incorporate this information into the management process.

Annual reports on the state of the climate and the ecosystem would help to identify when sudden climate events may necessitate a management response. Early examples of these reports include the Ecosystem Considerations report for the North Pacific Fishery Management Council, Integrated Ecosystem Assessments underway in the California Current and the northeast U.S., and the Ecosystem Advisories issued for the northeast U.S. Publicly available and easily understood websites would be an important part of this effort, similar to the Integrated Ocean Observing initiatives (http://www.ioos.gov). More widespread adoption of these reports and increased attention to improving their focus and explicit ties to management would help to integrate climate considerations into fisheries management. More broadly, the potential for changes in climate to affect the productivity of fish populations needs stronger recognition within the annual cycle of fisheries management, and regular reports can help to raise that awareness.

Build Rapid-Response Methods into Management

Despite the many predictable impacts of climate change, other climate impacts on fisheries will be unpredictable over the annual time-horizons of fisheries management. One method for dealing with this uncertainty is to react quickly as soon as impacts become apparent, even when the full mechanism is not understood (Peterman 2009). Fisheries scientists are beginning to develop methods for detecting and responding to changes in stock productivity and growth as part of the stock assessment process (Haltuch & Punt 2011; Peterman et al. 2000). The ecosystem monitoring and real-time synthesis of such data, as discussed above, is also a crucial first step in a rapid response.

Avoid Bycatch and Re-evaluate Closed Areas

Shifts in species distributions have particularly strong impacts on spatial fisheries management, including closed areas and bycatch avoidance. As described earlier for the Plaice Box in Europe, species may shift out of closed areas designed for their conservation and management (van Keeken et al. 2007). If such shifts are detected or predicted, it may be necessary to move closed areas to follow shifts in species.

Habitat models that incorporate temperature, bottom habitat, currents, oxygen, or other oceanographic conditions can be used to forecast future distributions as well as identify current habitats (Cheung et al. 2009; Lenoir et al. 2010). Real-time habitat distributions can be particularly useful for avoiding bycatch of protected species. The TurtleWatch product, for example, uses remotely sensed Sea Surface Temperatures and ocean currents to identify regions where interactions between long-line fishing vessels and loggerhead turtles are particularly likely (Howell et al. 2008). In these regions, it is recommended that fishermen avoid using shallow-water sets.

Assess Management Strategies Under Climate Change

Even from detailed regional climate models, it is important to note that precise predictions of future conditions will not be possible and there will always be a chance of unexpected transitions. Such uncertainty is not a reason for inaction: instead, it means that a range of potential future scenarios must be explored and management strategies evaluated against them. Scenario-building and evaluation is now recommended as a routine part of climate adaptation in terrestrial conservation (Gillson et al. 2012), and the process of testing management strategies under a range of future scenarios can be applied much more widely to climate change questions in fisheries. The best management approach is often defined as the one that will do the best across the range of possible futures, or alternatively, the one that is least likely to do poorly. By choosing management approaches that are robust to a wide range of possible futures, the consequences of ecosystem surprises can also be minimized.

As one example, Kaplan *et al.* evaluated alternative individual fishing quota management options under ocean acidification scenarios for west coast U.S. groundfishes. In this case, individual fishing quotas outperformed status quo in all scenarios and appeared to be a robust management decision (Kaplan et al. 2010). Similarly, Kaplan et al. (2012) used an ecosystem model to evaluate gear switching and spatial management options at various scales for the west coast U.S., including an evaluation of tradeoffs between fisheries and conservation. Their paper did not consider climate impacts, but the model was designed so that it could do so in the future.

Maintain Resilience of Fishing Communities

Adapting fisheries to climate change is not only about fisheries management; it is also about social and economic transitions for coastal towns and cities that rely on fishing for their culture, identity, and economy. Fishing communities exploit particular regions of the ocean (St. Martin & Hall-Arber 2008b), and climate change is nearly certain to change the fishing opportunities available to these communities, including through range shifts that move some species away and bring others close enough to exploit. These shifts will require adaptive responses from fishermen and fishing communities, which may include increased travel to new fishing grounds, switches to fishing new species, development of new business and social networks, or decisions to transition out of fishing altogether (Coulthard 2009; McCay 2012; Pinsky & Fogarty 2012; St. Martin & Hall-Arber 2008a). Highly specialized fisheries with low flexibility are less likely to adapt smoothly to the challenges of climate change. In Maine, for example, the lobster fishery has been proposed as a "gilded trap" that encourages over-specialization and over-investment, leaving a large swath of the coastal economy and society exposed to the possibility of a lobster crash (Steneck et al. 2011). On the West Coast, in contrast, a diversity of fishing options has fostered greater social resilience by allowing fishers to switch among species and buffer themselves against fluctuations in any one species (Norse & Crowder 2005). In some cases, individual transferable quotas and the increased complexity of regulation have reduced flexibility in fisheries (Murray et al. 2010), and this process appears likely to make future adaptation more difficult. More generally, societies and communities adapted to climatic variability (e.g., El Niño/La Niña cycles) appear more likely to have the flexibility and adaptability to cope with climate change, while those used to targeting long-lived, stable species like cod may have fewer coping mechanisms (Perry et al. 2010).

In light of these coming societal transitions, actions that enhance the flexibility of the fishing industry in a region will be important (Coulthard 2009). Co-management, or the sharing of regulatory decision-making between the government and fishing stakeholders, has been suggested as one mechanism for enhancing the ability of fishing communities to cope with change (McCay et al. 2011). Secure and exclusive fishing rights also promote future-oriented action that can help with difficult transitions (McCay et al. 2011), though these must be approached carefully in the context of climate change so that they don't remove the flexibility that will be needed for fisheries adaptation.

Conclusion

Climate drives changes in fish populations and in fisheries that are already visible in the U.S. These changes, including shifts towards higher latitudes and changes in the mix of species available to fisheries, are likely to become much more pronounced in coming decades. Adapting fisheries management will likely require two parallel and complementary approaches: 1) anticipating climate impacts where possible to guide preparations, monitoring, and long-term planning, and 2) maintaining management flexibility, ecosystem monitoring, and rapid-response capabilities to adapt quickly when ecosystems change unexpectedly. Specific opportunities include

- More effectively provide and translate climate information for fisheries management
- Design management processes that allow rapid response when climate impacts are detected
- Consider shifts in species distributions in order to avoid bycatch and ensure closed area effectiveness
- Use future climate scenarios to evaluate the robustness of current and alternative management strategies
- Support economic and social transitions in coastal communities as they adapt to changing conditions

Given the clear signals from past climate impacts and the strong importance of fisheries to our coastal economies, efforts to adapt fisheries to climate impacts will be most effective if they begin as soon as possible.

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DISCUSSION SUMMARY
Session 2 Topic 1

Assessing Ecosystem Effects and Adapting to Climate Change

Speakers

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MALIN PINSKY, SMITH FELLOW, PRINCETON UNIVERSITY

Panelists

JOHN ANNALA, CHIEF SCIENTIFIC OFFICER, GULF OF MAINE RESEARCH INSTITUTE

JASON LINK, SENIOR SCIENTIST FOR ECOSYSTEM MANAGEMENT AT NOAA FISHERIES

BRAD WARREN, DIRECTOR OF GLOBAL OCEAN HEALTH PROGRAM, SUSTAINABLE FISHERIES PARTNERSHIP

Rapporteurs

KIM GORDON, FISHERIES LEADERSHIP & SUSTAINABILITY FORUM

WHITNEY TOME, FISHERIES LEADERSHIP & SUSTAINABILITY FORUM

Moderator

JOHN HENDERSCHEDT, EXECUTIVE DIRECTOR, FISHERIES LEADERSHIP & SUSTAINABILITY FORUM

Discussion Summary:

Assessing Ecosystem Effects and Adapting to Climate Change

The following themes and findings emerged during the discussion during this session.

Address the Root Causes of Climate Change: Legislative Changes Beyond Fisheries

A key finding emerging from this session was the need to address the root causes of climate change. As the framework for Federal fisheries management, the Magnuson-Stevens Fishery Conservation and Management Act provides managers with tools for responding to the symptoms and impacts of climate change on ocean ecosystems, but it does not address the underlying problem. Fishery managers are already beginning to see climate change influence the effectiveness of management measures. As the velocity of climate change increases, it will grow even more challenging for fishery managers to respond to the impacts of climate change on U.S. fisheries. Members of Congress, the Administration, and other elected officials should address the root causes of climate change in order to protect and conserve our nation's fishery resources and ocean ecosystems.

Climate Change: Policy, Guidance and Best Practices

Evaluate and Incorporate Ecosystem Productivity Change Into Fishery Management

Climate change is affecting the productivity of our oceans and impacting fish populations. These ecosystem productivity changes impact the amount of fish the ocean can support and ultimately how many fish can be sustainably harvested. Fishery managers must evaluate ecosystem-level productivity change, consider how it affects managed stocks, and incorporate these changes into fishery management.

Facilitate Precautionary Management to Prepare for Climate Change Effects

The science is clear that climate change will affect ocean ecosystems, fish populations, and fisheries. Fishery managers can proactively prepare for these effects by incorporating precaution into their fishery management strategies.

UTILIZE A PRECAUTIONARY APPROACH FOR DEVELOPING AND EMERGING FISHERIES

Climate change can cause shifts in species distribution and other potentially unpredictable responses. As species migrate into new management areas and other changes occur, fishery managers may not have all the necessary information to sustainably manage these emerging fisheries. For example, anticipating reduced sea ice cover in the Arctic in the future, the North Pacific Fishery Management Council developed an Arctic Fishery Management Plan to preclude the development of new fisheries until sufficient data becomes available to make responsible management decisions. Managers must use precaution with emerging fisheries until comprehensive information is available on stock status and sustainability.

DEVELOP A COMPREHENSIVE NATIONAL PLAN FOR CLIMATE IMPACTS ON FISHERIES AND DEVELOP TOOLS THAT WILL FACILITATE REGIONAL CLIMATE CHANGE STRATEGIES

Fishery managers must plan now for the effects of climate change. The state of Alaska developed a climate change strategy that includes research priorities. Managers should engage in regional and national planning exercises to develop climate change strategies that will provide managers with the ability to respond quickly and mitigate rapid changes associated with climate change.

PROTECT THE MOST SENSITIVE SPECIES AND HABITATS

Managers should implement precautionary measures now to protect highly productive habitats and dependent fish communities. Coral reefs and reef communities, for example, support fisheries in many U.S. management regions and are particularly sensitive to climate change.

Implement Adaptive Management to Allow Rapid Response to Climate Change Effects

Scientists predict that the velocity of change associated with climate is likely to increase with time. Making changes to fishery management plans and regulations is a cumbersome and time-consuming process that may not be capable of responding quickly to change. Fishery managers should implement a framework for adaptive management that allows for rapid response to the effects of climate change.

MODIFY REFERENCE POINTS AS CLIMATE CHANGES

Climate change can affect the productivity and abundance of stocks. Managers may need to reconsider and potentially modify reference points over time in response to these changes. In some instances this may be a necessary precaution to account for uncertainty. In other cases it may be necessary to recalibrate maximum sustainable yield based on changing productivity in the ecosystem. Finally, the development of reference points should shift from a single-species approach to being calculated on an ecosystem basis.

ADDRESS REBUILDING REQUIREMENTS WHEN ENVIRONMENTAL CONDITIONS MAY BE A PREDOMINANT FACTOR IN A STOCK'S CONTINUING DECLINE OR NON-RECOVERY

Climate change may impact rebuilding of depleted stocks due to ecosystem shifts and changes in productivity. Managers must have sufficient flexibility with rebuilding requirements to develop and implement attainable rebuilding strategies that adapt to the new productivity potential of species when the ecosystem has fundamentally changed because of climate.

INCORPORATE AN ENVIRONMENTAL TRIGGER MECHANISM INTO THE FEDERAL FRAMEWORK TO INITIATE MANAGEMENT ACTIONS

As scientists continue to understand and anticipate the effect of climate change on fish stocks, it may be possible to incorporate environmental triggers into fishery management plans. For example, if we know that ocean temperatures will affect the distribution of a stock, managers can develop specific management actions contingent upon observed ocean temperature changes. Ocean acidification can also lead to lower productivity, therefore managers could create a framework tied to ocean chemistry. Managers can also develop triggers to react quickly to sudden events. For example, algal blooms can grow quickly and create more toxins in a high carbon dioxide ocean environment. By identifying and establishing a suite of management options in advance, management can respond quickly to an outbreak.

EVALUATE EFFECTIVENESS AND UTILITY OF FIXED CLOSED AREAS

Many fishery management plans rely on fixed area closures to meet conservation objectives. Climate change can cause fluctuations in abundance and shifts in the distribution of species. With these changes, place-based closed areas may no longer have the desired effect or serve the purpose for which they were established. Scientists should evaluate the effectiveness and utility of closed areas as species distribution changes and their value in supporting wider age structures of potentially vulnerable populations. Managers should consider other management strategies if closed areas no longer accomplish management objectives.

ALLOW FLEXIBILITY IN COUNCILS' ABILITY TO RESPOND TO SPATIAL, ALLOCATION AND DISTRIBUTIONAL EFFECTS OF CLIMATE CHANGE

Managers will need flexibility to respond to the spatial, allocation, and distributional effects of climate change. Managers should build flexibility into catch share programs that would allow the fishery to adapt to changes in abundance. Some catch shares constrain the ability of the fleet to shift in species, gear types, and areas; therefore the regulatory regime would hinder the fleet's ability to adapt to change. Similarly, as species distributions shifts, allocations of quota may be out of sync with species distribution.

ASSESS BARRIERS TO ADAPTATION

The changes caused by climate, including species distribution and productivity, can be costly, yet there are barriers that constrain the fishery management system's ability to adapt to changing conditions. An assessment should be conducted to identify and overcome these barriers.

DEVELOP DECISION SUPPORT TOOLS THAT ALLOW COUNCILS TO RESPOND TO RAPID CHANGES

The fishery management system must develop decision support tools that allow Councils to respond to rapid environmental and ecosystem changes. In some cases, the effects of climate change may outpace the timeline for traditional changes to fishery management plans and regulations. By developing decision support tools now, Councils will be better prepared to respond to rapid change.

Increase Coordination Between and Across Jurisdictions

Climate change is causing chemical, physical, and biological changes in marine ecosystems around the globe. Scientific studies have documented the shifts in species distribution and changes to ecosystem structure and function. These changes emphasize the need to increase existing coordination across the regional Councils, states, Federal agencies, and international governing bodies in order to effectively address climate change, and plan for anticipated changes and sustainably manage marine resources. Coordination is also needed to ensure that collective fishing activity across jurisdictions does not result in overfishing.

Support and Prioritize Science

Science has come a long way to develop tools and models that synthesize data, evaluate impacts, and predict future change. Sciences and managers must work together to identify the highest priorities for research in order to support management needs.

Assess the Efficacy of the National Ocean Policy as a Vehicle to Address Climate Change

Several different perspectives were raised about the National Ocean Policy. On one hand, the discussion raised questions about how to influence activities outside the authority of fisheries managers that have an impact on ocean ecosystems and fish populations. For example, agricultural activities in the Midwest contribute to the creation of the dead zone in the Gulf of Mexico. Fisheries managers have little influence on impacts that occur far beyond the coastal zone. The National Ocean Policy is a bottom-up process that allows everyone to have input. On the other hand, some participants felt the bureaucracy of the National Ocean Policy diverts limited resources and duplicates existing efforts.

Endangered Species Act: Base Listings on Actual Trends Rather Than Assumed Projected Trends of Climate Change

The National Marine Fisheries Service has received petitions to list species under the Endangered Species Act based on possible declines due to climate change for coral species. This follows a threatened listing for polar bears and an announcement that ringed and bearded seals may also be listed. Some participants felt that listings should be based on observed trends showing decline of a species' population rather than on an anticipated trend based on climate assumptions. Some felt this approach erodes the management authority of state and regional Councils who have the expertise and resources necessary to implement conservation measures for these species. Federal agencies should engage in a proactive planning process in collaboration with fishery management authorities when considering and responding to impacts and projected impacts from climate change.

Integrated Ecosystem Assessments

The ability to collect and analyze large volumes of data is expanding rapidly with current technology, and this information can provide us with resources for responding to climate change. By conducting integrated ecosystem assessments (IEAs), scientists and managers begin to highlight the costs and benefits of management options and search for win-win strategies.

Integrate IEAs and All Component Models into Management Process

IEAs provide fishery managers with a powerful tool to use a lot of data and information when making fishery management decisions. Wherever possible, fishery managers should integrate IEAs and component models into the management process. While IEAs are in development and will continue to evolve and expand, scientists must also derive less data and resource intensive tools for use in the management process today.

Develop Ecosystem Models, Tools and Assessments at a Regional Level

While IEAs provide the gold standard for integrating information, it will take time and resources to develop and implement them in all regions. In the meantime, scientists must continue to build tools that, like building blocks, will eventually support a more fully developed IEA. We need to change fundamental single-species stock model designs to be more flexible and allow more formulations. New models, tools and assessments should:

- Synthesize data from non-fishing sources and incorporate socioeconomic as well as ecosystem parameters. For example, one participant highlighted the expansion of the energy industry in the ocean and how this affects ecosystem sustainability and productivity when new devices are placed in previously undeveloped areas. The leases for energy have long time frames, so fishermen and fishery managers must consider not only where fisheries occur today, but where fish and fishing activity may be in the future.
- Respond to changing parameters. Climate change affects life history parameters and species distribution that should be captured in models in order to best reflect what's happening in the ocean.
- Predict future ecosystem states. Scientists should build predictive capabilities into modeling and assessments wherever possible. Fishery managers can prepare for anticipated changes and respond more quickly with predictions of future ecosystem states.
- Scientists should strive to include both short- and long-term guidance to managers. Managers need guidance for setting annual specifications, but also need to prepare for long-term management strategies that may be different than current conditions.
- Account for cumulative impacts of climate change. Cumulative impacts can have large ramifications. The changes happening in ocean ecosystems do not occur in isolation. Scientists and managers must look at compensation, magnification and a variety of responses to a variety of influences. Managers must account for cumulative impacts on ocean ecosystems. Cumulative impacts have larger ramifications when a stock is overfished.

AUDIENCE, SESSION CHAIRS, AND RAPPORTEURS FROM THE DAIS. PHOTO: PFMC

PAPERS

Session 2
Advancing Ecosystem-Based Decision-Making

Topic 2
Forage Fish Management

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A SCIENTIFIC PERSPECTIVE ON ECOSYSTEM RELATIONSHIPS OF FORAGE FISH: ISAAC C. KAPLAN

FORAGE FISH MANAGEMENT IN THE US: A COMMERCIAL FISHING PERSPECTIVE: RON LUKENS

A Case for Precautionary Management of Forage Fish

Peter Baker
Director, Northeast Fisheries Program, Pew Environmental Group

Abstract

As knowledge about marine ecosystems expands, our nation's fishery management infrastructure must evolve to keep pace. Recently, marine scientists have developed new understanding about one of the ocean's most important attributes: forage fish. Forage fish provide a vital link between small protein-rich plankton and top predators that make up our marine megafauna. Managing forage fish to sustain the productivity and resilience of marine ecosystems, and the health of top predators, is becoming increasingly important to modern fisheries management. As single-species, maximum sustainable yield (MSY)-based management has proven ineffective in managing forage fish, a paradigm shift must occur. Fishery management must move towards ecosystem-based fishery management with new strategies to manage forage fish acting as a sensible next step for that transition. As our knowledge evolves and fishery management follows, ideas such as incorporating forage fish as indicators of ecosystem health and the need to protect essential fish habitat will come to the forefront.

Forage Fish: Definition and Importance

Small, schooling fish that swim in ocean waters play an important role in our marine ecosystems. These "forage fish" are so-called because ocean predators, like larger fish, birds and marine mammals, rely on them as food. Recognizing the importance of forage fish for ecologically-sound fisheries management, a distinguished international group of 13 scientists formed the Lenfest Forage Fish Task Force (LFFTF) to review the impacts these species have on ecosystems. In 2012 they published a report that defined forage fish and made recommendations for how to manage them sustainably worldwide. For small fish species to meet the "forage fish" criteria, they must have several key characteristics. Forage fish:

- Transfer energy from the lower to higher levels of the food web by eating plankton, and then being eaten by larger predators;
- Are the most numerous fish by number of individuals, despite only a few forage fish species existing in any ecosystem;
- Are schooling fish that are small in size, mature early, live short lives and bear large numbers of offspring (Pikitch et al. 2012).

Many species of forage fish swim the nation's oceans, coastal waters, and estuaries. Some species are managed in Federal Fishery Management Plans (FMPs). Others are managed through interstate compacts such as the Atlantic States Marine Fisheries Commission (ASMFC). Many more species go completely unmanaged. Some examples of forage fish important to our marine ecosystems include:

- *Atlantic herring*—Atlantic herring is a keystone species in the Gulf of Maine ecosystem, supporting commercial fishing and serving as a major food source for many of the ecosystem's predators including codfish, striped bass, bluefin tuna, and endangered whales. Recent research reveals that predators can consume 300,000 tons of herring a year—roughly three times the amount caught by fishermen (Overholtz 2007). Given the major role herring play in the food web, managers need to take into account the needs of predators when setting fishing limits for herring.

- *Pacific sardines*—Pacific sardines support a valuable commercial fishery whose U.S. scope extends from southern California to the coast of Washington. They are a key forage species in the California Current Ecosystem. Pacific salmon stocks, albacore tuna, many groundfish species, seabirds such as brown pelicans, and marine mammals from harbor seals to whales depend on Pacific sardine as a major source of food. Ensuring sufficient abundance of Pacific sardine is therefore necessary for maintaining healthy populations of these important species at the top of the food web.
- *Atlantic menhaden*—Atlantic menhaden play an important role in fisheries and marine ecosystems from Maine to Florida. This valuable forage species is a food source for wildlife such as whales, dolphins, ospreys and eagles, as well as valuable Federally-managed fish species like tuna, cod, striped bass and tarpon. The Atlantic states recently took action to end overfishing of Atlantic menhaden, recognizing its importance to the diet of numerous valuable recreationally and commercially targeted species.

Ecological Importance

Forage fish play a pivotal role in food webs of many coastal and marine ecosystems. They form an essential link between primary and secondary producers (e.g., phytoplankton and zooplankton) and top predators (e.g., large fishes, marine mammals and birds). According to the research by the LFFTF, three-quarters of marine ecosystems worldwide have predators that are highly dependent on forage fish (Pitkitch et al. 2012). Scientists have estimated that total consumption of forage fish by the world's marine mammals can amount to 20 million tons each year (Kaschner et al. 2006). A single humpback whale can consume 1,000 pounds of forage a day (Witteveen et al. 2006). Numerous seabird species rely on abundant forage as well, requiring roughly 12 million tons annually. Recent research suggests that keeping one-third of the forage fish biomass in the water is necessary to sustain healthy breeding populations of seabirds (Cury et al. 2011).

In addition to their role as prey, forage fish provide other important ecological services. Most notably, researchers have discovered that forage fish can play a significant role in removing carbon dioxide from the ocean's surface by feeding on plankton and producing carbon-rich fecal pellets that sink to the ocean depths (Saba and Steinberg 2012). Migrating anadromous forage species, such as river herring and shad, also play a valuable role in transporting marine-derived nutrients to rivers and streams, and thus have significant impact on the productivity of freshwater systems (Hall et al. 2012). Forage fish are also important predators, feeding on planktonic organisms, including the eggs and larvae of other fish species. Studies have suggested that forage fish predation can have important top-down effects on phytoplankton and zooplankton populations, with implications for the wider food web (Cury et al. 2000). Given the important role forage fish play in marine ecosystems, fishery managers should be precautionary about setting catch limits for these species.

Historical Role

Forage fish species have always played an essential role in America's marine ecosystems, transferring energy from plankton to predators. Native Americans and early colonists depended on forage species such as river herring, shad, and menhaden as important protein sources in their diet, and fertilizer for crops (McKenzie 2010). Recreational fishing in coastal rivers and the oceans has been a national pastime for centuries. As the U.S. experienced the 19th century industrial revolution and the population expanded west, new forage fisheries like the Pacific sardine industry developed. This expansion provided thousands of jobs and served as the economic engine in many coastal communities like the famed "Cannery Row" in Monterey, California. By the 1960s, industrial fishing technologies had been introduced which increased the ability to catch and process previously unimaginable quantities of forage fish, creating higher profits and fewer jobs. Today, many forage fish populations are at historic lows or have collapsed, due in large part to overfishing. Since 1976, Federal management has focused on achieving conservation through single-species management with considerable success, but the system has failed to fully account for the value of forage fish left in the ocean. New ways of accounting for the supportive value of forage fish, like the recommendations of the LFFTF, should be implemented when setting catch levels.

Economic Role

Forage fish have continued to play a critical role in providing protein for humans. In 2011, the U.S. commercial fishing industry landed 9.9 billion pounds of seafood (NOAA 2012)[1]. Forage fish directly or indirectly provide much of the foundation for this important industry. Americans consume roughly 15 pounds of seafood per person annually and forage fish are essential prey for some of the most valuable food fish (NOAA 2012). For example, the majority of the Alaska walleye pollock diet is krill, along with other forage fish such as capelin and sandlance (NOAA 2011). Without these abundant prey sources, the largest fishery in the U.S. could collapse, which is a key reason why directed commercial fishing for krill and other forage species is prohibited in Federal waters off the Alaskan coast.[2] Forage fish also bring food to our tables indirectly as the primary source of bait in many of America's commercial and recreational fisheries. In the Northeast, American lobster and blue crab fisheries primarily use forage species such as herring and menhaden as bait. The domestic reduction industry lands menhaden in the Atlantic Ocean and Gulf of Mexico, which becomes protein for humans indirectly as feed for livestock and aquaculture.

The Task Force reported fluctuations in reliance on forage fish, with some ecosystems, especially areas of ocean upwelling, relying more heavily on forage fish abundance. However, in 75 percent of the ecosystems studied, there was at least one predator that depended on forage fish for over half of its diet, and in 29 percent of the cases there was a predator that was "extremely dependent," relying on forage fish for over 75 percent of its diet. This research creates a framework that managers can use for determining the importance of forage fish in the ecosystems they manage, and making wise choices that support all the species in the marine food web. Because of their importance as food for larger, higher-value fish, small forage fish are worth more in the water, rather than as direct commercial catch. The LFFTF studied 72 ecosystems and estimated that the value of direct landings of forage fish is $5.6 billion, whereas their "supportive value" to other commercial species is approximately double, at $11.3 billion.

Deficiencies in Current Forage Fish Management

Currently, many of the nation's forage fish are entirely unmanaged. In addition, many of the managed species face overexploitation because of several factors, including the reliance on single-species, MSY management, and static assumptions regarding natural mortality, among other factors. Moreover, economic analysis in fishery management plans too often relies only on the costs and benefits to directed forage fisheries (and their end markets, such as bait users) rather than evaluating the value of leaving forage fish in the ocean to provide ecosystem services and feed dependent predators.

The LFFTF found that "conventional management can be risky for forage fish because it does not adequately account for their wide population swings and high catchability. It also fails to capture the critical role of forage fish as food for marine mammals, seabirds, and commercially important fish such as tuna, salmon, and cod" (Pikitch et al. 2012).

1 The majority of this increase in catch was from Gulf of Mexico menhaden, a key forage fish, which increased by 407 million pounds (42 percent) in the Gulf states, see page ix. By weight, 79 percent of these domestic landings were consumed directly as human food, 3 percent were used as bait, and the remaining 18 percent were taken by the reduction industry, see Table: "Disposition of U.S. Domestic Landings, 2010 AND 2011," page 6.

2 See Final Environmental Assessment for Amendments 87/96 to the NPFMC Groundfish FMPs at http://tinyurl.com/lkhqunb.

Pacific Coast Councils: Examples of Effective Forage Fish Management

As ecosystem science has progressed and the implications for management have become clear, we have seen positive examples of ecosystem principles, like forage fish protection, being incorporated into existing management. For example, the North Pacific and Pacific regional Councils are leaders in protecting the forage base and the marine food web.

Specifically, the North Pacific Fishery Management Council (NPFMC) amended the Gulf of Alaska and Bering Sea/Aleutian Islands Groundfish FMPs in 1998 to preclude directed fishing on a suite of forage species.[3] According to National Marine Fisheries Service (NMFS), this was "necessary to conserve and manage the forage fish resource off Alaska…a critical food source for many marine mammal, seabird and fish species."[4] The NPFMC amended these FMPs in 2010 to update these actions, maintaining the prohibition on directed fishing and designating these forage species as ecosystem component species (ECS), consistent with the new National Standard 1 guidelines revised in response to the 2007 reauthorization of the Magnuson-Stevens Act (MSA)[5]. The NPFMC also created an Arctic FMP in 2009 whose primary purpose was to preclude new commercial fisheries in the Arctic Management Area, including for forage species, unless and until robust information was available and deemed sufficient to approve a new fishery.[6]

Meanwhile, the Pacific Fishery Management Council (PFMC) amended its Coastal Pelagic Species FMP to put in place a harvest prohibition on all species of krill.[7] The PFMC is also actively considering additional protections for all other unmanaged forage species, and in June 2012 adopted an objective of prohibiting new directed fisheries on unmanaged forage species.[8]

These examples of precautionary forage policy do not create winners and losers, nor do they have significant negative impacts on existing fisheries. In fact, proactive and precautionary management of the forage base can help increase both the productivity and sustainability of all fisheries. Conservation groups are not alone in this view. The NPFMC's ban on new fisheries for forage species is hailed in an industry-sponsored study as one of thirteen "best practices in ecosystem-based fishery management" (Warren 2007). The use of the ECS category by the NPFMC to advance an ecosystem-based approach to management through forage protection is of particular note. The NPFMC has applied the category to implement concrete measures to understand and protect the food web, recognized as one of the basic tenets of ecosystem-based fishery management (Christensen and Maclean 2011).[9] This approach should be undertaken by additional fishery management Councils.

Existing Legal and Regulatory Tools and Authority to Manage Forage Fish

Several MSA provisions provide authority for management of forage fish. The MSA requires every FMP to contain a number of specific provisions, all of which must be consistent with ten National Standards (NS) for conservation

3 See Final Rule implementing Amendments 36/39 to the NPFMC Groundfish FMPs at http://tinyurl.com/kbpjuxb. This action identified and protected over 20 important forage species in 9 scientific families by prohibiting directed fishing on those species.

4 50 CFR 679. See also June 2004 PFMC Meeting. Exhibit G.4.a Situation Summary.

5 See Final Environmental Assessment for Amendments 87/96 to the NPFMC Groundfish FMPs at http://tinyurl.com/lkhqunb.

6 See Final Rule implementing the Arctic FMP at http://tinyurl.com/km37bc9.

7 See 2009 Final Rule implementing the Amendment 12 to the CPS FMP at http://tinyurl.com/kxnl5c3.

8 See June 2012 PFMC Decisions Summary at http://tinyurl.com/cqrlxrg, page 4.

9 See Ecosystem-Based Fishery Management: a Report to Congress by the Ecosystem Principles Advisory Panel, available at http://tinyurl.com/mv4k3nd at pp. 29 and 33.

and management.[10] Importantly, NS 2 requires that all management measures be based on the best available scientific information.[11] The MSA also provides managers with discretion to implement additional measures that can be used to manage forage fish, including broad authority "to conserve target and non-target species and habitats, considering the variety of ecological factors affecting fishery populations; and . . . prescribe such other measures . . . necessary and appropriate for the conservation and management of the fishery."[12] While the MSA's required and discretionary provisions provide ample authority to manage forage species, and more broadly to engage in ecosystem-based management, codifying some of these provisions into requirements would create a strong framework for future management of forage fish. Several of the relevant provisions of the Act are briefly summarized below:

1. *Stocks in the Fishery*. The MSA requires that managers include any stock in need of conservation and management in an FMP.[13] In making this determination, Councils are required to look to factors such as the need for
    - rebuilding, restoring, or maintaining "any fishery resource and the marine environment,"
    - assuring among other things, a food supply and recreational benefits, and
    - avoiding long-term adverse effects on fishery resources and the marine environment.[14]
2. *NS 1: Preventing Overfishing*. The NS 1 requirements to achieve the dual goals of preventing overfishing while achieving optimum yield on a continuing basis have primacy over all other MSA requirements.[15] "Overfished" and "overfishing" are defined as "a rate or level of fishing mortality that jeopardizes the capacity of a fishery to produce the maximum sustainable yield on a continuing basis."[16] As fisheries managers typically recognize, the Act requires that excessive mortality of any forage stock must be reduced or maintained at levels necessary to prevent overfishing of that same stock of forage fish. However, the overfished/overfishing definition does not specify that the fishery experiencing an excessive rate or level of fishing mortality, and the fishery whose capacity to produce MSY is jeopardized, be the same fishery. Thus, the MSA provides the authority to manage the mortality of forage species at levels that do not jeopardize the capacity of dependent predator species to produce MSY.[17]
3. *NS 1: Achieving Optimum Yield (OY).* The MSA defines "optimum yield" as the amount of fish that "will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems," and "is prescribed as such on the basis of the maximum sustainable yield from the fishery, as reduced by any relevant economic, social, or ecological factor."[18] The NS 1 guidelines reflect this statutory emphasis on ecosystem protection, specifying that "maintaining adequate forage for all components of the ecosystem" is a key consideration relevant to OY.[19]
4. *Annual Catch Limit (ACL) Requirements*. Setting ACLs requires establishment of a scientifically-robust acceptable biological catch (ABC) control rule.[20] An appropriate ABC control rule establishes an approach for setting catch levels that will vary as a function of where the stock is relative to an appropriate target biomass (target above Bmsy for forage fish) and accounts for scientific uncertainty.[21] NS 2 requires that ABC control rules be based on the best available science, and several recent studies address setting ABC control rules for forage fish, and call for new approaches (Pikitch et al. 2012, Smith et al. 2011, Cury et al. 2011,

10 16 U.S.C. §§ 1853(a), 1851(a).
11 16 U.S.C. § 1851(a)(2).
12 16 U.S.C. § 1853(b)(12)-(14).
13 16 U.S.C. § 1852(h)(1); 50 C.F.R. § 600.310(d), (h).
14 See 16 U.S.C. § 1802(5).
15 16 U.S.C. § 1851(a)(1); 50 C.F.R. § 600.310(l).
16 16 U.S.C. § 1802(34).
17 NMFS's essential fish habitat (EFH) guidelines support this interpretation of overfishing. These regulations specify that the loss of prey species may constitute an adverse effect on EFH and note that habitat loss or degradation can contribute to a species being identified as overfished. 50 C.F.R. §§ 600.810(a), 600.815(a)(1)(C), (a)(7).
18 16 U.S.C. § 1802(33).
19 50 C.F.R. § 600.310(e)(3)(iii)(C).
20 16 U.S.C. § 1852(g);50 C.F.R. § 600.310(b).
21 See e.g., 50 CFR § 600.310(c)(3), (f)(2)(ii)-(iii).

Tyrrell et al. 2011). Thus, setting ABC control rules for forage fish based on the best available science requires management consistent with the risks associated with forage fish populations' tendency to swing dramatically, their high catchability, and the critical role of forage fish as food for commercially valuable species, marine mammals, and seabirds.

5. *Essential Fish Habitat (EFH).* EFH includes "the waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity," and each FMP must "describe and identify [EFH] for the fishery . . ., minimize to the extent practicable adverse effects on such habitat caused by fishing, and identify other actions to encourage the conservation and enhancement of such habitat."[22] EFH regulations treat prey species as an integral component.[23]
6. *Minimizing Bycatch.* National Standard 9, and related provisions, require that conservation and management measures minimize bycatch to the extent practicable.[24] Forage species tend to swim in large schools and sometimes mix with other species of forage fish (e.g., river herring and Atlantic herring). They are thus susceptible to becoming bycatch, because fisheries targeting forage species generally use large mid-water trawl nets or purse seines capable of indiscriminately taking entire schools of fish.
7. *Maximizing Economic and Social Benefits*. National Standards 4 and 8 support managing forage species to maximize overall economic and social benefits to fishermen and fishing communities, consistent with the MSA's conservation provisions.[25] Conserving forage species can be crucial to these requirements because forage species provide the prey base that supports recreational and commercial fisheries.
8. *Non-Magnuson-Stevens Act Authority*. Additional authorities exist that can affect forage fish management.
   - *Interstate Fisheries Management*. Near-shore fisheries are typically managed in coordination by states through interstate compacts with varying levels of binding authority, and in some cases an overlay of Federal authority. For example, on the East Coast the ASMFC manages state fisheries pursuant to a compact and the Atlantic Coastal Fisheries Conservation and Management Act gives ASMFC plans legal force.[26] These authorities require "coastal fishery management plans" consistent with Magnuson-like standards designed to ensure that FMPs "promote the conservation of fish stocks throughout their ranges and are based on the best scientific information available."[27]
   - *Endangered Species Act (ESA)*. The ESA provides protection for endangered and threatened species.[28] Key authorities strictly limit the take of listed species, require designation of critical habitat and plans for their recovery, and impose consultation requirements on Federal agency actions affecting listed species.[29]

Improving Forage Fish Management as a Step Towards Ecosystem-Based Fishery Management

Currently, single-species management characterizes most fishery management strategies in the United States, including forage fish fisheries. Over the last several years, fishery management Councils and NOAA Fisheries have begun to discuss and plan for moving away from single-species management towards ecosystem-based fishery man-

22 16 U.S.C. §§ 1802(10), 1853(a)(7).
23 50 C.F.R. §§ 600.810(a), 600.815(a)(7).
24 16 U.S.C. §§ 1851(a)(9), 1853(a)(11).
25 16 U.S.C. §§ 1851(a)(4), (8).
26 16 U.S.C. §§ 5104 –5108.
27 See e.g., 16 U.S.C.. § 5104(a)(2)(A).
28 16 U.S.C. § 1531(b).
29 16 U.S.C. §§ 1538(a)(1)(B), 1533(a)(3)(A), 1533(f)), 1536(a)(2).

agement. Changing management strategies for the nation's forage fish to precautionary management can be a useful next step in this transition.

Precautionary Management

Because of the vital role forage fish play in marine ecosystems and the reliance of predators on healthy forage fish populations, a precautionary management strategy is advised. While many forage fish are currently unmanaged or managed for maximum sustainable yield, forage fish are often overexploited, negatively impacting predators and marine ecosystems in general. The LFFTF recommended specific precautionary catch levels to protect forage fish and their dependent predators. Management strategies that limited fishing rates (F) to half the conventional rate effectively headed off declines in dependent predator populations. Reducing the fishing on forage fish not only benefited predators but also reduced the risk of collapsing forage fish populations, albeit with some forgone commercial yield. This approach must be considered for future management of forage fish species.

Ecosystem-Based Fisheries Management

Just about everyone whose livelihood depends on going to sea in search of fish understands that the fish they depend on are part of an intricate system of predators, prey, and habitat—an ecosystem. When humans first began to fish the seas close to shore, their predation was readily absorbed by thriving marine ecosystems. All this changed as the abundance of people and the power of fishing technology exploded: people became such a powerful force that they unwittingly transformed the ecosystems they depended upon, leading to the disappearance of critical fish stocks, and other unfortunate consequences. Single species management of fishing has helped, but has proven inadequate to restore marine ecosystems because it fails to account for the interactions among species that are fundamental to the food webs. Basic dependencies among predators and their prey, for example, continue to be perilously ignored. Entire ecological regions such as the Northeast U.S. are being subjected to ecosystem overfishing (Murawski 2000).

Ecosystem-based fisheries management (EBFM) is a promising approach to fisheries management that is within reach, offering a solution to these problems, but it remains to be fully implemented in U.S. Federal waters. In simple terms, EBFM is managing fisheries within an ecological region "so as to coordinate, account for, and include all factors in a holistic, synthetic, integrated fashion" (Link 2010). These broad goals of EBFM can be achieved through a range of approaches from simple steps, to the use of multi-species or full ecosystem models. Implementing management plans that take into account the unique role that key forage species (such as Atlantic herring, menhaden, sardines, and krill and other zooplankton) play in the marine ecosystem is a common sense, first step along the path to EBFM. Fisheries management has failed in many places because it has not recognized the ecosystem and has not been sufficiently precautionary. Precautionary management of forage fisheries, and protections for these key species, has not yet been applied to directed fisheries, although it is crucial to the future of a healthy U.S. fishing industry.

Lenfest Forage Fish Task Force Recommendations

In reviewing various ecosystems, the LFFTF considered both the impact of fishing on the forage species themselves and the consequences of removing these fish from the ocean for the predators that depend on them as food. They discovered that conventional MSY management practices when applied to forage fish are often riskier than expected because these small schooling fish are particularly vulnerable to net capture and because these fishes typically undergo relatively wide population swings. They also discovered that harvest of forage fish puts their predators at risk of collapse.

Based upon an extensive analysis of ecosystems around the world, the LFFTF recommends managing forage fish so that the biomass is kept at levels substantially above those typically used as targets for other kinds of fish. In every case, they recommend a careful evaluation of the available information for a given forage species and its dependent predators, with specifics of guidance tailored accordingly. It is generally recommended that harvest control rules be adopted that stop fishing when population biomass falls below a threshold (e.g., corresponding to 40 percent of the biomass expected without fishing), and that strive to keep the biomass near 75 percent of B_0. Fishing mortality (F) should be held below half of the traditional F_{MSY}, or to half of the natural mortality rate if that is well-estimated and less than F_{MSY}. The Task Force also recommended that no new fisheries should be allowed to develop on forage stocks with limited information, a description that characterizes most currently unfished and unmanaged forage species.

In summary, the work of the Task Force shows that forage fish play a vital role supporting ecosystems and that the best available science demands a precautionary approach to managing these stocks (Gerrodette et al. 2002). In terms of developing new fisheries for as yet unexploited stocks of forage fish, caution is clearly warranted and the burden of proof must be on those proposing such fisheries to clearly establish that the proposed fisheries are ecologically-sound based on new scientific work on forage fishes. The U.S. should make precautionary management of its forage fishes a priority as a critical step toward EBFM, and fisheries management should move away from MSY management for these species.

Suggested Requirements Before New Forage Fish Fisheries are Conducted

Because of the important role forage fish play in marine ecosystems, new forage fish fisheries should be prohibited until a stock assessment has been conducted and required criteria for measuring when the stock is overfished and overfishing is occurring has been established. The stock assessment and stock status criteria must take into account:

- Ecosystem functions of the target forage fish.
- Historical, current, and future needs of predators that consume the target species.
- Variable abundance of the target species in response to fluctuating environmental conditions.

Fishing should be allowed only after an FMP is developed that:

- Establishes a management program that is consistent with the recommendations of the Lenfest Forage Fish Task Force, including the harvest control rule, precautionary mortality reference points, and a biomass target closer to the biomass with no fishing (B_0) than is typical in conventional management (i.e. $B>B_{MSY}$).
- Evaluates and quantifies the bycatch and habitat impacts of the fishery.
- Implements measures to monitor and reduce bycatch and habitat impacts in the fishery.
- Analyzes the environmental consequences of target species removals and the economic costs and benefits of direct harvest compared with leaving forage fish in the water.

Developing Federal Management Plans for Forage Fish Primarily Caught in Federal Waters

U. S. Federal fisheries management has a strong record of ending overfishing and in a number of cases rebuilding depleted fish stocks (NOAA 2012). However, many forage fish species that swim in the nation's Exclusive Economic Zone are currently unmanaged in Federal waters, and are also either unmanaged or poorly managed in state waters by interstate fishery management bodies. Efforts are underway to bring additional forage fish, such as river herring and shad on the East Coast, under Federal fishery management plans.[30] Improved coordination between interstate and Federal management is also required. Many additional species of forage fish would benefit from the requirements outlined in the MSA (e.g. ending overfishing, rebuilding fish stocks, minimizing bycatch, protecting habitat). This could be accomplished through joint management by Federal fishery management Councils, NMFS

30 See MAFMC, Scoping Document for Amendment 15 to the Atlantic Mackerel, Squid and Butterfish Fishery Management Plan, available at http://www.mafmc.org/fisheries/fmp/msb.

and interstate compacts like the Atlantic States Marine Fisheries Commission. Managing these forage fish by the standards of the MSA, and ultimately transitioning to EBFM, will result in a benefit to predators, the ecosystem, and the nation as a whole.

Conclusion

Forage fish play an important role in the nation's marine ecosystems and in the diets of top marine predators. For this reason, management of forage fish must be aligned with new ecosystem science and improved accordingly. The Lenfest Forage Fish Task Force report, which provides a set of robust recommendations to protect forage fish and move our nation's fishery management forward, should serve as the basis for sound management of our critically important forage species. Many more species of forage fish must be brought under precautionary, Federal management as the nation transitions from single-species to ecosystem-based fisheries management.

Key Recommendations

- Transition from single-species to ecosystem-based fisheries management.
- Ecological role of forage fish should be accounted for when setting catch limits.
- Economic value of forage fish should be expanded to include their supportive value to other commercial and recreational fisheries, and eco-tourism industries.
- Risk of wide population swings and high catchability of forage fish should be accounted for in fishery management plans.
- Stock assessments and FMPs should be developed before forage fisheries can be expanded or initiated to maintain their vital role in marine ecosystems.
- Protections afforded in the MSA should be given to forage fish caught in Federal and state waters, through improved coordination between fisheries management authorities.

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A Scientific Perspective on Ecosystem Relationships of Forage Fish

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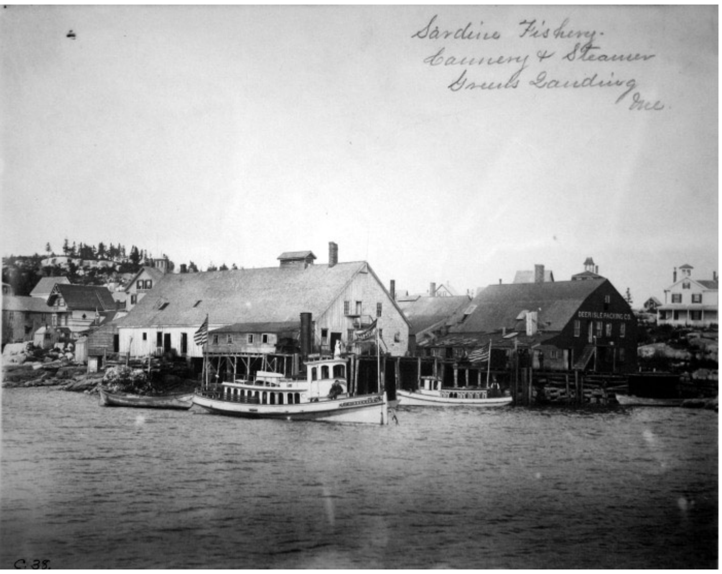
Abstract

Forage fish such as anchovy, sardines, herring, and menhaden are typically highly abundant plankton feeders, form dense schools, and play a key role in transferring production from phytoplankton and zooplankton to larger predators. On the global scale, harvests of forage fish total over 20 million metric tons annually and account for 25-30 percent of global fisheries landings. The key scientific challenges with respect to forage fish are understanding their high levels of population fluctuation, and understanding their supporting role—both ecologically and economically—in the fishery food web and ecosystem. Both characteristics make traditional fishery reference points (such as maximum sustainable yield) difficult to estimate. New approaches, largely based on global data analysis, economic analyses, and ecosystem modeling, can help to evaluate the trade-offs between forage fish yield, harvest of predatory fish, and persistence of protected predators and other marine species. Encouragingly, recent modeling work suggests that very simple harvest policies, quite similar to those already put in place by Regional Fishery Management Councils for many stocks, may be robust to climate-driven population fluctuations, and may minimize impacts of forage harvest on other fisheries and predators. The challenge at a regional level may be to identify, from a policy perspective, how to adjust harvest policies so that trade-offs are acceptable to stakeholders and the public.



Introduction

Definition of Forage Fish

On the global scale, harvest of forage fish such as anchovy, sardines, herring, menhaden, capelin, and mackerel total over 20 million metric tons annually and account for 25-30 percent of global fisheries landings (Figure 1). Forage species are typically highly abundant plankton feeders, form dense schools, and play a key role in transferring production from phytoplankton and zooplankton to larger predators (Smith et al. 2011). This definition excludes juveniles of species that mature to much larger sizes (e.g. tunas); it also excludes some smaller species (e.g. shortbelly rockfish, *Sebastes jordani*) that are known to be important prey items (Ainley et al. 1996, Lowry and Carretta 1999) but differ in other respects such as schooling behavior and life history. In the context of Regional Fishery Management Councils, a clear definition of "what is a forage fish" has been useful in the drafting of a Fishery Ecosystem Plan for the U.S. West Coast (Pacific Fishery Management Council 2011).

Here I focus mostly on forage *fish*, but the broader scientific literature on forage species includes invertebrates such as krill (*euphausiids*) and squid. The scientific literature on krill harvest and management in Antarctica offers examples of precautionary management and an awareness of the role of krill for predators such as whales, penguins, and fur seals (Constable et al. 2000). Euphausiid harvest has ranged from 104,000–215,000 metric tons annually during 2005–2010 (FAO 2010).

In this review, I first give some context by presenting data on U.S. forage fish landings. I then discuss the relationships between forage fish and their environment, in terms of oceanographic effects, population cycles, and the role that forage fish play in supporting predator populations. Finally, I discuss challenges and scientific evaluations of options for management of forage fish. Examples are taken from international studies as well as from U.S. fish stocks, with a bias towards the U.S. West Coast.

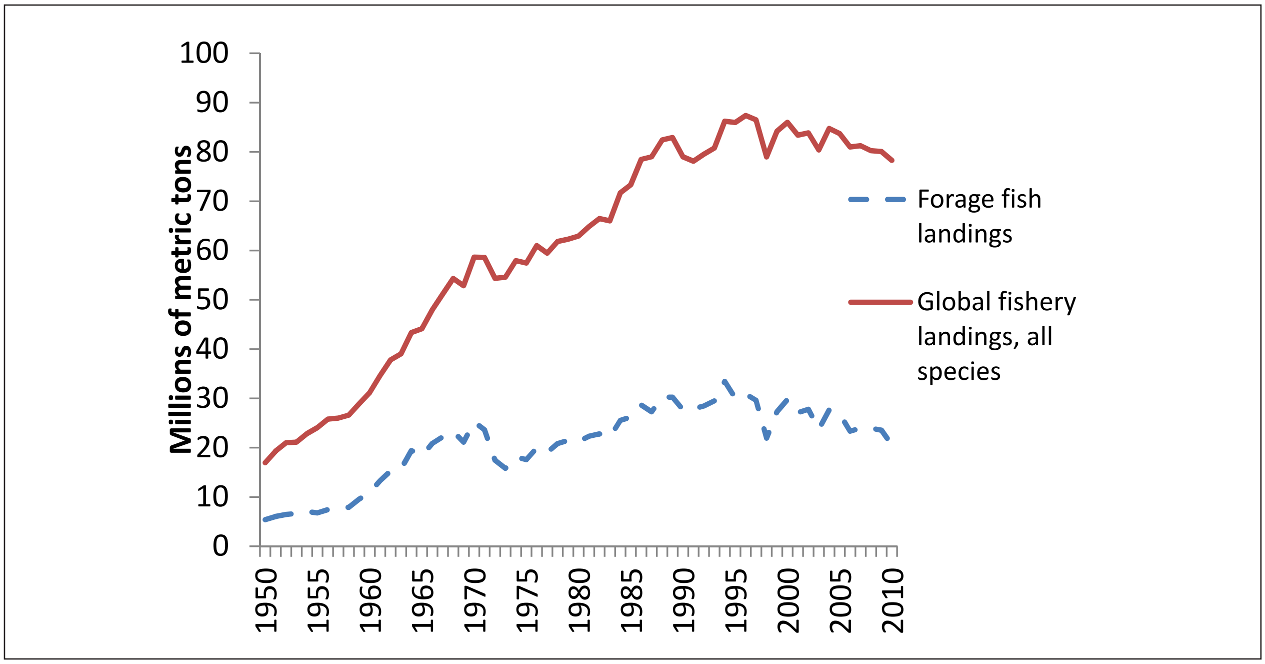


Figure 1. Global landings of forage fish and krill (FAO 2010); Forage fish here include the category "Herring, sardine, anchovy" as well as mackerels and capelin. Forage species were approximately 26%-32% of global landings for 2005-2010.

Discussion

Trends in U.S. Forage Fish Landings

U.S. landings of forage fish have been fairly stable at 715,000–1.5 million metric tons annually since 1950 (Figure 2), though there are important distinctions in trends for individual stocks. Landings for the period from 2005-2011 increased from 786,000 to 1.15 million metric tons; almost 70 percent of total landings are Atlantic and Gulf menhaden.

On the East Coast and Gulf of Mexico, alewife were harvested in the 1950s and 1960s but declined steeply after that (Figure 3). Aside from menhaden, landings are dominated by herring (with a peak of 101,000 metric tons in 2009), with increases in mackerel landings beginning in the 1980s. West Coast landings data (Figure 4) and abundance demonstrate cyclical patterns for anchovies and sardine (MacCall 1996). California market squid landings now exceed those of forage fish, and squid are also a major prey item for West Coast predators.

Figures 3 and 4 illustrate a key characteristic of forage species: they tend to have very large (more than tenfold) changes in population abundance that occur over short periods, often less than a decade. These population fluctuations are evidenced in both landings data and surveys of population abundance. When considering the impacts that these landings have on the harvested stocks (whether sardine, herring, menhaden, etc.), it is valuable to view these removals as a fishing mortality rate or exploitation rate. This exploitation rate can be compared between stocks or subspecies with similar productivity. For instance, Pacific sardine (*Sardinops sagax caerulea*) exploitation rates by the U.S., Mexico, and Canada are currently 0.145 (Hill et al. 2011), while the subspecies of Australian sardines (*S. sagax neopilchardus*) is currently lightly fished, with a fishing mortality rate of less than 0.03 yr^{-1}. Stocks of the South

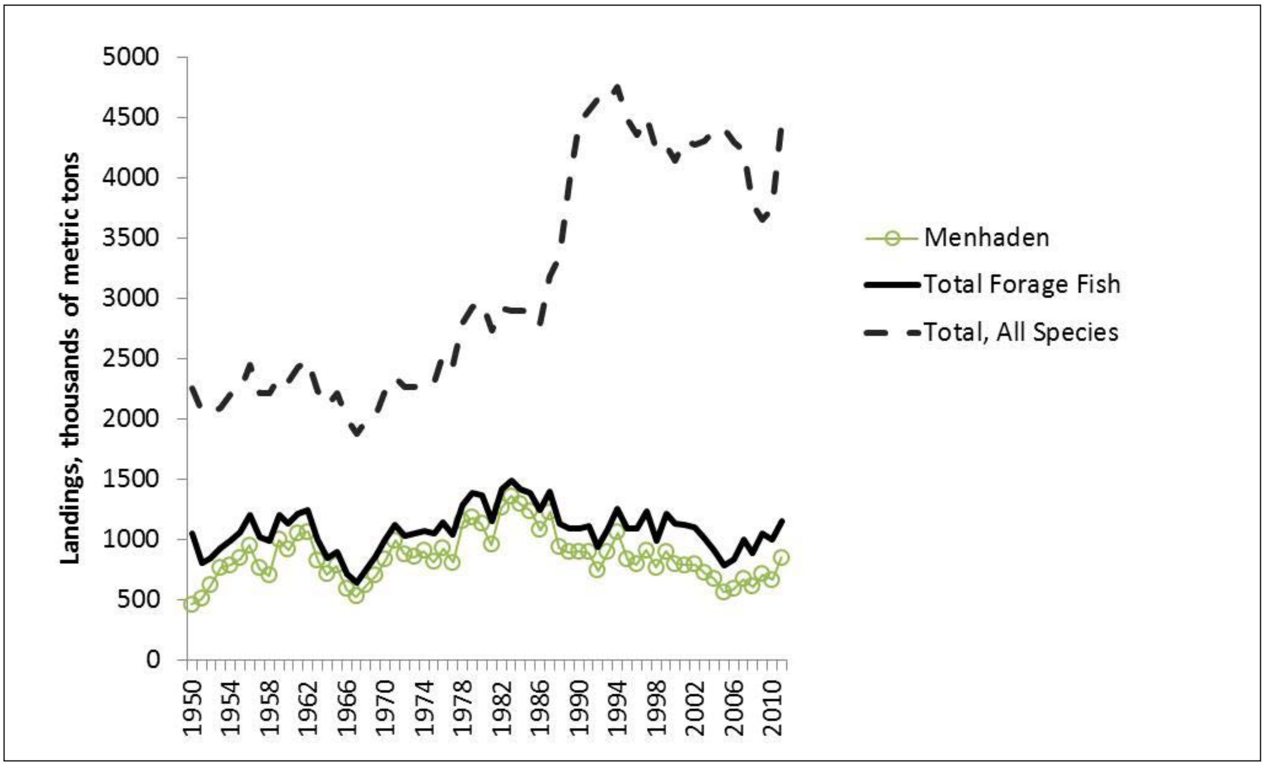


Figure 2. U.S. landings of menhaden, all forage species (including menhaden), and all species combined (NOAA ACL database 2012); Forage species here include alewife, anchovies, Atlantic herring, Pacific herring, jack mackerel, Atlantic mackerel, chub mackerel, menhaden, Pacific sardine, California market squid, and longfin squid.

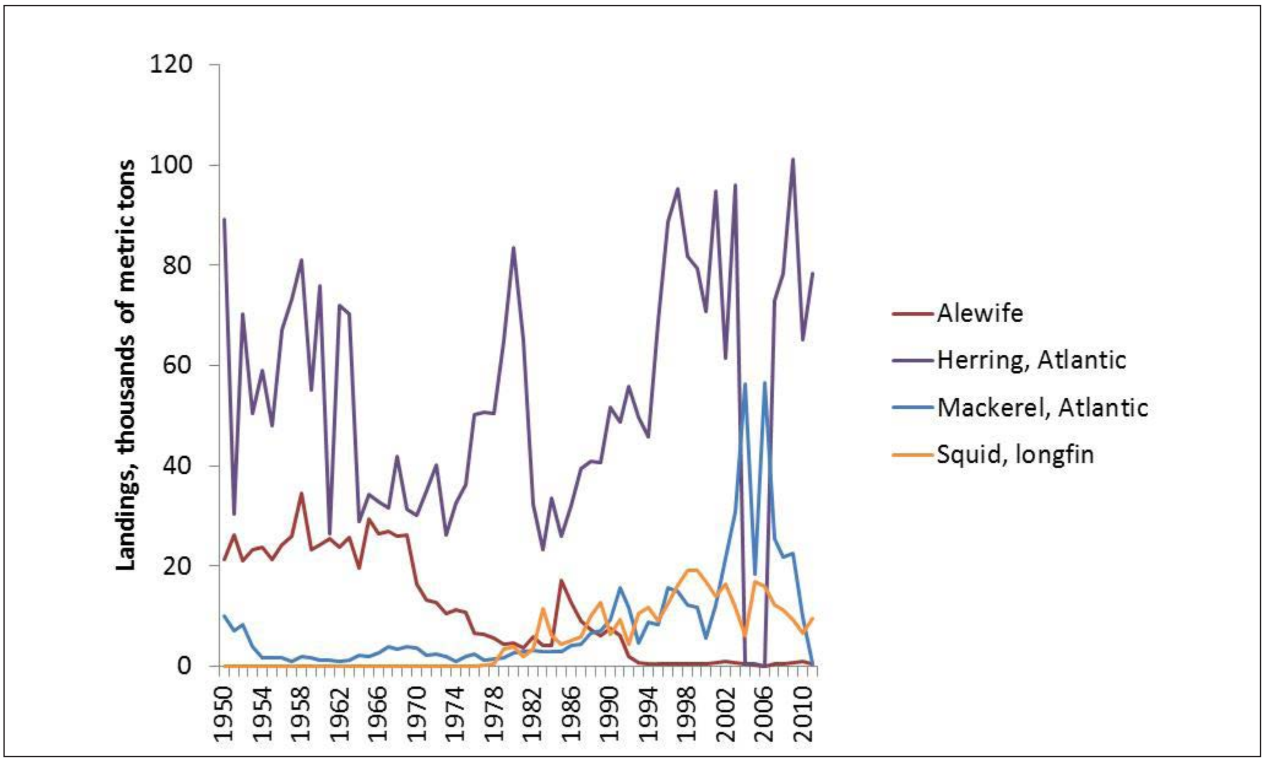


Figure 3. U.S. landings of forage species (excluding menhaden) along the Atlantic and Gulf of Mexico coasts (NOAA ACL database 2012). Minor forage species with annual landings <50 metric tons not shown.

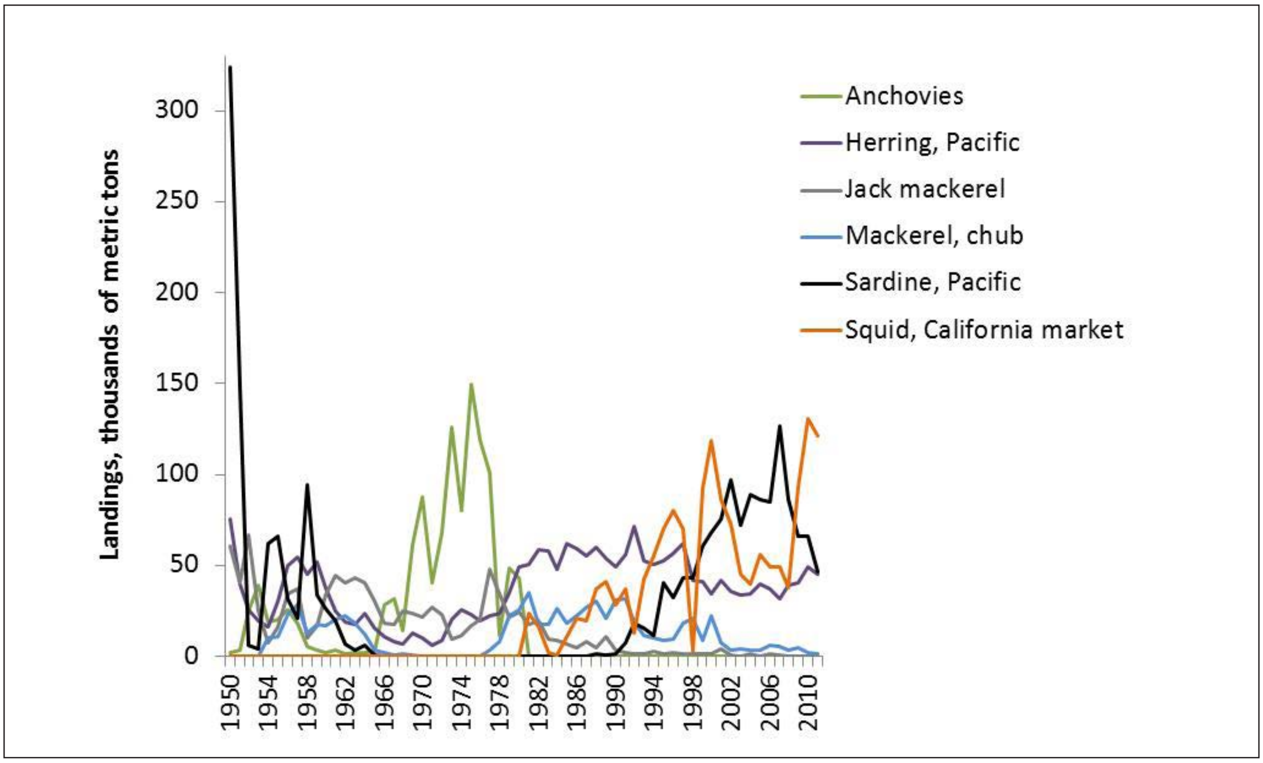


Figure 4. U.S. landings of forage species in West Coast and Alaskan waters (NOAA ACL database 2012). Minor forage species with annual landings <50 metric tons not shown.

African and Namibian subspecies (*S. sagax*) have fishing mortalities closer to 0.3 yr^{-1}; and the North/Central Peruvian stock (*S. sagax*) is currently harvested at approximately 0.18 yr^{-1} (Barange et al. 2009).

On a very crude level, the landings data illustrate the tons of prey (forage) removed from the systems, and no longer available to predators. The implications of such population fluctuations and predator demands are discussed below.

Population Dynamics and Role of Forage Fish in the Food Web

POPULATION FLUCTUATIONS

Forage fish differ from other stocks due to their population fluctuations and to their ecological role in the food web. Fishery landings, scientific surveys, and on-the-water experience point to the strong decadal-scale cycles in many forage fish stocks. Such cycles occur for fishery landings throughout the world (Alheit et al. 2009). European catch records indicate strong fluctuations in catch, and likely abundance, of herring and sardines over ten centuries (Alheit and Hagen 1997). On the U.S. West Coast, Baumgartner et al.(1992) have identified strong cycles of abundance in patterns of fish scales deposited in the sediment over the last 1700 years. It is notable that these fluctuations were present long before modern fishing began; this does not mean that fishing lacks effect, but that it occurs in the context of somewhat unstable productivity for these stocks. For sardine and anchovy, previous authors have suggested that there was a global synchrony to fluctuations of each species, and that the two species cycled asynchronously (out of phase). However, new evidence and interpretation suggests that these cycles are determined by processes at the scale of single oceans, rather than by global drivers, with no consistent inverse correlation between sardine and anchovy abundance (Field et al. 2009, MacCall 2009a).

Though environmental or climate effects are often assumed to drive these cycles, disentangling the exact mechanism is not always straightforward. In Chesapeake Bay, Kimmel and colleagues (2009) found that years with low precipitation and low river discharge coincided with higher abundance of juvenile menhaden. These authors proposed that entry of menhaden larvae from the ocean into the Chesapeake may be facilitated during dry years. For sardine and anchovy stocks, the exact mechanism for population fluctuations has been debated for nearly forty years. One theory by MacCall (2009b) noted that anchovies are smaller, and are therefore restricted to areas closer to shore, and so their productivity declines when nearshore upwelling and nutrients decline during periods of weak currents. In a comparable study, van der Lingen and colleagues (2006) proposed that warm water conditions associated with weak currents favor a food chain with smaller plankton that are primary prey for sardine; during stronger current flows and colder conditions, larger plankton species become more abundant, as does their predator, anchovy.

Just as bankers may be more interested in forecasts of what the stock market will do, rather than why it will do it, natural resource managers and the fishing industry may be satisfied with straightforward measures that predict trends in forage fish populations. However, even identifying these simple proxies can be challenging. For instance, Jacobson and MacCall (1995) found that Pacific sardine recruitment increased with sea surface temperature. In an analysis of the continuing time series, McClatchie et al. (2010) found that the relationship no longer held; an even more recent study with improved statistical analyses (Lindegren and Checkley 2012) suggests that the relationship remains valid. Such scientific debate is not merely an academic exercise, as the Pacific Fishery Management Council has in the past adjusted harvests following a rule that includes temperature (Hill et al. 2008).

Role as Prey

Predator diets, whether observed in a laboratory or at a filleting table, often indicate that small pelagic fish are important as prey. For example, on the West Coast (Figure 5), seabirds, salmon, and albacore tuna diets suggest reliance on forage fish such as sardine, anchovy, herring, and smelt for more than 50 percent of their diets (Dufault et al. 2009). In systems such as the Benguela Current in the South Atlantic off Africa, an upwelling region similar to the U.S. West Coast, a small number of forage species play critical roles in transferring primary and plankton production to top predators (Cury 2000). In a global review that utilized 72 ecosystem models to handle the "book keeping" of predator diets, Pikitch et al. (2012b) found that half of all predator groups relied on forage fish for more than 10 percent of their diets, and 16 percent of predators relied on forage fish for more than 50 percent of their diets.

Below, I discuss the evidence that reduced abundance of forage species can impact predator abundance, particularly predators that can't easily switch from forage fish to some other prey species. The extent to which predators decline when forage fish are depleted is relevant to potential impacts on harvested predator stocks, and species of conservation concern such as marine mammals and birds. Finally, I discuss fishery management responses that may address this concern.

Food Web Impacts of Fishing Forage Fish

The move toward ecosystem-based management of marine resources (Pikitch et al. 2004, McLeod and Leslie 2009) has encouraged a broader perspective regarding the impacts of fishing. Fishing on small pelagic fish is understood to potentially impact a suite of non-harvested species, particularly predators. Recent advances in scientific capacity, in particular global analysis of long-term data sets and development of ecosystem models, can begin to quantify expected food web responses.

Though it is difficult to predict complex food web responses from observations of a single location or system, global analyses by large groups of scientists have offered key insights. A team of scientists studied 14 species of seabird in seven different marine ecosystems (Cury et al. 2011) and suggested that seabird breeding success declines when prey abundances are less than about 1/3 maximum. (Prey included forage fish but also a broader set of species such as krill and walleye pollock.) The authors suggest that this may be a rule of thumb for ecosystem-based management of forage stocks.

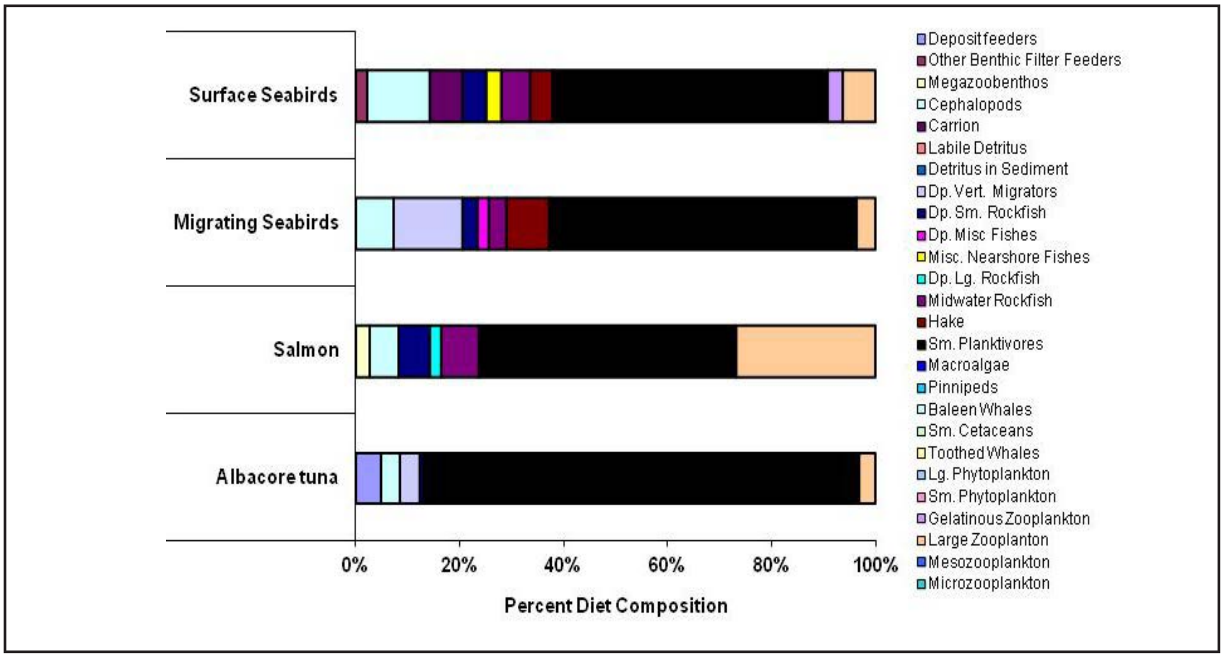


Figure 5. Diet composition of four groups of predators in the California Current, U.S. West Coast. Black portions of bars are small planktivores, a forage group that includes sardine, anchovy, smelt, and herring. From Dufault et al. 2009.

Ecosystem models (Rose et al. 2010, Fulton 2010) are a new type of analysis that has developed rapidly as computer speed increased in the last decades. Such models typically simulate and predict oceanographic conditions, multiple species of predators and prey, and fishing. In most models, predator diets fluctuate as different prey items change in their abundance or availability. Several ecosystem modeling frameworks operate on a map-based framework, while others ignore space (much like a traditional stock assessment). These models are almost always intended as strategic tools—essentially "flight simulators" to test ideas about how the ecosystem works, how fisheries might respond, and what implications stem from management actions. Ecosystem models are not tactical tools that would be used for example to precisely set quotas.

In an ecosystem modeling study, Smith et al. (2011) found that across five global regions, harvest of forage groups had large impacts—positive and negative—on many other species. This was particularly true for forage groups that comprised large portions of an ecosystem's biomass, or that were highly connected in the food web (e.g. had many predator/prey links). The study included forage fish, but also key prey groups such as myctophids (lanternfish) and krill. Biomass changes of more than +/- 40% were observed throughout the food webs, including fishery target species. Impacts on seabirds and marine mammals were often negative. The authors found substantial impacts on the food web when forage stocks were fished down to levels (typically 60 percent of unfished abundance) that gave maximum sustainable yield. Reducing catches so that forage species were fished less intensely (to 75 percent of unfished abundance), reduced these food web impacts but led to only 20 percent reductions in yield. Consistent with Smith et al, Kaplan et al. (2013) found that harvest of forage fish and krill had large impacts in two ecosystem models that simulated the California Current food web. Depleting krill to 40 percent of unfished levels altered the abundance of 13–30 percent of the other functional groups by more than 20 percent. Depleting forage fish to 40 percent altered the abundance of 20–50 percent of the other functional groups by more than 20 percent.

The focus of the ecosystem modeling studies above was primarily to characterize the magnitude of impacts, and to identify broad groups (such as all birds or mammals) that might be most susceptible to forage fish depletion. Another recent study (Pikitch et al. 2012a) identified specific characteristics of predators that predict this susceptibility. Drawing from ten ecosystem models in a global database, Pikitch and colleagues (2012a) developed statistical relationships that predict the likelihood of a particular predator declining, given the amount of targeted forage species in its diet, and the forage species' depletion level. For instance, for a predator with half of its diet comprised of a forage species, the forage species would need to be maintained above 57 percent of unfished levels for a decline of more than 50 percent for that predator to be unlikely or very unlikely. The results could serve as guidelines for systems or species that lack the detailed ecosystem modelling analyses of Smith et al. (2011).

In summary, modeling results and some observational studies suggest that predators, and the food web in general, are affected by depletion of forage groups. Predators will often decline when forage fish are depleted, though predators' ability to switch diets may lead these declines to be less severe than would be predicted by diet compositions alone. Finally, some species that are prey or competitors of forage fish may increase in abundance when forage fish are removed.

Ecosystem models, including those discussed above, are always incomplete cartoons of the true world. One large gap is modelers' inability to represent local depletion of forage fish around bird and mammal colonies, rookeries, and haulouts. Local depletion of forage stocks, and negative impacts on critical life stages such as seabird fledgelings (Ainley et al. 2009, Hipfner 2009), may explain differences between the coast-wide view taken by much of the modeling, and site-specific observations such as those by Cury and colleagues (2011) of seabird reproduction. A final consideration is that most ecosystem models do not reproduce the dynamic fluctuations that are typical of forage fish populations. Further use of ecosystem models to evaluate harvest policies will require either that such fluctuations are directly forced on the models, or that detailed feeding mechanisms (such as those described above for sardine and anchovy) are included to lead the models to reproduce these cycles.

The Case for Balanced Exploitation

Though there has been an increasing demand for conservation of forage fish, balanced exploitation—harvest of forage species as well as higher trophic level species—may reduce negative ecological effects. Zhou and colleagues (2010) argued that fishery managers should attempt to spread fishing mortality more evenly across species, sizes, and sexes, in an effort to minimize impacts on biodiversity, ecosystem function, and ecosystem and fishery productivity. Such balanced exploitation would establish minimum abundances for each target population, above which fishing would be allowed at a rate proportional to the productivity of the stock (Zhou et al. 2010). This concept of proportional mortality implies that fast-growing and early-reproducing species, including most forage fish, could be fished more heavily than longer-lived species. A broader set of forage species would be harvested, though harvests would not necessarily increase on current target forage stocks. Garcia and colleagues (2012) tested the concept of balanced exploitation using 36 multi-species ecosystem models that represented 30 systems around the world. They found that harvest policies that encouraged fishing across a broad range of species and sizes led to higher yields, fewer extinctions, and higher abundances.

For many parts of the U.S., balanced exploitation would be a paradigm shift in management—a shift toward exploitation and assessment of a broader 'basket' of forage species; high exploitation rates for productive forage fish groups; less emphasis on bycatch reduction; and development of markets for large volumes of species that are traditionally discarded and not targeted. Fishery Councils and other resource managers, whose management actions are often currently triggered by single-species reference points (in other words, if a species is above or below some threshold abundance), would likely be guided more by community and ecosystem metrics related to biodiversity, size of fish, and likelihood of extinction or reduction of biodiversity. Though these are not the currencies of most U.S. fisheries management, metrics of fish size and diversity are now calculated by NOAA from existing fisheries and survey data (Ecosystem Assessment Program 2009, Levin and Schwing 2011), and likelihood of extinction is central to management of some species such as salmon (Legault 2005). In summary, true balanced exploitation may not be practical or legal under U.S. law, but the concept may help us understand and monitor potential ecological effects of "less balanced" fisheries policies.

Economic Value of Forage Fish

Due to the role of forage fish in supporting the abundance of other species, recent analyses have begun to calculate not only the landed (dockside) value of forage fish, but also their contribution as "inputs" to the production of tunas, cod, pollock, and other predatory fish.

Pikitch et al. (2012b) used a global set of ecosystem models to quantify the direct contribution of forage fish to harvest value ($) and the indirect contribution when forage fish are preyed upon by higher-trophic level fishery target species. As an example, an indirect contribution of forage fish to tuna might be calculated as $8 million if forage fish comprised 80 percent of tuna diets, and the tuna fishery had a landed value of $10 million. Overall, Pikitch and colleagues estimated that forage fish contribute a total of about U.S. $16.9 billion to global fisheries values annually, with $5.6 billion in direct catch and roughly twice as much ($11.3 billion) in indirect supporting value for commercially targeted predatory species. Fishery Councils that are charged with managing recreational fisheries might also consider the supporting role of forage fish for recreational anglers, which were not included in the global analysis of Pikitch and coauthors.

On the U.S. West Coast, Hanneson et al.(2009) and Hanneson and Herrick (2010) also developed bio-economic models for forage fish and their predators, and identified situations (such as dockside prices for both prey and predators) for which higher or lower harvest of forage fish would be economically optimal. For instance, under base assumptions, they found that if sardine predators (ranging from tunas to seabirds) have an average value of $0.12 per kg, sardine are worth more as forage than as harvest, while if sardine predators are not valued at all, optimal sardine harvest rate is high, $0.45 yr^{-1}$. Analyses such as these will be essential tools if fishery managers are to consider economics as they evaluate tradeoffs between harvest needs of different sectors, and between harvest of forage fish and energetic needs of predators.

Target Reference Points

Predatory fish such as groundfish are often managed on the basis of reference points that can reduce biomass to below 50 percent of unfished levels (Clark 2002). However, several studies have found that lower fishing rates—meaning lower harvests—may be more appropriate for forage species, based on single-species (not ecosystem) considerations. These guidelines for harvest rates are useful in considering options for management approaches (see below).

A species' natural mortality rate (due to factors such as predation, disease, and old age) can serve as a useful management guidepost that can be estimated from available data (Pauly 1980) and can be related to harvest rates. Caddy and Csirke (1983) reviewed global data and suggested that small pelagic fish species may only be able to sustain fishing mortality that is considerably less than their very high natural mortality (e.g. predation rates). Similarly, Patterson (1992) and Mertz and Myers (1998) suggest that small and medium sized pelagic groups might have optimal fishing rates that are only 50-60 percent of the natural mortality rate, lower than for larger predatory fish. Such fishing mortality rates typically will lead to biomass levels substantially above 50 percent of unfished levels.

Note that these target fishing mortality rates from previous studies did not include specific relationships between a set of predators and prey. Given the new studies such as the food web and ecosystem modeling discussed above, decision makers may now wish to consider whether target rates and reference points should explicitly take food web impacts into account. Combining results from stock assessments, food web modeling, and economic analyses could allow decision makers and stakeholders to weigh trade-offs between conservation, harvest of small pelagic fish, and other fishery and economic goals.

Management Approaches for Forage Fish

The fluctuating population dynamics of small pelagic fish, and their role as forage, may require a management approach different from that used for other stocks. However, a number of examples offer avenues to tackling these challenges and addressing these ecosystem considerations.

In the U.S. and in other countries, reference points based on maximum sustainable yield (MSY) and unfished biomass ($B_{unfished}$) are central to management decisions and goals (*Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006* 2007, European Commission 2010). From a scientific perspective, it is difficult to provide advice regarding MSY for forage fish: MSY and unfished biomass are moving targets, due to shifting climate, recruitment, and stock productivity. One potential response would be to develop fishery management strategies that explicitly adjust fishing mortality rates in response to climate, as has been proposed by MacCall (2002) and King and McFarlane (2006). However, statistical estimation of these productivity shifts and fluctuating reference points is difficult in a stock assessment context (A'mar et al. 2009, Haltuch et al. 2011). Climate variability affects marine ecosystems. The mechanisms relating low-frequency environmental fluctuations (regime shifts, and these difficulties may outweigh the theoretical benefits.

Simpler management approaches may be necessary to address the impacts of fluctuating populations without attempting to statistically estimate fluctuating management reference points. Threshold control rules (Figure 6) are one management approach that is robust to these fluctuations. Threshold control rules allow no fishing below a minimum stock abundance, with the fishing mortality rate increasing gradually up to a maximum as abundance increases. Such a threshold control rule is in place for Pacific sardines (Pacific Fishery Management Council 2006), and was implemented 35 years ago for anchovy (Pacific Fishery Management Council 1978). For a Japanese sardine stock, Hurtado-Ferro and colleagues (2010) compare performance of a simple threshold control rule with a slightly more elaborate threshold rule that reduces maximum fishing mortality rate when environmental conditions are poor. In this simulated case, the more elaborate rule performed slightly better than a simple threshold rule, particularly in terms of avoiding heavy depletion of the stock. However, overall these two threshold rules performed similarly, and substantially better than a policy with a fixed fishing mortality rate and no minimum biomass threshold.

Threshold control rules may also be a strategy to address ecosystem impacts by "setting aside" a minimum forage base for predators. Pikitch et al. (2012a) applied ecosystem models for ten different marine regions, and scored harvest control rules in terms of impacts on dependent predators, as well as fishery yields. Their results led to the recommendation that fishery managers implement threshold control rules that set aside a minimum of 30 percent of each forage stock as unfished, and limit fishing mortality rates to less than three-quarters of F_{MSY} (fishing mortality that results in maximum sustainable yield). In cases where less information is available about a forage stock, Pikitch et al (2012a) recommended maximum fishing mortality rates of half of F_{MSY} and measures to keep biomass above 80 percent of unfished levels. This target of 80 percent is comparable to the 75 percent reference point identified by Smith and colleagues (2011) as a target that would greatly reduce impacts on predators, while lowering fishery yields by only ~20 percent.

Threshold control rules that accommodate predator needs will often imply forage fishery yields below what might be calculated as optimal by single-species stock assessments. Economic and social costs of reduced harvests would need to be weighed by local decision makers, for instance at the Regional Fishery Management Council level. The trade-offs are not just between forage fish harvest and protected predators such as birds and mammals. As mentioned above, there are also economic costs in terms of yield of predatory fish (tunas, salmon, etc.), and other metrics related to biodiversity and community metrics such as size of fish. Current harvest rates on forage fish vary widely by species and region; in some cases exploitation rates are already very low. In those cases, scoping exercises or scenario planning (Alcamo 2008, Ash et al. 2010) can be used to identify potential increases in market demand or harvests in the future, and to focus management efforts.

Conclusions

Of the trigger questions posed on the topic of forage fish, I have addressed three here from the scientific perspective (while several others fall more in the policy realm):

- Do current characteristics of forage fish warrant a departure from the current management approaches, characterized by some as a traditional single-species approach?

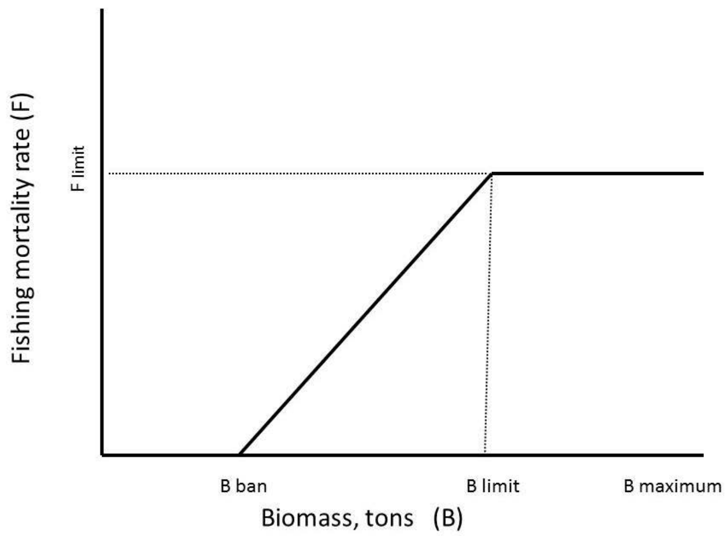


Figure 6. Example of hypothetical threshold harvest control rule, which adjusts fishing mortality in response to changing biomass of the stock. F limit is the maximum allowable fishing mortality rate; B ban is the biomass below which fishing is not allowed; B limit is the biomass above which fishing can operate at the maximum rate (F limit); B maximum is a maximum observed or estimated unfished stock biomass.

The key scientific challenges with respect to forage fish are understanding their high levels of population fluctuation, and understanding their role—both ecologically and economically—in the fishery, the food web, and the ecosystem. Both characteristics make traditional fishery reference points difficult to estimate, despite the centrality of reference points such as MSY in U.S. fishery policy.

- Where on the trophic scale should we be harvesting and managing species? As societal targets change, is there a need to redefine optimum yield and what the Regional Fishery Management Councils should be managing for?

Analyses discussed here related to balanced exploitation suggest that ecological effects of fishing may be minimized if fishing is spread more evenly across species, sizes, and sexes. This would involve harvesting a broader set of forage species, but not necessarily increasing harvests on current target forage stocks. Such an approach of balanced exploitation would face practical challenges related to marketing, assessment, and bycatch. Balanced exploitation may not be practical or legal under U.S. law, but this research topic may help us understand and monitor potential ecological effects of "less balanced" fisheries policies.

Modeling and field studies suggest trade-offs between harvest of forage fish, versus harvest of larger fish and conservation of predators such as marine mammals and birds. Approaches identified here (global data analyses, economic approaches, and ecosystem modeling) can identify these trade-offs; generally the scientific literature suggests that harvest of forage species at their single-species optimum leads to declines in protected species and other harvested stocks.

- How should management reconcile ecosystem services valuation and the economic value of forage fisheries? What are some of the trade-offs?

New approaches presented above, largely based on global data analysis, economic approaches, and ecosystem modeling, can help to evaluate the trade-offs between forage fish yield, harvest of predatory fish, and persistence of protected predators and other marine species. Several of the analyses suggest rules of thumb for predicting impacts of forage species harvest on predators; others offer examples of detailed ecosystem modeling that, where available, can provide predictions tailored for particular regions and species.

Encouragingly, recent modeling work suggests that managing with very simple threshold harvest control rules (Figure 6), quite similar to those already put in place by Regional Fishery Management Councils for many stocks, may

be robust to climate-driven population fluctuations, and may minimize impacts of forage harvest on other fisheries and predators. The challenge at a regional level may be to identify, from a policy perspective, where to set the reference points (B_{limit}, F_{limit}, B_{ban} in Figure 6) so that trade-offs are acceptable to stakeholders and the public. Coupled with spatial management that restricts fishing near sensitive breeding areas for marine mammals and birds, appropriate control rules may provide a balance between the competing demands on forage fish.

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Forage Fish Management in the United States: A Commercial Fishing Perspective

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Abstract

Ecosystem-based management is a term very familiar to fisheries scientists and managers, as well as environmental groups and the fishing public. Actual understanding of exactly what ecosystem management is likely varies among all the groups identified. What is clear to most is that ecosystems are very complex, causing management of those systems to be quite complex as well. For some species, Atlantic menhaden for example, ecosystem approaches to management are more realistic through the use of multi-species modeling. While simpler than full ecosystem management, multi-species modeling is still complex and is very data intense, requiring extensive predator/prey data. Because of the regional variability of species, species interactions, and environmental conditions, among other factors, management of coastal and marine species is largely conducted through Federal Regional Fishery Management Councils and interstate fisheries commissions on a "fishery" (generally single-species) basis. Likewise, so-called "forage" species should be managed through these existing regional management systems under the well-tested fisheries management framework enshrined in the Magnuson-Stevens Act (MSA) and mirrored by the commissions, incorporating knowledge gleaned through improved understanding of ecosystem and species interactions. The fact that forage species represent a food source for other species simply means that extra layer of complexity must be considered when conducting the science and designing a management approach. As it is important to understand what eats forage species, it equally important to understand what forage species eat. There could, in fact, be situations in which forage species consume egg, larval, or juvenile forms of other, economically important species, exemplified by the impact of North Sea herring on eggs of plaice and cod (Daan et. al 1985).

The following recommendations are presented:

Recommendation 1: If a management entity is planning to engage in ecosystem approaches to management, provisions to collect the appropriate type and amount of data should be ensured.

Recommendation 2: Any process to establish a goal or goals (a desired ecosystem state) for ecosystem-based management must be fair and balanced, involving affected user groups, and must consider scientific, economic, and sociological factors, as well as the legal framework. For example, if a process to manage Atlantic menhaden using ecosystem-based management strategies allows anti-commercial fishing groups to dominate, the outcome for the directed commercial fishery would likely be negative. In addition to scientific factors, issues such as jobs, economic well-being, cultural history, and historic participation and dependence on a fishery must play a prominent role in the decision-making process.

Recommendation 3: Management of forage species should be accomplished at the regional, not national, level. Policies and management approaches affecting both forage and predator species will be most effective if achieved under the existing management structures.

Recommendation 4: It is not necessary to change the Magnuson-Stevens Act or the Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA) to achieve effective management of a group of fish categorized as forage. They will, however, require the same due diligence that is required of effective management of other species: a full understanding of and data on 1) life history characteristics, 2) predator/prey and other species interactions, 3) fishery scope in space and time, and 4) fishery practices, among other factors I may have missed.

Recommendation 5: Full implementation of ecosystem-based management may, however, require legal changes, particularly to allow one fishery to be managed for the benefit of another. True ecosystem-based management also should allow for reducing the size of certain predator stocks (by, for example, temporary "overfishing") for the benefit of forage and other non-forage stocks alike, if doing so would to improve ecosystem dynamics and increase economic yields. As such, the goals of ecosystem-based management should be defined in broad terms that recognize the need to maintain a healthy marine ecosystem, strong commercial and recreational fisheries, and vibrant fishing communities by considering species interactions while maximizing the benefits marine resources provide. It must also be accompanied by a legal framework that supports this approach.

Recommendation 6: Further, more expansive research should be conducted to determine the possible effects of climate and weather on the status of fish populations under management, specifically forage species.

Recommendation 7: It is important to understand the food sources that are required of forage species for at least two specific reasons. First, if food could be a limiting factor in the overall success of a population, it is important factor to help explain possible declines in fish health or abundance. Second, species such as Atlantic menhaden that are filter feeders could, and may, consume meroplankton, including eggs and larvae of other species. Very little is known about the possibility of this occurring and what the potential impacts may be on species of economic importance.

Introduction

One of the most talked about concepts in natural resource management over the last ten to fifteen years is ecosystem-based management. It is a concept that sounds and feels right. Most scientists can readily see the allure. We know that all things in nature are connected. There is no meaningfully distinction between state and Federal waters or separating watersheds from the estuaries they feed, and yet we draw jurisdictional lines. We know that phenomena such as rainfall, large storm events, and shifts in temperature all affect the natural system individually and in combination, and yet we are limited to managing only activities that we can affect, which usually comes down to fishing activities. We push and shove at improving coastal water quality, but human-driven economic development activities typically win over attempts at control. These are but a few of the many and complex issues related to the ecosystem. Can humans manage ecosystems? Perhaps the future will hold real ecosystem management, but for now we are experimenting with ecosystem-based management or ecosystem approaches to management.

Ecosystem-Based Management and Multi-Species Management

Recognizing that humans are not capable of managing natural, large-scale, environmental phenomena, we have begun to focus on those things that we think we can affect. Ecosystem-based management, at least for Atlantic menhaden, has emerged in the form of multi-species management. This session is dedicated to examining issues related to managing forage fish; not simply managing the extraction of forage fish, but also managing forage fish as a food base for predators. The harvest of forage fish needs to be in the context of the relative importance of the species in question to the predators upon which they rely. Of specific interest to the commercial fishing industry is *How do we account for predation mortality on forage fish while successfully managing for direct harvest?*

Forage can be either a noun or a verb, either a source of food or the act of looking for food. It is a fact that just about everything in the coastal and ocean environments is forage at one time or another in their life cycles. It is worth pointing out that the MSA does not include or define "forage fish" as a specific category of fish, so it behooves us to come to some understanding of what species we are categorizing as such. There is a general agreement about the characteristics of forage fish, and it is clear that Atlantic and Gulf menhaden, species with which I am most familiar, meet "forage fish" characteristics. The identification and definition of "forage fish" for management purposes should be left to the Regional Fishery Management Councils and Interstate Marine Fisheries Commissions to determine in the context of species currently under their management or as future species to manage. This is partly because variability among forage fish is high. For example, Pacific sardine, Atlantic herring, and Atlantic menhaden all exhibit different life histories and predator/prey relationships. Attempting to address forage fish at the national level will not allow the flexibility to account for such variability. Addressing forage fish through the development of a National Standard under the MSA would most likely limit managers' ability to confront issues specific to forage species, their ecosystems, and their predators. While it is true that forage fish present a challenge to current single-species management approaches, it is not necessary to create a different management structure to confront that challenge.

Continuing this theme, the Atlantic States Marine Fisheries Commission's (ASMFC) Atlantic Menhaden Technical Committee has used a model known as the Multispecies Virtual Population Analysis (MSVPA-X) to model predator and prey populations dynamics and estimate natural mortality for Atlantic menhaden. This is an example of ecosystem-based modeling in the form of multi-species modeling. The MSVPA-X currently includes the following predators and estimates of their predation pressure on Atlantic menhaden: striped bass, bluefish, and weakfish. These species are used, because there is an available predator/prey database for each, and these three species constitute the majority of predation mortality on Atlantic menhaden in the Chesapeake Bay. Coast-wide, resurgent spiny dogfish populations are likely another major source of predation. While the MSVPA-X could be used to support multi-species management, its use in this case doesn't really represent multi-species management. It is currently used as a tool to assist single-species management of Atlantic menhaden using the output of three single-species assessments to provide better estimates of time- and age-varying estimates of natural mortality for the menhaden assessment. It is, however, a step in the right direction. While this approach appears to result in positive benefits to the Atlantic menhaden stock assessments, alternative approaches may be needed to address other forage species and their predators. This fact exemplifies why such management decisions should be made at the regional level.

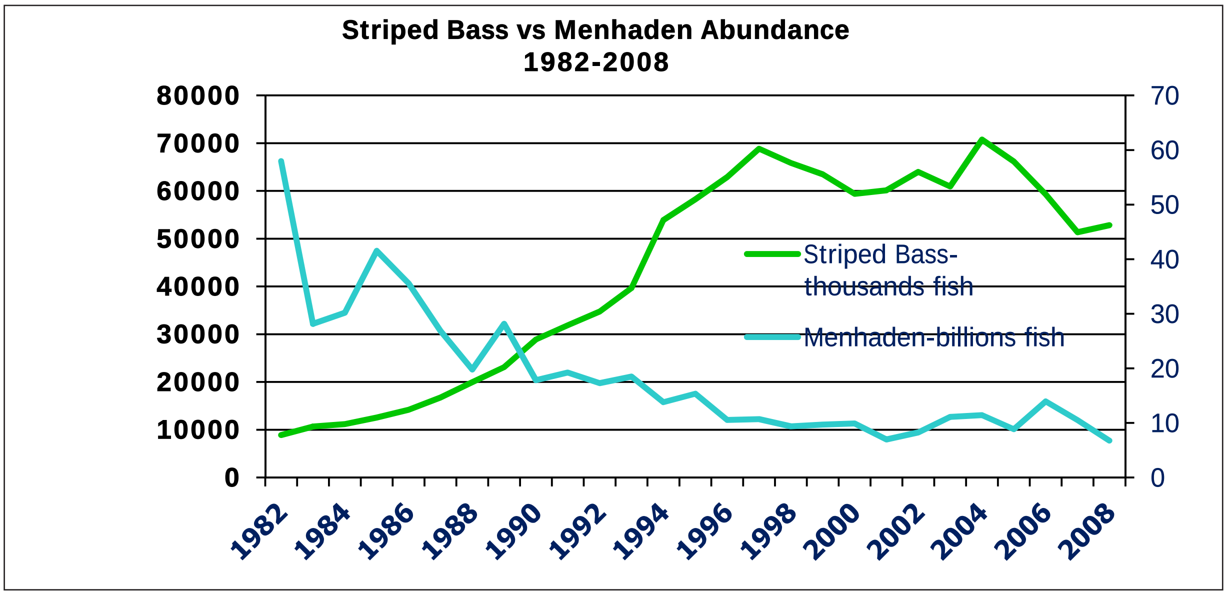
The Technical Committee is currently considering additional species, like dogfish, to include in future stock assessments. This approach seems reasonable, as it includes the use of reliable data on actual predation mortality over time. It is an approach that adheres to the tenets of the MSA and the ACFCMA by using the best available science. The multi-species approach requires that fisheries scientists and managers do their due diligence by conducting a defensible analysis of the species involved in the predator/prey relationship. Not all species are associated with long-term predator/prey data sets, and therefore, some would present unique challenges for management. However, for those species for which data are available, appropriate scientific scrutiny should be required in developing management strategies for harvest. Lumping "forage fish" into a single management category and establishing across-the-board management standards does not allow for flexibility to develop scientific or management strategies to address specific regional needs.

Management of Forage Species

In managing marine species, regardless of specific management goals, it is important to understand their life history characteristics. Such life history characteristics include life span, growth, genetics, sex ratios, food habits, environmental preferences and tolerances to name a few. Forage fish exhibit large shifts in abundance, even without fishing pressure, typically influenced by environmental conditions impacting predator and prey populations and their recruitment success. This is certainly true with menhaden, as recognized by NOAA Fisheries, stating that "menhaden recruitment appears to be independent of fishing mortality and spawning stock biomass, indicating environmental factors may be the defining factor in the production of good year classes" and the ASMFC which concluded in its 2010 stock assessment (ASMFC 2011) that fluctuations in menhaden abundance may be "almost entirely driven by non-fishery sources."

This particular life history characteristic poses real challenges to developing a management strategy that may span climate regimes that can sometimes prevail for 20 to 30 years. In the case of Atlantic menhaden, new science examining the role of climate in recruitment of coastal species has shown that some climate regimes enhance recruitment success for some species, while diminishing recruitment success for others. In other words, certain species wax while others wane under certain environmental conditions. A shift in climate regime can trigger the opposite effect (Wood and Austin 2009).

Striped bass is often seen by many as a species that requires large schools of menhaden in their diet for their survival. Many believe that there are currently too few menhaden available to striped bass, a situation that has resulted in striped bass exhibiting poor condition and sometimes showing lesions attributed to nutritional stress. According to Wood and Austin (2010), striped bass and Atlantic menhaden are typical of species types whose recruitment success is affected by climate—climatic conditions favoring striped bass cause menhaden to languish and *vice versa*. The chart shown below uses data from ASMFC stock assessments for both striped bass and Atlantic menhaden. The figure represents total abundance of Atlantic menhaden in billions of fish and striped bass in thousands of fish.



The two species are negatively associated. Beyond climatic conditions favoring predator over prey, or the other way around, another element of this inverse relationship is a factor common to all such relationships, be it striped bass and menhaden or rabbits and foxes. In a perfectly natural system unaffected by humans, population booms of predators will increase pressure on prey, driving down their abundance. As food becomes a limiting factor, predator species decline and lessen pressure on prey, allowing those species to rebuild (Zwolinskia and Demerb 2012). These direct impacts are exacerbated and confounded by a myriad of other factors, just a few of which include conditions favoring recruitment, food supplies for prey populations, disease outbreaks in dense populations, relative abundance of various prey species, and all the other competitors in the ecosystem. Further, many pelagic stocks each of which may meet any reasonable definition of forage actually compete with each other in the same ecosystem and are seldom, if ever, at peak biomass at the same time (Springer and Speckman 1997). There is more than a bit of hubris in thinking we can micromanage an ecosystem and enforce a balance among interrelated species through human action. In the end, ecosystem management comes down to the choices we make as humans to decide what a specific ecosystem should look like. What it *will* look like is up to nature.

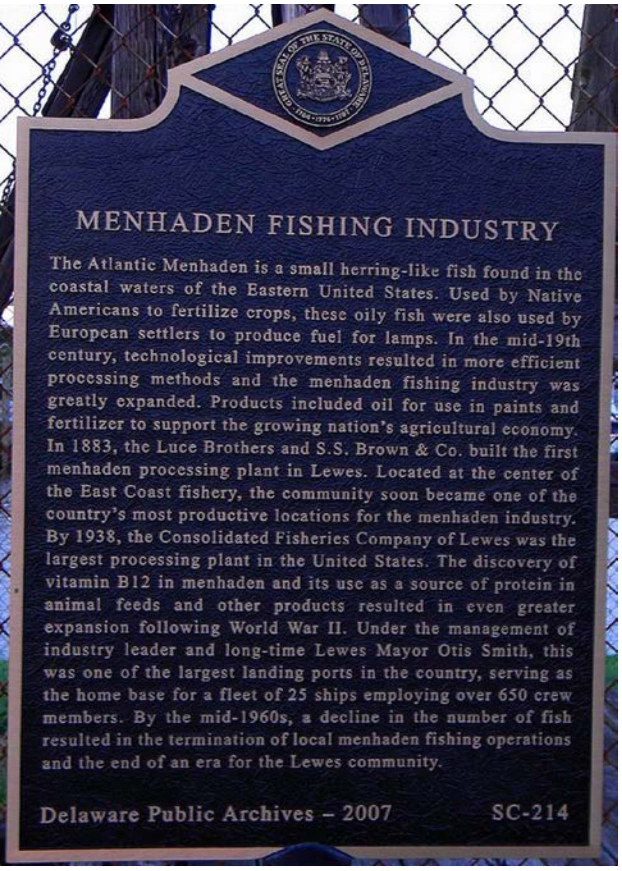
This illustrates the need to manage species in their own contexts. If scientists, managers, and the public believed that simply cutting harvest of Atlantic menhaden would immediately result in more and healthier striped bass, they all would be sorely disappointed. In fact, a natural experiment has been conducted over the past twenty-plus years. Menhaden harvests coast-wide declined 34 percent based on average harvests for the period 1955 through 1989 versus 1990 through 2011. Absolute removals in the Chesapeake Bay have also declined significantly (about 31 percent), particularly after the institution of a cap on removals by the reduction fishery in 2006.

This significant reduction in harvest did not lead to an increased menhaden population. In part, recruitment may have been, on average, slightly lower in the latter decade compared to the 1990s. That recruitment has not increased in the face of significantly reduced pressure on spawners underscores the lack of a spawner-recruit relationship in the stock and the importance of environmental conditions on success (ASMFC 2009). Further, the remarkable stability in the menhaden spawning stock over the past twenty to twenty-five years, even as harvest has dramatically decreased, suggests that increased predator populations, particularly striped bass and dogfish, have been taking their share as forage. One of the results of the most recent menhaden stock assessment is a notable recent increase in natural mortality, particularly on the older age classes. That the stock has not declined, suggests that there are ample menhaden to meet the needs for predation (Crecco 2010) and the directed fishery.

This is an observation, not a definitive scientific result. However, it would suggest that the menhaden example over this period would make an excellent case study for further investigation of the predator/prey relationship. I would note, however, that if we want to ensure that predators have food, those fish will be removed from the population. We cannot judge the success of our management programs simply on the basis of the number of prey species left in the water. Cutting directed harvest in order to leave more forage in the water for predation should result in a quantifiable increase in the abundance or condition of predator species which are believed to be dependent upon the species in question. In addition, cutting directed harvest in order to leave more fish in the water in order to increase biomass of the forage species should result in an increase in recruitment and, ultimately, an increase in biomass. Certainly, management actions should be evaluated to determine if the desired result is achieved. If forage fish population levels are high, it is more likely an indication of depressed predator stocks than a healthy marine ecosystem.

In this regard, if we want to move towards true ecosystem-based management, we need to understand what these prey species are eating. We know that when species like deer proliferate, they will over-graze and eventually cause shortages and population decline. It should not be merely assumed that similar issues do not arise in the marine context. This is particularly true for piscivores like herring, which are considered "forage fish" (Daan *et al.* 1985). They prey on eggs of plaice and cod. It makes no sense to ignore this element of the equation.

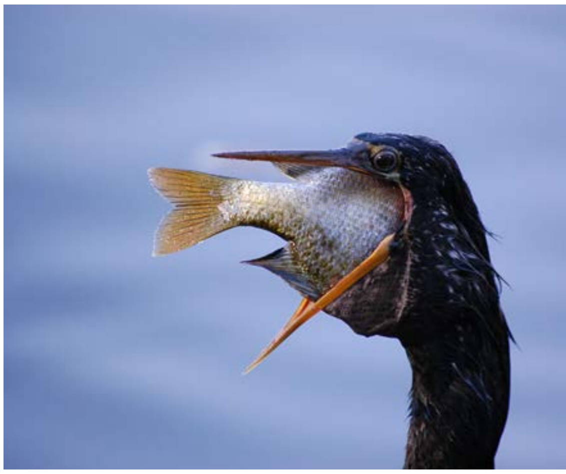
Even the ecosystem impacts of a species like menhaden, which subsist primarily on planktonic life, should be accounted for in ecosystem-based management. As juveniles and adults, menhaden are filter feeders, an energy-intensive method of food intake (as young-of-year, menhaden have teeth and feed like any other fish). Menhaden thus search out high-energy zones, areas of high concentration of zooplankton and the phytoplankton upon which they prey. Menhaden, whose gillrakers expand with age, target increasingly larger food sources. Swimming in schools of millions, menhaden can efficiently sweep an estuary of a large percentage of its planktonic composition (Durbin & Durbin 1998).



The question no one has yet investigated, however, is whether menhaden in primary nurseries for other fish, like the Chesapeake Bay, also consume "meroplankton," or temporary plankton. That is, eggs and larvae. There is no evidence to suggest that menhaden actively avoid these sources of what would be an important source of protein. From a purely practical perspective, it is nearly impossible to imagine that large schools of menhaden would not be a large source of predation on these early life stages.

To raise the question is not to answer it. It is fascinating to imagine menhaden preying on striped bass. More fundamentally, however, given the pure efficiency of such a large component of our ecosystem—that is, all species we can agree fit in the category of "forage"—it would be counterproductive to remain willfully blind to the role on recruitment and population of other stocks that is attributable to their predation. Certainly, any system of management that ignores these ecological processes cannot call itself ecosystem-based.

As a final note, moving toward ecosystem-based management that includes the objective of establishing catch levels to preserve the health of the ecosystem and setting catch levels in forage fisheries to benefit predator stocks may require a change in law. It does not take a legal expert to understand that the MSA's goal of achieving the level of biomass that produces maximum sustainable yield for all stocks of fish at the same time in perpetuity is ecologically impossible. Nor is it clear that the law's requirement to achieve optimum yield from each fishery allows for such trade-offs between fisheries. More broadly, we should recognize principles of ecosystem-based management should not solely encompass the concept of maintaining forage stocks for the maximum health of all predator species. It must also recognize that there are times when it is prudent, both from a management perspective and the law's goal of achieving the maximum benefit from our marine resources, to "prune" predator stocks to help enhance the health of stocks on which they prey—whether such stocks are "forage fish" or simply piscivores lower down the food chain. Spiny dogfish are the best current example, as this low value species' abundance and voraciousness is credibly thought to be having an adverse impact on more valuable fisheries. However, being able to utilize this as tool in the ecosystem-based management toolbox may require "overfishing" as it is currently defined—and prohibited—by law. This is but one of the many challenges in the move toward ecosystem-based management.



Conclusions and Recommendations

Managing ecosystems is a worthy goal. It is, however, not without a considerable amount of costs, both monetary and otherwise. Generally speaking, fisheries management is engaging in ecosystem approaches to management, attempting to incorporate certain components of ecosystem management into the assessment process. An example of this is the use of the MSVPA-X to account for predation mortality within the Atlantic menhaden management process. While this is a positive step, it leaves a long road ahead to achieve real ecosystem management that will account for climate conditions, localized weather conditions, spatial changes, water quality issues, among others.

Conclusion 1: Ecosystem approaches to fisheries management will require the use of mathematical models which will require a great deal of data.

Recommendation 1: If a management entity is planning to engage in ecosystem approaches to management, provisions to collect the appropriate type and amount of data should be ensured.

Conclusion 2: Ecosystem-based management can be viewed as an attempt to maximize the use of ecosystem parameters along with fisheries data to achieve a desired ecosystem state. In order to be successful, such a process will require the involvement of affected user groups to assist in determining what the desired ecosystem state is.

Recommendation 2: Any process to establish a goal or goals (a desired ecosystem state) for ecosystem-based management must be fair and balanced, involving affected user groups, and must consider scientific, economic, and sociological factors. For example, if a process to manage Atlantic menhaden using ecosystem-based management strategies allows anti-commercial fishing groups to dominate, the outcome for the directed commercial fishery would likely be negative. In addition to scientific factors, issues such as jobs, economic well-being, and cultural history must play a prominent role in the decision-making process.

Conclusion 3: Regional Fishery Management Councils and Interstate Marine Fisheries Commissions exist and provide an important service in fisheries management because they recognize that fisheries populations, including forage species, vary significantly regionally. Problems that plague one region may not be a problem in another region.

Recommendation 3: Management of forage species should be accomplished at the regional, not national, level. Policies and management approaches affecting both forage and predator species will be most effective if achieved under the existing management structures.

Recommendation 4: It is not necessary to change the MSA or the ACFCMA to achieve effective management of a group of fish categorized as forage. They will, however, require the same due diligence that is required of effective management of other species: a full understanding of and data on 1) life history characteristics, 2) predator/prey and other species interactions, 3) fishery scope in space and time, and 4) fishery practices, among other factors I may

have missed.

Conclusion 4: Recommendation 4 speaks only to improved management under the current legal framework. The move toward ecosystem-based management that includes providing for the health of the marine ecosystem as a whole while also maintaining the MSA and other fisheries laws goals of maximizing economic and recreational benefits from our Nation's fisheries likely will require a change in law. Such changes should give managers discretion to make decisions to manage resources in a manner consistent with these objectives, including allowing fishing predator stocks down (as well as building forage stocks up) when justified biologically and economically.

Recommendation 5: Define the goals of ecosystem-based management in broad terms that recognize the need to maintain a healthy marine ecosystem, strong commercial and recreational fisheries, and vibrant fishing communities by considering species interactions while maximizing the benefits marine resources provide. Develop a legal framework that supports this approach.

Conclusion 5: It is clear that some species, a good example being Atlantic menhaden, are affected by large-scale, long term climate factors, such as El Niño and the North Atlantic Oscillation, among others. It is believed that such factors may significantly affect recruitment success for Atlantic menhaden and striped bass.

Recommendation 6: Further, more expansive research should be conducted to determine the possible effects of climate and weather on the status of fish populations under management, specifically forage species.

Conclusion 6: Very little investigation has been done into the issue of what forage species are eating.

Recommendation 7: It is important to understand the food sources that are required of forage species for at least two specific reasons. First, if food could be a limiting factor in the overall success of a population, it is important factor to help explain possible declines in fish health or abundance. Second, species such as Atlantic menhaden that are filter feeders could, and may, consume meroplankton, which is eggs and larvae of other species. Very little is known about the possibility of this occurring and what the potential impacts may be on species of economic importance.

There is a lot of work left to be done before moving in this direction. Hopefully the next generation of marine biologists will take up the challenge of investigating these unresolved issues.

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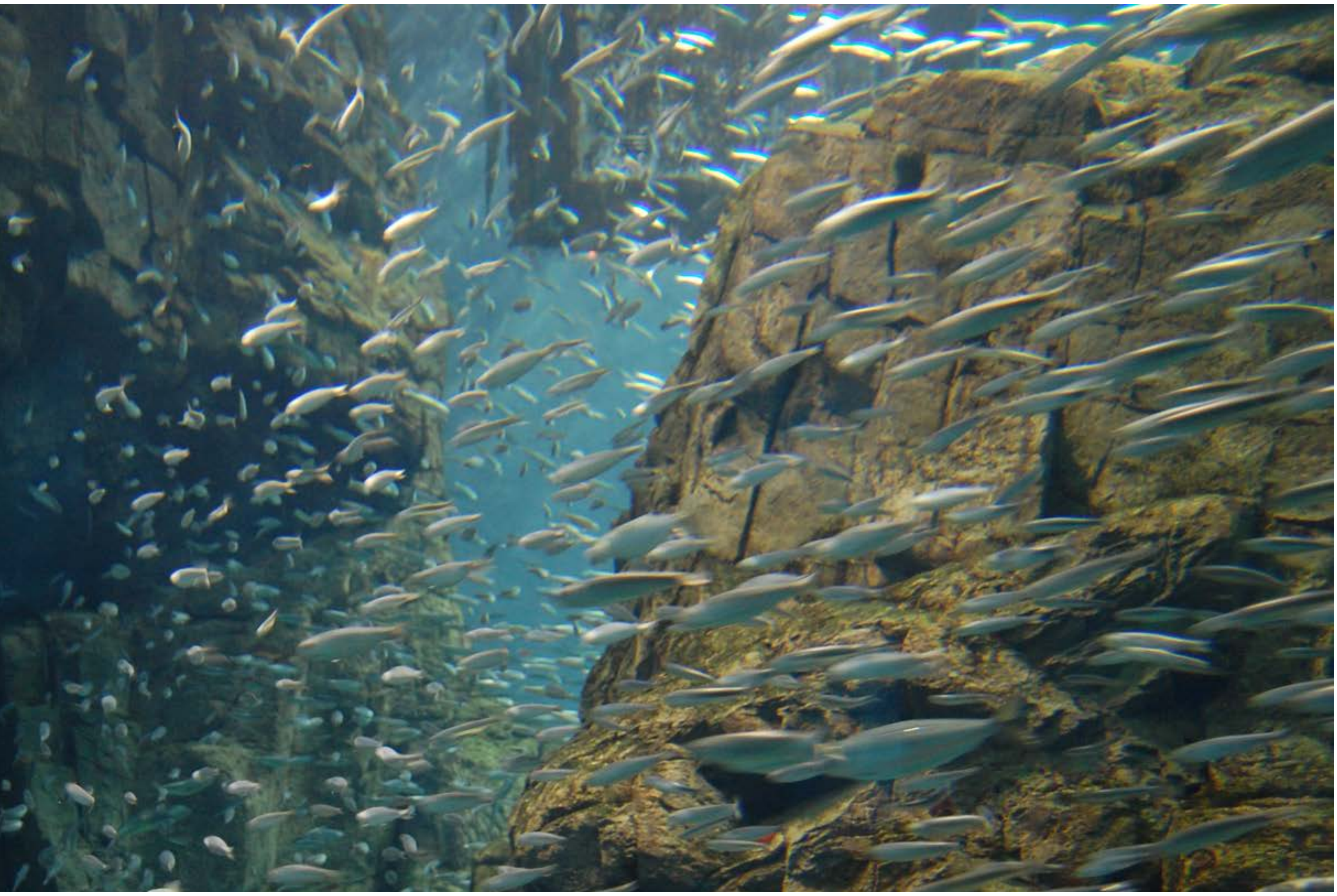

SARDINES. PHOTO: TKOSAKA, FLICKR CREATIVE COMMONS.

DISCUSSION SUMMARY AND FINDINGS
Session 2 Topic 2

Forage Fish Management

Speakers

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Discussion Summary: Forage Fish Management

The following findings emerged during the discussions under Session 2, Topic 1: Forage Fish Management.

Proposed Legislative Changes: Stay the Course or a New National Standard for Forage Fish?

No Changes to the Magnuson-Stevens Act are Necessary to Sustainably Manage Forage Fish

One of the main questions of this session was, "Do we have the tools to effectively and sustainably manage forage fish?" Most participants agreed that there are many tools available to effectively manage forage fish under existing laws, regulations, and authorities.

Establish a New National Standard to Ensure Adequate Forage to Support Vibrant Fisheries, Wildlife, Communities, and Ecosystems

Some participants countered that simply having access to the tools is not sufficient if management authorities are not willing to use them. This led to a finding that the Magnuson-Stevens Act (MSA) should be amended to include a new National Standard that establishes a mandate to ensure an adequate forage base to support vibrant fisheries, wildlife, communities, and ecosystems.

Several other legislative ideas emerged during the discussions:

- Moving toward ecosystem-based management of forage species and reliance on more complex ecosystem models may require a change to MSA.
- Define forage species in MSA.
- Transfer current forage species provisions in National Standard 1 guidelines into MSA requirements.

Best Practices for Management

Maintain a Regional Approach by Defining and Identifying Forage Species at the Regional Level

Many panelists and members of the audience showed general support for using the existing management structures at the Regional Fishery Management Councils and marine fisheries commissions to manage forage fish. The regions should define "forage" based on the unique ecosystem and the complex species interactions in each area. The responsible management authorities should identify specific forage species for their region.

Use Meta-Analysis and Global Studies to Provide Rules of Thumb as a Starting Point in Discussions for Forage Fish Management or as a Guide in Data-Poor Situations

Global meta-analysis can be used to aggregate data across regions and species to gain insight into how predator populations may respond to forage fish populations. For example:

- Sea bird breeding success responds to the level of prey abundance, therefore prey abundance should be maintained above 1/3 of unfished biomass to support sea bird populations.
- Harvesting forage species at maximum sustainable yield (MSY) can have large impacts on other parts of the ecosystem, suggesting that comparatively small reductions in catch below MSY can lead to big benefits for other species in the ecosystem.
- Ecosystem models can also provide insight on the critical forage fish biomass needed. If predators have a 25-50 percent diet dependency on the prey and managers want a 75 percent confidence of success, then forage biomass should remain above 57 percent of unfished levels to avoid a 50 percent decline in dependent predators.

The results of these studies provide meaningful guides to forage fish management (for more information and references see paper by Isaac Kaplan). The results of these studies also provide a scientific starting place for managing data-poor species. Based on these and other studies, participants offered the following rules of thumb for managing forage species:

- Maintain prey abundance above one-third of unfished biomass
- Maintain 30 percent of each forage stock as unfished set-aside
- Establish fishing cutoff values at no less than 40 percent of unfished biomass
- Specify a limit biomass threshold greater than or equal to the long-term average biomass that produce MSY, below which a forage fishery is considered to be overfished
- Limit $F<3/4\ F_{msy}$
- Maintain fishing mortality below half of the traditional F_{msy} or to half of the natural mortality rate
- When less information is available $F_{max}=1/2F_{msy}$ and B>80%
- Use natural mortality as a guidepost for management

It was also noted that while global analysis is a helpful guidance, the use of regionally-specific data and studies is preferred when available.

Use Threshold Harvest Control Rules to Manage Forage Fish

Many fisheries already use harvest control rules in management and many of the participants supported their expanded use for forage fish. Threshold harvest control rules establish a framework for management based on the abundance of the population. When the biomass of a stock is abundant, the fishing mortality rate is permitted to increase up to a limit; however, as the biomass declines, fishing mortality is reduced. When biomass falls below a certain level, fishing is no longer permitted. The targets and limits of the harvest control rule describe the management response that will be followed based on the stock status. Threshold harvest control rules minimize impacts on other fisheries and predators, are robust to climate-driven population fluctuations, and force frank discussions of acceptable tradeoffs.

While harvest control rules focus attention on establishing harvest limits from directed fisheries, the consideration

of bycatch is another important source of mortality that must be considered when controlling the catch of forage fish. For example, managers may set incidental take limits on all forage species caught as non-target species (e.g.. Alaska groundfish bycatch caps).

Develop Ecologically Based Reference Points

Forage species inherently display wide population fluctuations that can swing dramatically each year and are often sensitive to changes in climate. They also exhibit schooling behavior that lead to high catch rates. As scientists and managers develop biological reference points, it is important to account for the risk of high population swings and catchability, as well as consider a broad range of ecosystem services provided by forage species when setting targets and limits.

Conduct Economic Valuation

The session included an extensive discussion on the topic of economic valuation. There was a cautious interest in including more economic valuation in management decisions on forage fish. Many questions arose on what economic data was appropriate or being used, along with the methodologies used to derive economic valuation information. Some economic studies suggest that forage fish may be more valuable left in the water as prey to predator populations that demand a high price at the dock. Another study found that the optimal fishing mortality rate for sardines depends on how much we value their predators (tuna, seabirds, mammals). While no agreement arose on these topics, there were several aspects of economic valuation that emerged:

- Consider the value of leaving forage fish in the water,
- Consider the value to fishing communities (both direct harvest and indirect through bait), and
- Include the supportive value as prey to other fisheries, as well as activities such as eco-tourism (i.e. whale-watching or sea lions).

Clearly there is a need for additional research as well as methods for weighing the complex tradeoffs and information relating to the economic value of forage fish.

Account for Ecosystem and Predator Needs by Requiring Explicit Consideration of the Impact of Forage Species on the Ecosystem and Fishing Communities

Forage fish play an important role in maintaining healthy and resilient marine ecosystems. Scientific tools exist through ecosystem modeling and integrated ecosystem assessments to consider and account for the role of forage fish in their environment. Forage fish management should account for the dynamic needs of predator populations, the availability of alternate prey and ecosystem services when conducting stock assessments, establishing optimum yield, and setting annual catch limits.

Evaluate Tradeoffs

New scientific and management tools are now available to help evaluate tradeoffs in fishery management decisions. Global data analysis allows datasets from around the world, across regions and species, to be aggregated and evaluated to determine general trends that can be used as "rules of thumb" for managers. Ecosystem models can evaluate the implications of forage fish harvest levels on predators and other ecosystem services. Integrated ecosystem assessments can evaluate the role of climate on forage fish populations, among other things. Economic valuation can identify the various and complex benefits of forage fish to the ecosystem, fisheries, and fishing communities. By using these existing tools (and developing new tools), managers should move beyond a single-species approach by defining and explicitly considering the tradeoffs across species and interests when making management decisions for forage fish. There was recognition that we cannot maximize all species at all times in management, making it important to consider tradeoffs and establish priorities.

Evaluate and Address Localized Depletion

Localized depletion occurs when forage fish (or prey) become depleted in specific areas or during specific times. It can be the result of excessive fishery removals, but also the result of climate and other environmental factors. It is believed that localized depletion is problematic because there is insufficient prey to meet the foraging demands of predatory populations during critical times or life history stages. Some participants felt that localized depletion can in turn affect communities, for example, if the opening of a fishing season depends on the arrival of prey to bring the target species inshore. Others felt there is inadequate scientific proof on where and whether localized depletion takes place, therefore additional research is needed to validate its occurrence. Spatial management and gear modifications were suggested as tools for addressing localized depletion. In addition, diet studies could be used to identify hot spots for pulse feeding, allowing for adaptive or dynamic management to avoid localized depletion.

Prohibit New Fisheries on Forage Species Until Scientific and Management Evaluations are Conducted

Some panelists raised concerns about new fisheries developing on forage species. There are fears that the rising demand for fish meal and oil for aquaculture or terrestrial animal feed, or other markets, may result in the initiation of new fisheries for species low on the food chain. The current process makes it cumbersome to add species to management plans, yet relatively easy for a fishery to begin. New tools are needed to prevent fisheries from developing on unmanaged species. In order to provide protection to forage species and marine ecosystem, no new fisheries should be initiated or expanded until a stock assessment is conducted and a management plan is developed and approved. Another tool suggested to address new fisheries was to create a list of managed species that included all forage fish stocks.

Implement Real-Time Data Collection to Inform Adaptive Management

The wide population fluctuations typical of forage species make it challenging to consider tradeoffs between stability and opportunity in the management of directed fisheries. For example, on the West Coast, precautionary measures protect forage stocks in low abundance years, but also limit the fishery from taking advantage of high abundance years. A new system of scientific capacity to assess population abundance on an annual basis should be paired with adaptive management that provides the regulatory flexibility to implement management measures in real-time. This new system would allow the fishery to sustainably access higher catches, while still protecting the stocks and ecosystem when abundance is low by ratcheting down catch rates when stocks are in decline. This is an opportunity to increase reliance on the industry to collect data and conduct cooperative research. It was also suggested that this could be funded through fishery revenues.

Require Scientists to Provide Managers with an Index of Key Forage Species Composition and Abundance in Each Region

The forage base is an important indicator for understanding the dynamics of predatory populations and the health and productivity of the marine ecosystem. Currently, managers will look at stock assessments for managed forage species, but they do not have insight into the overall health of the combined forage base that supports higher trophic levels. Scientists should look at all the fishery indices available to define the forage base, evaluate the composition, and report to managers on annual trends in each region.

Improve Inter-Jurisdictional Coordination on Forage Fish Management

Recognizing that a great deal of coordination and cooperation already happens between state and Federal partners, there was general awareness and agreement that improvements are both possible and necessary. In some cases, state agencies or inter-state commissions provide the lead management authority for forage species, while a Regional

Fishery Management Council has the lead authority for its predators. In other cases, two management authorities share responsibility for the management of the same species. And even within management authorities, improved coordination is possible between fishery management plans for predator and prey stocks. In addition, issues such as at-sea bycatch, or river passage and water quality highlight the importance of coordination between state and Federal managers. In addition to improved domestic coordination, additional attention can be focused on international coordination. For example, require National Marine Fisheries Service (NMFS) to pursue international agreement on catch allocations and give NMFS mandate to impose trade sanctions on countries that refuse to engage in an international agreement of straddling stocks (i.e. Pacific sardine). As fishery management moves toward more integrated ecosystem approaches, management must also respond with more integration and coordination across jurisdictions and management plans.

Invest in Science: Advance Scientific Tools and Conduct New Research

The science behind forage fish and ecosystems has developed rapidly over the past decade. Managers now have more tools and greater access to data and information than ever before. A lot is known about the science behind forage fish, their role in the ecosystem, and the important historical and economic role forage fisheries play in our country.

On the other hand, we need to collect more and better data. Many suggestions were offered on how to improve or expand the science and research for forage fish:

- Conduct more expansive research to determine the effect of climate and weather on the status of forage fish populations.
- Investigate the role of habitat in supporting forage fish stocks.
- Collect new data on life history characteristics needed to inform stock assessments.
- Conduct new research on the diet of forage fish and how their consumption impacts other species.
- Conduct assessments on predator needs and alternative prey to include in harvest control rule formulas.
- Study the impacts of higher abundance of forage species on the ecosystem.
- Collect better fishery-independent data for forage species.
- Develop better spatial models to address localized depletion and competition.
- Evaluate the effectiveness and utility of closed areas to protect and maintain healthy forage fish populations.

The discussion recognized that current fiscal limitations make it necessary to prioritize research needs. Congress and the Administration need to make an investment in science—advancing the scientific models and hiring or training staff—as fishery management transitions from single-species to ecosystem-based management.

Moving Toward Ecosystem-Based Fishery Management

Transition from Single-Species to Ecosystem-Based Fishery Management

Within the broader discussion of ecosystem-based decision-making, there were intersections between the three topics of climate, forage, and habitat in each session, including the forage fish session. For example, one participant asked, "Is there more that we can do to improve forage fish stocks besides restricting fishing?" Participants noted the importance of protecting habitat as a possible means to improve productivity without associated reductions on fishing catches. There was also recognition of the strong influence that climate change exerts on forage fish and ecosystem health and productivity. Participants recognized that fishery management must move toward understand the linkages across these topics and focus management efforts on integrated ecosystem considerations.

Establish an Ecosystem Scientific and Statistical Committee at the Council or Commission Level

In addition to new basic science on forage fish species, there is a greater need to integrate across multi-species and ecosystem considerations. Some Regional Fishery Management Councils have established Ecosystem Scientific and Statistical Committees (SSCs) that have the expertise and mandate to evaluate ecosystem considerations and provide management advice. An Ecosystem SSC is a place to engage scientists across disciplines and jurisdictions to evaluate new ecosystem science and inform management. Some participants recommended the establishment of Ecosystem SSCs as a best practice to assist in forage fish management as well as other ecosystem-related issues.

Build Capacity to Use New Management Tools and Advance Ecosystem-Based Decision-Making

With the new tools and scientific assessments available, additional staff training will be necessary. New tools and methods offer great promise in expanding our capacity to incorporate new and important data sets into management decisions. It's important that staff and managers understand the capabilities, limitations and appropriate applications of new tools. In addition, conduct fully-integrated management strategy evaluation linking single-species fishery models with multi-species and ecosystems models. The fishery management system must build capacity to advance ecosystem-based decision-making.

While a wide range of views and opinions were offered during the session, all were in agreement that all stakeholder groups want healthy, sustainable forage fish populations.

SCIENCE ACTIVITY: STUDYING ECOSYSTEMS. PHOTO: JUDY BAXTER, FLICKR CREATIVE COMMONS.

PAPERS

Session 2
Advancing Ecosystem-Based Decision-Making

Topic 3
Integrating Habitat Considerations

Should Habitat Conservation Become a New National Standard for Fishery Management Plans?

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Abstract

The coastal and marine environment off the U.S., as well as elsewhere around the globe, is continuing to experience change brought about by a combination of human intervention and climate. We cannot afford to have loss of fish and shellfish habitat take a back seat as the U.S. ocean policy and analogous policies of other coastal nations play out. Habitat conservation to support fisheries resources needs to be a prime objective in coastal and marine spatial planning (CMSP). Already an essential part of fisheries management, perhaps the most effective way to keep habitat conservation in the forefront as CMSP develops is to make it a National Standard under the Magnuson-Stevens Act. Establishing a National Standard for habitat conservation would elevate the importance of identifying essential fish habitat (EFH), focus habitat-related research and monitoring, facilitate operational improvements to the Federal process involved with habitat conservation, and help the Regional Fishery Management Councils refine their habitat conservation objectives for fisheries management.

Introduction

The coastal and marine environment off the U.S., as well as elsewhere around the globe, is continuing to experience change brought about by a combination of human intervention and climate. Human intervention, triggered by the need for new sources of renewable energy and additional sources of protein, is leading to an increasing demand for tidal- and wind-based power systems, unrelenting fishing pressure on wild fisheries stocks, and expansion of offshore aquaculture operations. All these competing demands, many of which are destructive to habitats that support fisheries resources, are being placed on marine ecosystems that are already stressed by climate change. Climate change in the coastal and marine environments is causing ocean warming, which is leading to shifts in distributions of marine biota, lowering of ocean pH, sea level rise, and loss of polar ice caps, among other things.

We cannot afford to have loss of fish and shellfish habitat take a back seat as the U.S. ocean policy and analogous policies of other coastal nations play out. Habitat conservation to support fisheries resources needs to be a prime objective in CMSP. Already an essential part of fisheries management, perhaps the most effective way to keep habitat conservation in the forefront as CMSP develops is to make it a National Standard under the Magnuson-Stevens Act.

Habitat Conservation and the Magnuson-Stevens Act

The current incarnation of the Magnuson-Stevens Fishery Conservation and Management Act ("the Act," PL 94-265) contains several provisions related to conservation of habitats supporting fishery resources. Fishery management plans are required to identify and describe essential habitat for managed species, minimize adverse effects of fishing practices on habitat (to the extent practicable), and identify other actions that could be taken to conserve habitat. Also, Regional Fishery Management Councils are encouraged to comment on Federally licensed and permitted projects that may adversely impact habitat of their managed fisheries stocks.

The Act and its associated guidelines, however, still fall short in terms of promoting habitat conservation. For example, NOAA Fisheries does not have regulatory authority over actions that may adversely affect EFH. The Act also does not require periodic monitoring to ensure that EFH is maintaining the functions necessary to support the well being of fisheries resources. Furthermore, there is a tenuous link between habitat conservation and ecosystems-based fisheries management (EBFM); the Act encourages the Regional Fishery Management Councils to pursue EBFM, but these provisions are fishery-focused and offer no clear guidance as to how changes to local habitats supporting fisheries resources are to be considered in the broader ecosystem context. Finally, the Act does not offer guidance as to how habitat conservation should be integrated into CMSP, essentially leaving it up to the individual regional Councils to figure out how to get the habitat conservation foot into the slowly opening CMSP door.

NOAA Fisheries' Habitat Blueprint

Although the Act falls short of providing NOAA Fisheries, and through it the Regional Fishery Management Councils, with the tools necessary to conserve habitat supporting fisheries resources, NOAA has recently developed a habitat blueprint to address habitat conservation on a much broader scale. The purpose of the Habitat Blueprint is to provide "... a forward looking framework for NOAA to think and act strategically across programs and with partner organizations to address the growing challenge of coastal and marine **habitat loss and degradation**," integrating habitat conservation requirements "... for fish, threatened and endangered species, marine mammals, and other natural resources within the coastal zone" (http://www.habitat.noaa.gov/habitatblueprint/). The approach taken in the Habitat Blueprint is three-fold: (1) establish NOAA habitat focus areas for long-term habitat science and conservation; (2) implement a systematic and strategic approach to habitat science to inform effective decision-making; and (3) strengthen policy and legislation to enhance our ability to achieve meaningful habitat conservation. The remainder of this paper will focus on the third approach, strengthening policy and legislation, as it relates to the Act.

A Modest Proposal

Currently, the Act requires that fishery management plans developed by the regional Councils and ultimately approved by the Secretary of Commerce must adhere to ten National Standards.

To strengthen the habitat conservation requirements of the Act, I propose adding a new, eleventh National Standard:

> **Minimize adverse impacts on essential fish habitat to the extent practicable.**

The implications of this proposed text are far-reaching. Depending on how the associated guidelines are written, it could give the Secretary of Commerce regulatory authority (i.e., veto power) over Federally licensed or permitted projects that may adversely affect EFH. This veto power would be akin to the veto power currently held by the Administrator of the Environmental Protection Agency over Federal projects that could adversely affect water or air quality. The guidelines could also require identification and monitoring of activities that could potentially negatively (or positively) impact EFH. Finally, NOAA Fisheries and the Regional Councils would be able to move from their current consultative role to a role that is more active and cooperative, perhaps even pre-emptive, as they work in closer cooperation with other regulatory agencies.

Is establishment of such a National Standard for habitat conservation justified? Absolutely. Once approved by the Secretary of Commerce, fishery management plans, plan amendments, and framework actions are considered public policy. My experience has been that public policy carries a lot of weight in Federally-approved actions and associated judicial rulings. Furthermore, rebuilding fishery stocks and maintaining them at sustainable levels involves much more than addressing overfishing; habitats must be capable of supporting the renewed production of fishery stocks, especially if those stocks are at or near their historically highest levels of abundance. Finally, strengthening the habitat conservation provisions of the Act would provide a greater guarantee that objectives of fishery management plans can actually be achieved.

Establishing a National Standard for habitat conservation would elevate the importance of identifying EFH, focus habitat-related research and monitoring, facilitate operational improvements to the Federal process involved with habitat conservation, including closer coordination between and among regulatory and resource conservation agencies, and help the Regional Councils refine their habitat conservation objectives for fisheries management. Also, the National Standard would give the Secretary of Commerce more clout in reviewing offshore projects that are Federally licensed or permitted. A habitat conservation National Standard would also facilitate integrating habitat-level assessments into ecosystem-based fishery management and, on a broader scale, further facilitate CMSP by having a clear set of objectives that help define essential ecosystem services in support of fisheries management.

On the negative side, adding a new National Standard would very likely increase the probability of litigation, as managers try to address (and balance) the new standard with the ten existing ones. Meeting the guidelines that will be established for the new standard may lead to additional delays in approvals of fishery management plans and plan amendments. A stronger and broader base of scientific support will also be required, which may be difficult in the current era of shrinking budgets for state and Federal agencies.

Implications for Science

Almost any investigation into the relationship between organisms and their environment could be considered habitat research. A mission-oriented agency, such as NOAA Fisheries, however, cannot afford to conduct research for research's sake. Priorities need to be set in order to assure that research undertaken by agency scientists is responsive to the informational needs of its stakeholders, including the Regional Fishery Management Councils. Establishment of a National Standard for habitat conservation under the aegis of the Act would enable NOAA Fisheries and its funding partners to focus habitat-related science on efforts that will help the Regional Fishery Management Councils identify real or potential threats to habitat supporting fisheries resources, and develop means to prevent or mitigate their impacts.

The question is: will the current cadre of agency scientists and their academic partners be capable of addressing the questions about habitat conservation that are being asked, and will be asked, by fishery resource managers attempting to comply with the new National Standard? To do so, more emphasis will be needed on habitat monitoring and assessment. NOAA Fisheries already has a plan in place to steer habitat research in this direction. The Habitat Assessment Improvement Plan is intended to:

- "Assist [NOAA] in developing the habitat science necessary to meet the mandates of the [Act] and the economic, social, and environmental needs of the nation;
- Improve our ability to identify EFH and habitat areas of particular concern;
- Provide information needed to assess impacts to EFH;
- Reduce habitat-related uncertainty in stock assessments;
- Facilitate a greater number of "Marine Fisheries Stock Assessment Improvement Plan" Tier 3 stock assessments, including those that explicitly incorporate ecosystem considerations and spatial analyses;

- Contribute to assessments of ecosystem services (i.e., the things people need and care about that are provided by marine systems); and
- Contribute to ecosystem-based fishery management, integrated ecosystem assessments, and coastal and marine spatial planning." (NMFS 2010)

In addition to using the Habitat Assessment Improvement Plan to plot a course of action to meet the informational needs of fishery resource managers, additional research will be needed to solidify the linkage between habitat-related impacts on fisheries resources at the local level and ecosystem-based fisheries management at the regional level; i.e., assessment of habitat-related impacts should not be treated in isolation.

Summary

Expanding the use of oceans for renewable energy and aquaculture, along with increasing pressure on the marine environment brought about by human population growth and climate change, are prominent challenges to conservation of habitats that support production of marine fisheries resources. Current legislation governing fisheries resources management needs to adapt to these challenges. Establishing habitat conservation as a National Standard under the Act seems to be a logical next step in the execution of NOAA Fisheries' Habitat Blueprint, and the agency's Habitat Assessment Improvement Plan has already laid the groundwork for implementation of the standard. Some might argue that the Act already contains provisions to conserve habitat in a manner consistent with the Habitat Blueprint and Habitat Assessment Improvement Plan, and that additional legislative action is not necessary. In any event, it is a debate worth having.

Reference Cited

National Marine Fisheries Service. 2010. Marine fisheries habitat assessment improvement plan. Report of the National Marine Fisheries Service Habitat Assessment Improvement Plan Team. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-F/SPO-108. 115 p.

Integrating Habitat: A Necessary Part of the Equation

C. M. "Rip" Cunningham Jr.
Chair, New England Fishery Management Council

Introduction

Nobody thinks twice about constructing a suitable and solid foundation when a new building goes in the ground, but in managing the natural world, the foundation is often overlooked. It seems fairly basic that without suitable habitat, all effort to sustainably manage any resource is futile. Whether the living resource is terrestrial or marine makes little difference. Habitat forms the foundation on which everything else is built. For the marine environment, habitat forms the basis for the trophic pyramid, with high numbers of prey species at the bottom and the apex predators at the top. To quote Captain Thomas Brown, a nineteenth century naturalist, "Nature does nothing in vain:" a short quote with far-reaching implications. The natural world is more than a puzzle; it is more like a multidimensional chess game.

Given the importance of habitat in the natural world, why has it taken so long to incorporate it more prominently in the fishery management process? Is it simply because habitat is not easily visible below the surface of the ocean? Not likely, since for hundreds of years, fishermen have used that very subsurface structure to pinpoint concentrations of fish. Or is it more likely to be the product of a longstanding distrust of fisheries regulators by independent-minded fishermen? (The author's use of that term is gender neutral.)

As resource managers look to the future, incorporation of habitat into the entire marine ecosystem management process is necessary to ensure a sustainable outcome. This paper focuses on the incorporation of habitat considerations into the fishery management process, but it has implications in the broader scheme of coastal and marine spatial planning as well.

Background

The 1996 re-authorization of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), which came to be known as the Sustainable Fisheries Act, strengthened the importance of habitat protection for healthy fisheries and enhanced the ability of the National Marine Fisheries Service (NMFS) and the Regional Fishery Management Councils (Councils) to conserve and protect marine habitat through the Fishery Management Plan process as outlined in MSA 305 (b). The guidelines called this habitat "essential fish habitat" (EFH) and defined it broadly to include "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity." This is a very broad definition and one that may have been and continue to be part of the user group's concerns.

For the New England Fishery Management Council (referred to here as the New England Council or Council), the process started in 2003, prior to my appointment as a member. At this point, the Omnibus Essential Fish Habitat Amendment will not be completed and implemented until 2014, after my term limit deadline in 2013. Other Councils have completed this task in a fraction of this time, but in New England we have always felt that we are different! The Habitat Committee for the Council was one of my first committee assignments. Like most new Council members it took a while to get one's arms around the process as well as the subject matter. Most of my time in a leadership position with the Council has been focused on groundfish issues. However, as the Chair for the last two years, I have been trying to push the habitat process along without trying to overly influence the outcome. There are many points of view and political forces at play in the Council process. My philosophy is to try to help navigate through the issues, not try to dictate the eventual outcome.

To implement fish habitat protection, the MSA guidelines initially required that the Councils, along with input from NMFS, amend all of its fishery management plans (FMPs) to include habitat considerations by October of 1998. The Councils were required to:

- Describe and identify EFH for the species managed by the Council,
- Minimize to the extent practicable adverse effects on EFH caused by fishing, and
- Identify other actions to encourage the conservation and enhancement of EFH.

Also, according the Interim Final Rule (*Federal Register* Vol. 62 No. 244, December 19, 1997), the Councils were required to search out EFH that was judged to be particularly important to the long-term productivity of populations of one or more managed species or determined to be vulnerable to degradation. These areas should be designated as habitat areas of particular concern (HAPCs). The interim final rule insinuated that HAPC designation would require some higher level of conservation. For some in the fishing industry this raised another red flag.

The guideline also required a five-year review and update of the EFH Amendment, which in the case of some Councils, the New England Council in particular, became a complete review of the original amendment and a finer-scale look at EFH and HAPCs. The guidelines under Sec 305 (b) also specified the process for Councils to comment on and make recommendations to the Secretary of Commerce concerning any activity that may impact EFH. In the parlance of fisheries management and marine spatial planning, Councils were given an indirect consultation authority that allowed them to comment on any project that would or could impact EFH or HAPCs. On its face, this is a good thing. The problem is a lack of requirement for those receiving the comments to take any action.

New England Council Habitat Process

In October of 1998, the Council met its requirements under the MSA by submitting the Omnibus Essential Fish Habitat Amendment 1. This amendment incorporated the Northeast Multispecies FMP, Sea Scallop FMP, Atlantic Salmon FMP, Monkfish FMP, and components of the Herring FMP, which was a work in progress.

The purpose of this Amendment was to identify, protect, conserve, and enhance habitat. To support the Council's Habitat Policy, the objectives for the EFH Amendment were:

1. To the maximum extent possible, identify and describe all EFH for those species of finfish and mollusks managed by the Council.
2. To identify all major threats (fishing and non-fishing related) to EFH of those species managed by the Council.
3. To identify existing and potential mechanisms to protect, conserve and enhance the EFH of those species managed by the Council, to the extent practicable.

As outlined by the Interim Final Rule (*Federal Register* Vol.62 No. 244, December 19,1997), there were certain requirements that had to be met by NMFS and also by the Councils:

NMFS had to:

- Develop guidelines, by regulation, to assist the Councils in the description and identification of EFH in FMPs (including adverse impacts on EFH) and consideration of actions to ensure conservation and enhancement of EFH by April 11, 1997 (Sec 305(b)(1)(A))
- Develop schedules for amending FMPs for EFH, and for future periodic review of EFH amendment (Sec 305(b)(1)(A))
- Provide each Council with recommendations and information regarding EFH for each fishery under the Council's authority (Sec 305(b)(1)(B))
- Review programs administered by the Dept. of Commerce and ensure that relevant programs further the conservation and enhancement of EFH (Sec 305(b)(1)(C))
- Consult with Federal agencies regarding any activity, or proposed activity, authorized, funded or undertaken by the agency that may adversely affect EFH (Sec 305(b)(2))
- Coordinate with and provide information to other Federal agencies to further the conservation and enhancement of EFH (Sec 305(b)(1)(D))
- Recommend conservation measures for any action undertaken by any state or Federal agency that may adversely affect EFH (Sec 305(b)(4)(A))

The Councils were required/authorized to:

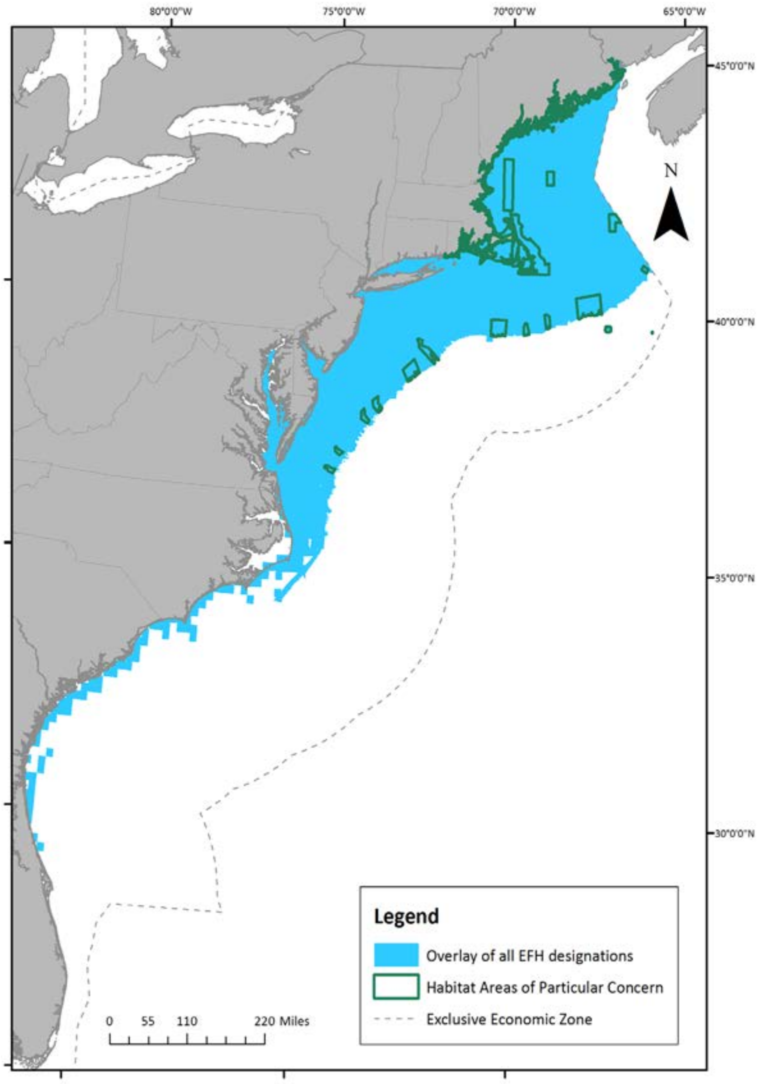
- Submit FMP amendments to the Secretary to implement the EFH and other new FMP requirements by October 11, 1998
- Describe and identify EFH for the fisheries based on the guidelines established by NMFS, minimize to the extent practicable adverse effects on such habitat caused by fishing, and identify other actions to encourage the conservation and enhancement of EFH (Sec 303)
- Comment on and make recommendations to NMFS and any Federal or state agency concerning any activity, or proposed activity, authorized, funded, or undertaken by any Federal or state agency that may adversely affect the habitat, including EFH or a fishery under its authority (Sec 305(b)(3)(A))
- Comment on and make recommendations to NMFS and any Federal or state agency concerning any activity that is likely to substantially affect the habitat, including EFH, of an anadromous fishery (sec 305(b)(3)(B)).

While the New England Council met all of its requirements, most of the EFH designations were very broad. In most cases, this included just about all of the areas showing at least moderate abundances of the species and the required life stage (egg, larvae, juvenile, adult and/or spawning adult) over a long time series of survey data. In effect this tended to water down (pun intended) the impact of the EFH designation. The Council designated only one small offshore area for the next level of habitat designation, as a HAPC. This was an area on Georges Bank that was considered important to juvenile cod. At the same time, some rivers along the Maine coast were designated as HAPC for Atlantic salmon.

In 2003, the Council started the process of reviewing and updating its EFH and HAPC designations and associated measures to minimize habitat impacts with an Omnibus EFH Amendment (2). The focus of this amendment was to refine the EFH designations to make them be those areas that had a higher level of importance to the individual species (Level 3 and 4) and to add a series of HAPC designations. As outlined in the Amendment, the purpose is to address additional measures that are necessary in order to:

1. To meet NMFS's published guidelines for implementation of the MSA's EFH provisions to review and revise EFH components of FMPs at least once every five years.

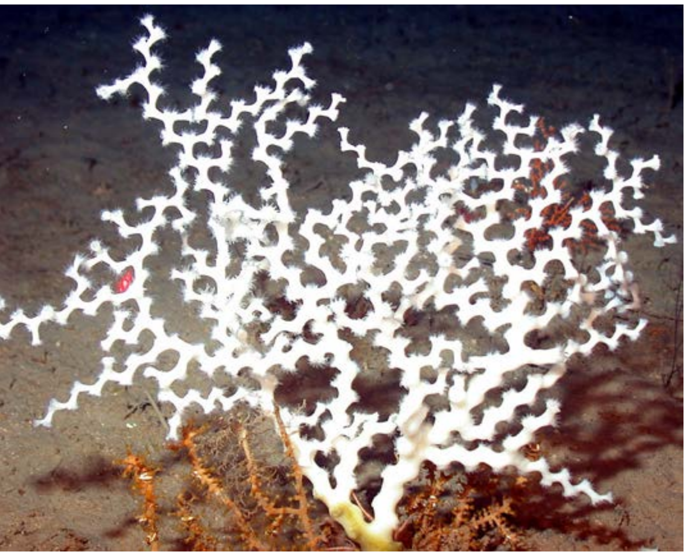
2. To develop a comprehensive EFH management plan that will successfully minimize adverse effects of fishing on EFH through actions that will apply to all Council-managed FMPs.



This figure shows an overlay of all the Omnibus EFH Amendment 2 proposed EFH designations for species managed by the New England Council. The proposed and existing HAPCs are outlined in green and include various areas on the shelf in addition to specific canyons and seamounts. (From Draft DEIS for Omnibus EFH Amendment 2.)

It has taken longer than several of the required five-year review cycles to fully complete the Omnibus EFH Amendment 2. Some might argue that since the Council completed and accepted the work on EFH and HAPC designation midway through the process, that it met its obligation under the five-year review requirement. Others would agree, but say that the Council did not submit this update for implementation until the entire process was complete. As stated earlier, my first term on the Council began with membership on the Habitat Committee. My nine-year tenure will end without that Amendment being completed. While this is incredibly slow progress, there are reasons how this slow progress has unfolded. Some of the problems should have been anticipated, while others could not have been. However, it is hard to know how much adverse effects minimization is needed, and also what "practicable" means. It seems as though practicable will be determined at the level of protections that will raise both the environmental non-governmental organizations and the industry to the same level of unhappiness about the amendment, but that's not exactly an objective criteria. It has been challenging for the Habitat Plan Development Team to provide advice about how much is enough in terms of habitat protection.

Much of the early committee work struggled with the designation of HAPCs because designation criteria and evaluation metrics were not well-defined. At the same time, some participants in the commercial fisheries that could be impacted began to get concerned that this process was merely a backdoor attempt to designate marine reserve closures to fishing. This concern was deepened by the second effort to pass Oceans 21 legislation in 2007, previously debated by Congress in 2005. This bill was a comprehensive attempt to put in place a coordinated and extensive plan to manage all the varied and sometimes contradictory uses of our oceans and marine resources. The bill did not pass, and those who fought against it demonized it as simply a way to zone the oceans to restrict fishing activities through marine reserves. This merely poured gasoline on the fire of concern about HAPCs and made the progress of the Omnibus EFH Amendment creep along. Part of this slow progress may also have been due to a lack of narrowly focused objectives for HAPCs. I cannot overstate the industry's (both commercial and recreational users) distrust of "government." This is a major reason why this process has dragged out so long and probably one that could have been mitigated with better planning.



Also, the 2007 Reauthorization of MSA gave the Councils specific authority to manage deep-sea corals. While the New England Council waited to see what the guidelines from NMFS would be, there was debate as to whether this should be part of the Omnibus EFH Amendment or a separate action. This also slowed down the process. Preliminary guidelines were sent to the Council in May 2010 and ultimately deep-sea corals were split out into a separate Council action in September 2012.

As the amendment progressed, the Council began to work on the adverse impacts aspect of the action. What became clear was the lack of a metric by which to measure these actual and potential impacts, yet under the MSA Councils are required to minimize the adverse effects of fishing on EFH. The Omnibus EFH Amendment 2 attempts to optimize the minimization of adverse effects on EFH across FMPs. To accomplish this, the Habitat Plan Development Team developed the Swept Area Seabed Impact (SASI) model. SASI was developed to estimate the magnitude, location and duration of adverse effects across gear types and FMPs. While this model had the potential to substantially improve the estimation of impacts, it was a new model that took time to develop and peer review. This caused another three-year delay in the amendment's progress.

SASI was not the only output from the Habitat Plan Development Team. As part of the whole SASI process the Plan Development Team developed a five component approach:

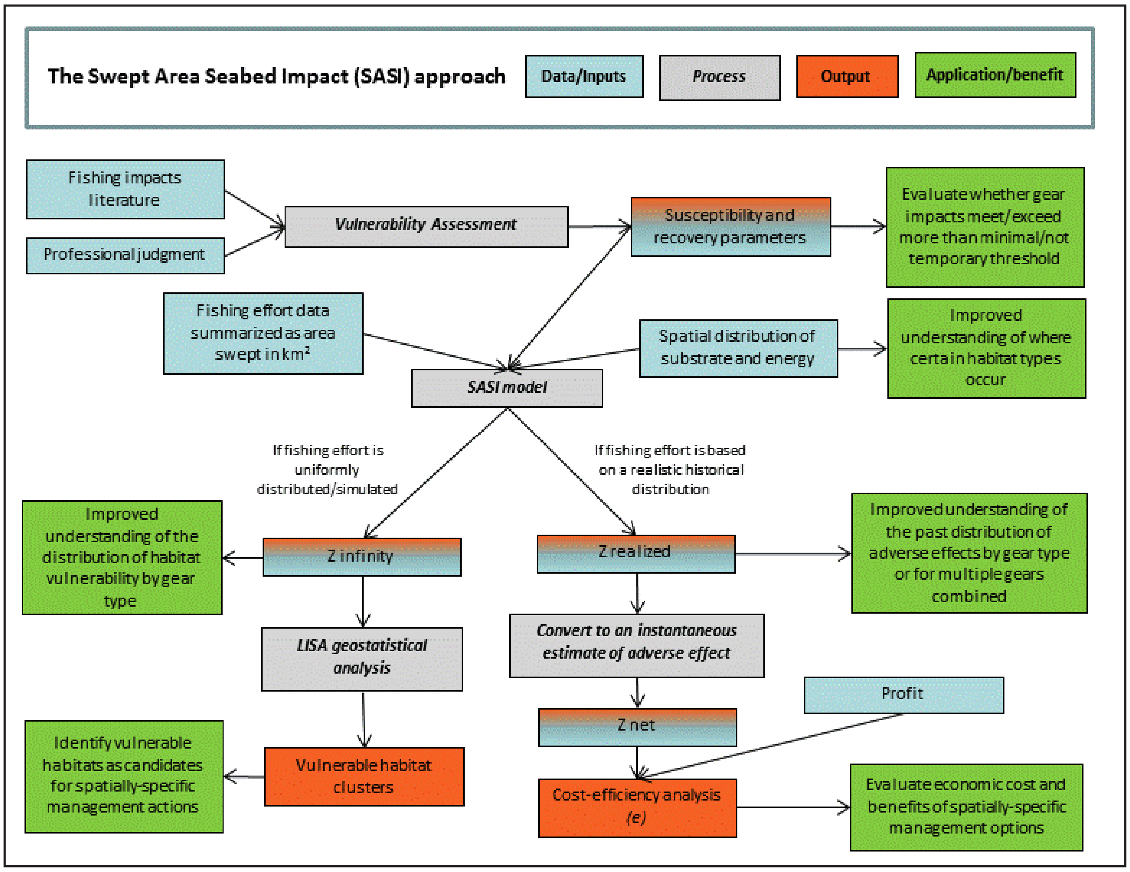
1. Vulnerability Assessment—a comprehensive review of the scientific literature on gear effects and a framework for generating susceptibility and recovery parameters for the SASI model.

2. SASI model—a geo-referenced analytical tool to estimate the adverse effects (Z) of fishing on seabed structure.

3. Local Indicators of Spatial Association analysis—a geostatistical approach to translate the broad array of highly vulnerable structural habitats identified in the Z analysis into smaller clusters that could serve as the foundation for habitat management area design.

4. Cost-efficiency analysis—to evaluate the costs (i.e. adverse effects to EFH) and benefits (profits) of various management alternatives.

5. Area Closure analysis—to estimate the potential magnitude of adverse effects generated by fishing under various area closing/open scenarios and to estimate the expected costs and benefits of implementing such scenarios.



For the New England Council, there were other issues that have also formed roadblocks to getting the EFH Omnibus Amendment completed. The first was a desire and need to coordinate this action with a re-assessment of the value associated with the groundfish mortality closures, which overlap spatially with existing habitat closures. If some areas were to be opened and others closed, it makes great sense to look at all the closed areas comprehensively. With this in mind, the final analysis and Council action has been further delayed to allow the Groundfish Plan Development Team, the Closed Area Technical Team and the Groundfish Committee time to evaluate all the groundfish mortality and spawning closures and suggest revisions as needed. One of the emerging complications has been a lack of data on egg and larval distribution and origination, as well as a lack of scientific data directly linking habitat and spawning success. The latest research by Vert-pre et al. (2013) indicates that spawning success is impacted by a number of variables. Unfortunately, as that process was partially underway, team members were pulled away to work on major groundfish problems with Gulf of Maine and Georges Bank cod and Georges Bank Yellowtail flounder.

The desired end game is the illusive, but comprehensive, analysis of all Council habitat and groundfish closed areas. Unfortunately the "groundfish disaster" caused the Council to want to find mitigation measures within some of the existing closures outside of this comprehensive plan. This continued to pull technical expertise away from any coordinated plan. It also meant that what was envisioned, as a coordinated and comprehensive analysis would become a piecemeal attack on closed areas that could have long-term detrimental impacts. At the same time as the groundfish industry was pushing for opening closed areas, the scallop industry was pushing to get other areas open for access to high concentrations of scallops which would result in lower interaction with yellowtail flounder. If that was not enough, the Mid-Atlantic Fishery Management Council was pushing to get part of Georges Bank reopened to dredging for ocean quahogs. It was akin to the Wild West of fisheries with a potential for unknown harm to habitat.

As this is written, the final chapters have not played out. The current timeline has the Council approving Omnibus EFH Amendment alternatives related to habitat and groundfish management in June. Selection of final alternatives is planned for September or November. Public hearings will take place during the summer. The Council will approve the EFH Omnibus Amendment 2 as soon after September as possible with implementation in 2014.

Strategic Plan

As part of the Omnibus EFH Amendment process, the Council crafted a strategic plan to outline how it will fulfill the mandates of MSA as they pertain to the EFH. This includes the five-year review process. It covers the implementation of the consultation process that gives the Council the authority to comment on any non-fishing activities that have the potential to impact EFH or HAPCs.

While I am not one for creating more rules, there has to be a better process for Council comments on non-fishing impacts. For the most part, Council comments get added to the file of public input and that is usually the end of the process. If Council comments are supposed to protect EFH and HAPCs, there needs to be a more formal process as to how comments are incorporated into the non-fishing impact review. The Council tends to defer to NOAA Fisheries Northeast Regional Office Habitat Conservation Division on these issues because it is simply too time consuming. Also, the Council and its staff do not have the expertise to consult on all manners of non-fishing impacts. Maybe the answer involves the Council prioritizing non-fishing impacts of greatest concern and focusing Council comments on those issues?

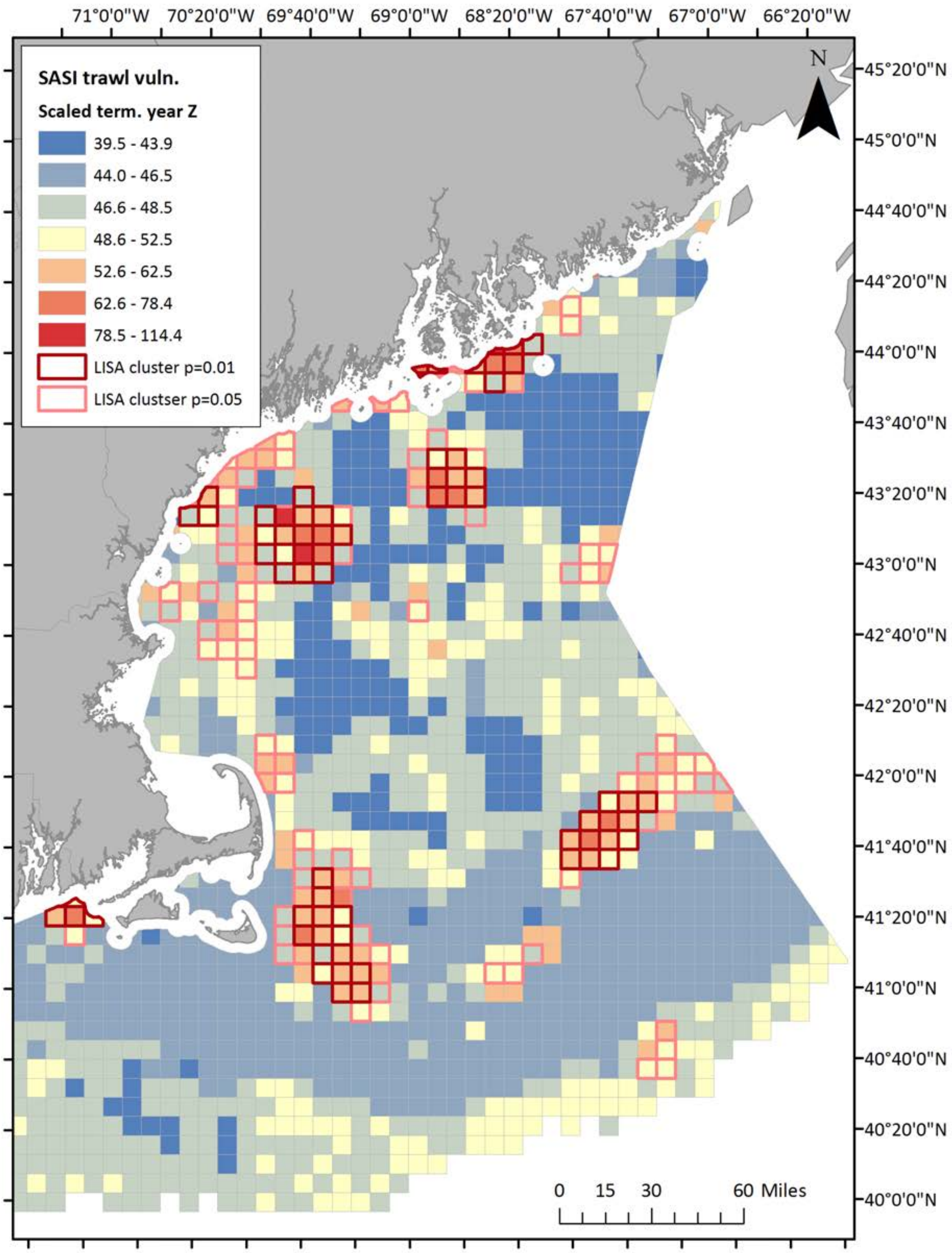
The goal of the Strategic Plan was to "improve the quality and increase the productivity of New England's fishery resources through implementation of the habitat management program." The goal is to be reached through a set of objectives that have largely been incorporated into, or are the basis of, Omnibus EFH Amendment 2.

Challenges and Tradeoffs

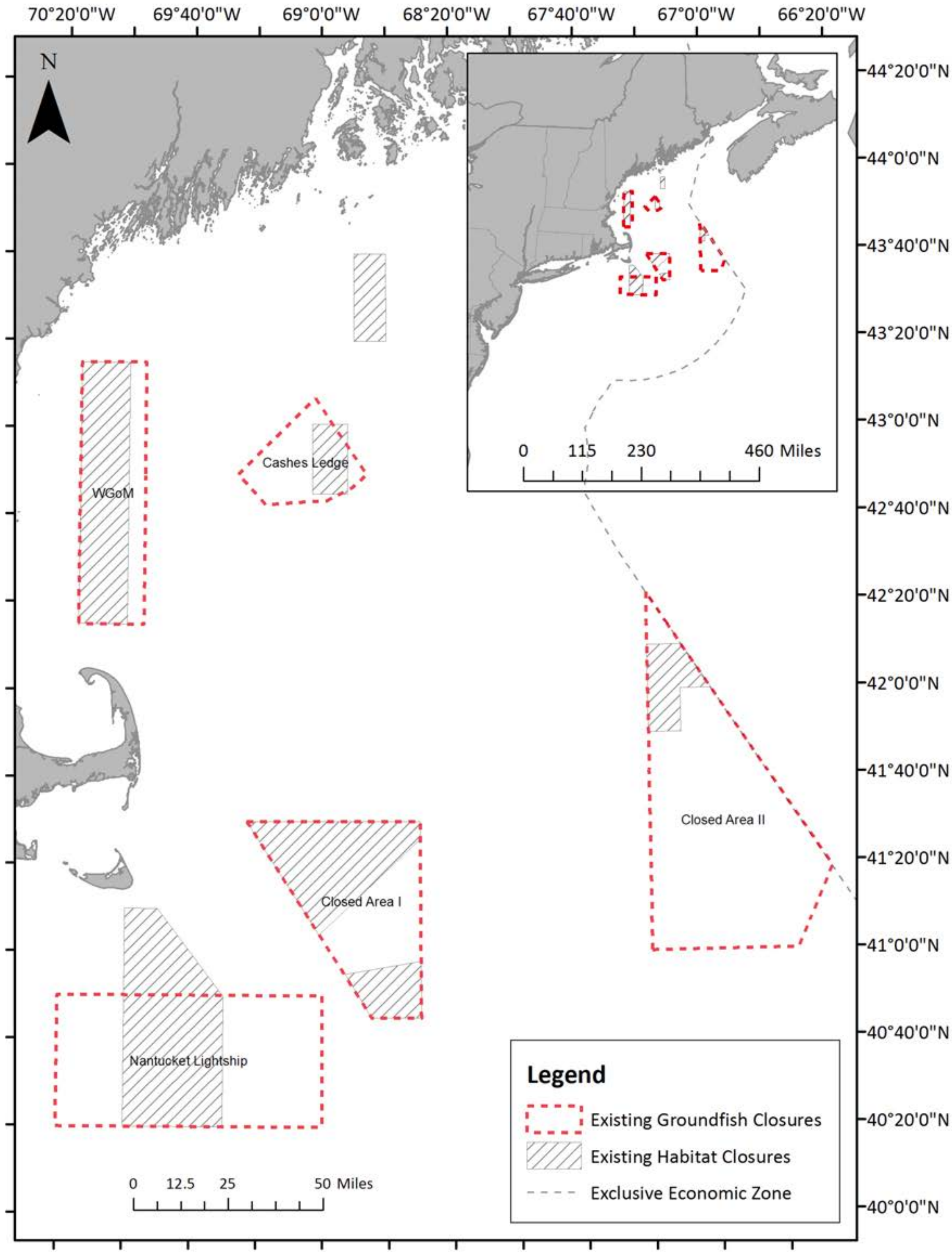
This process has been a lesson in balancing short-term needs of the fishing industry with the long-term viability of the resources. Managers tend to be very good at responding to public pressure, but not very good at being visionary. The concept of opening up some of these closed areas to access healthy fish stocks sounds reasonable. It sounds even more reasonable given the public outcry that the closed areas did not have any beneficial effect. Some would argue that if they had been beneficial then the stocks would be in better shape. That begs the question that without them would stocks have been in worse shape? In any case opening them without proper analysis undoes 20 years of sacrifice without any real understanding of what the benefits might have been.

If there are no more major potholes in the road, this amendment will have taken 11 years to complete. What are the takeaways from this process? First, be very clear in goal setting, so the public understands what the desired outcome is. When designating EFH, be clear as to what this means to the broad range of user groups. The same is true with designating HAPCs. Stakeholders should know what to expect for protective restrictions being placed on these areas. Stakeholders should also know what the benefits are for managing habitat as part of the process of managing fish. It should be noted that it is hard to know precisely what these benefits are, and that it's hard to know how much habitat protection may be necessary to achieve them. There is still a lot unknown about fish and their habitat needs/associations, and what is known could be changing in the face of environmental regime shifts.

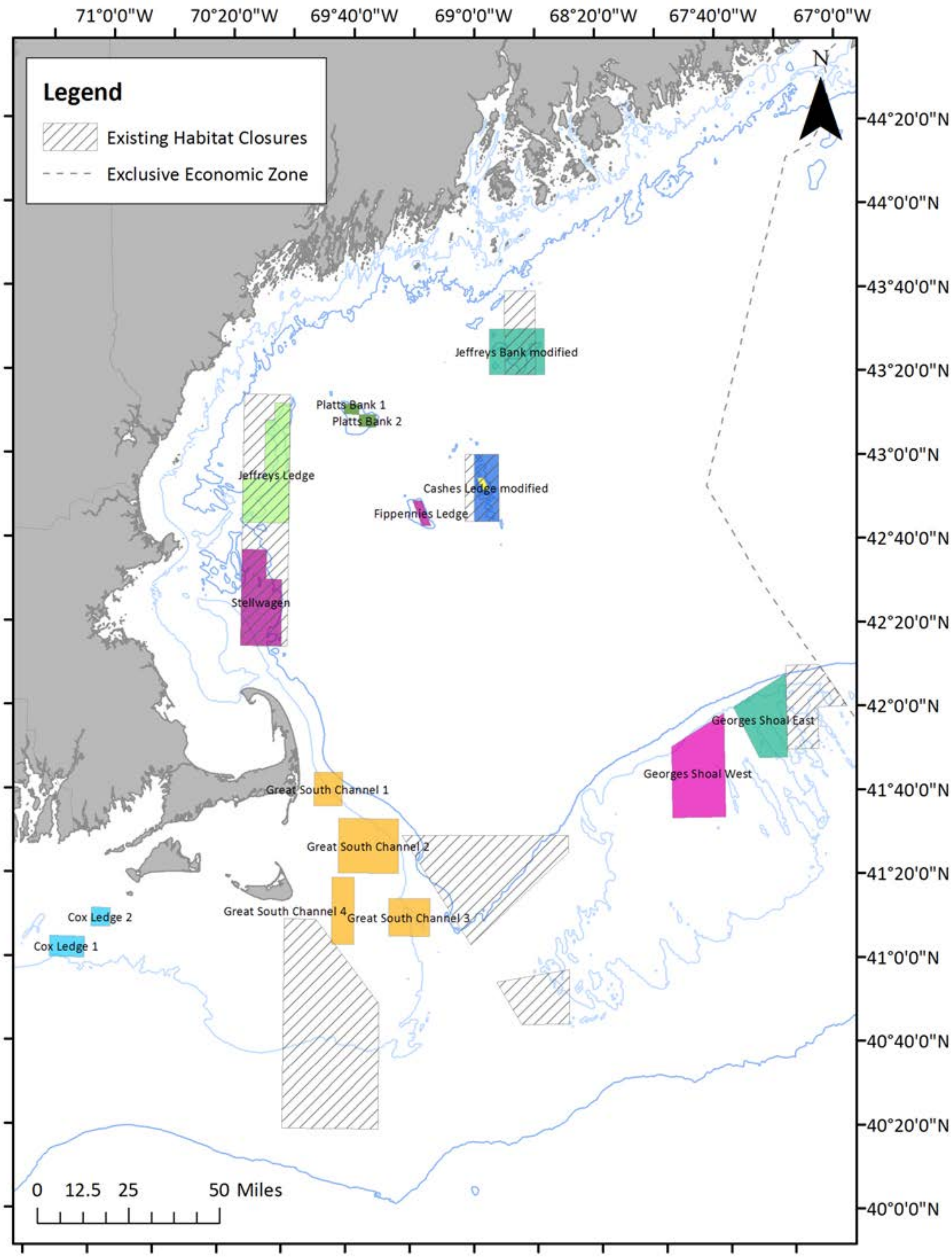
With this in mind, there may need to be more reference to and emphasis on habitat in MSA. While not exactly absent, habitat is only mentioned in one section of the Act, Section 305(b). While I am not sure that there needs to be a National Standard 11 dealing with habitat, having a more prominent inclusion of habitat in the Act would point out the importance of habitat to the overall process.



This figure shows estimated habitat vulnerability to otter trawl gear in the Gulf of Maine/Georges Bank region. Clusters of high values at two probability thresholds are shown in pink and red outlines. These outlined cells represent locations that have high vulnerability scores and are near other cells with high vulnerability scores, and were used by the Council's Habitat Plan Development Team and Oversight Committee as a foundation for habitat management area development. (From Draft Environmental Impact Statement (EIS) for Omnibus EFH Amendment 2.)

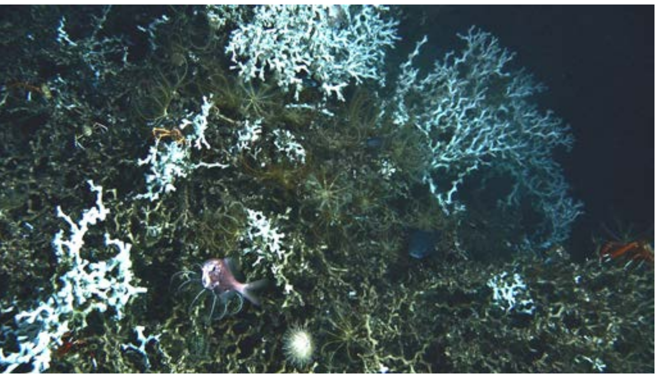


This figure shows the current habitat and groundfish management areas. The groundfish areas were closed to many types of gear capable of catching groundfish starting in the mid-1990s, and the habitat areas were closed to mobile bottom tending gear in 2004. (From Draft Environmental Impact Statement for Omnibus EFH Amendment 2.)



This figure shows the range of draft habitat management areas proposed in Omnibus EFH Amendment 2 as of January 2013. (From Draft Environmental Impact Statement for Omnibus EFH Amendment 2.)

The National Environmental Policy Act analysis for actions that include habitat and habitat impacts needs to compare current costs, if any, with the long-term benefits of habitat protection. In the "perfect" world this is sometimes hard to analyze, but it becomes even harder when the environmental regime is changing at the rate it appears to be in the Northeast. The fishing industry in New England has heard the "current pain for future gain" scenario before and has grown extremely leery of that elusive promise.



Conclusion

An elephant is best eaten one bite at a time. To the extent possible, divide a huge task into manageable chunks. The New England Council took on a large task with this EFH Omnibus Amendment 2 and then continued to make it bigger. It is better in my mind to accomplish smaller tranches. Certainly, it is easier for managers and stakeholders to focus their efforts. Setting clear and understandable goals and objectives upfront give stakeholders a better sense of transparency. In the Council's defense, it had been advised that severing updated EFH designations from the adverse impacts minimization measures was not a good idea, so the ability to simplify was limited. The Council certainly could have ignored the deep-water coral issues and would have saved a lot of time developing canyon and seamount HAPC proposals in 2006 and designing coral management alternatives in 2010-2011. In hindsight, the path may be clearer.

Going back to the opening statement, habitat is the foundation on which all resource management should be built. Without consideration of this important element, successful management and sustainable fisheries will be much harder to achieve. The sooner all the stakeholders realize this, the better the end product of the management process will be.

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Integrating Habitat in Ecosystem-Based Fishery Management

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Abstract

Healthy freshwater, coastal and marine habitats are essential to fisheries and coastal communities, and to the ecosystem functions on which both depend. Since the 1996 Sustainable Fisheries Act, Regional Fishery Management Councils in partnership with the National Oceanic and Atmospheric Administration (NOAA) Fisheries Service have made progress on addressing adverse impacts of fishing and non-fishing activities on habitat. Yet too often, habitat issues have not been integrated into mainline fisheries management. Many coastal habitats are still at risk, with adverse impacts to fisheries that are poorly understood and masked by overfishing. Our success in addressing overfishing provides an opportunity for a greater focus on habitat, better integrating habitat issues into ecosystem-based fisheries management and better integrating marine fisheries into an ecosystem approach to ocean management. We propose several practical steps toward this goal: 1) Identifying and delineating priority habitats and their vulnerabilities; 2) Setting habitat conservation objectives; 3) Integrating habitat conservation explicitly into other aspects of fisheries management; and 4) Expanding partnerships and building alliances to conserve habitat. NOAA's Habitat Blueprint (2012) provides a roadmap to focusing Federal resources and achieving these steps.

Introduction

Healthy habitats sustain resilient and thriving marine and coastal resources, communities, and economies. It is appropriate that habitat conservation is a major topic in the Managing our Nation's Fisheries 3 conference, as the ecosystem functions, goods and services provided by conserving and restoring riverine, coastal and deepwater habitat play a critical role in sustaining fisheries and recovering protected species. Therefore it is imperative that we incorporate habitat conservation into any effort at ecosystem-based management.

The goal of ecosystem-based management is to sustain diverse, productive, resilient coastal and marine ecosystems and the services they provide, thereby promoting the long-term health, security, and well-being of our nation (National Ocean Council 2012). To reach this goal, we must ensure that the ecosystem services provided by protecting and restoring riverine, coastal and deepwater habitat are more clearly defined, demonstrated, and valued. The National Oceanic and Atmospheric Administration (NOAA) has established a Habitat Blueprint that gets to the heart of ecosystem approaches to management. The Blueprint provides a focusing mechanism to leverage NOAA and other funding sources on issues critical to accomplishing our habitat conservation mission.

In this paper, we briefly sketch out the progress that the Regional Fishery Management Councils (Councils) and the National Marine Fisheries Service (NOAA Fisheries) have made in addressing the two major components of the habitat challenge in the context of fisheries: (1) fishing impacts to habitats—affecting the goods and services these habitats provide to society; and (2) non-fishing impacts to habitats upon which fisheries productivity depends. We then propose some practical steps that we in the fisheries community can take to further advance the integration of habitat considerations into ecosystem-based management. NOAA's Habitat Blueprint provides the forward-looking framework for achieving these steps. It is designed to help NOAA think and act strategically across programs and with partner organizations to increase the effectiveness of our efforts to improve habitat conditions for coastal and marine life, including fisheries species, thereby providing economic, cultural, and environmental benefits to our society.

Progress to Date

In 1996, the Sustainable Fisheries Act added the essential fish habitat (EFH) provisions to the Magnuson-Stevens Fishery Conservation and Management Act (MSA). These provisions require NOAA Fisheries and Councils to identify and describe EFH and minimize, to the extent practicable, the adverse effects on such habitat caused by fishing. The provisions were added in recognition that degradation of fish habitat threatened many of our nation's fisheries stocks and that habitat conservation should be used as a tool to achieve sustainable fisheries. Since 1996, NOAA Fisheries and the Councils have made significant strides in identifying, protecting, and restoring fisheries habitat, including identifying EFH for multiple life stages of more than 1,000 species of Federally-managed fishes and designating over one hundred habitat areas of particular concern (HAPCs). The regular five-year reviews of EFH and HAPC designations that have begun to be implemented by the Councils are serving a key role in moving toward adaptive management that uses the best available scientific information.

Fishing Impacts

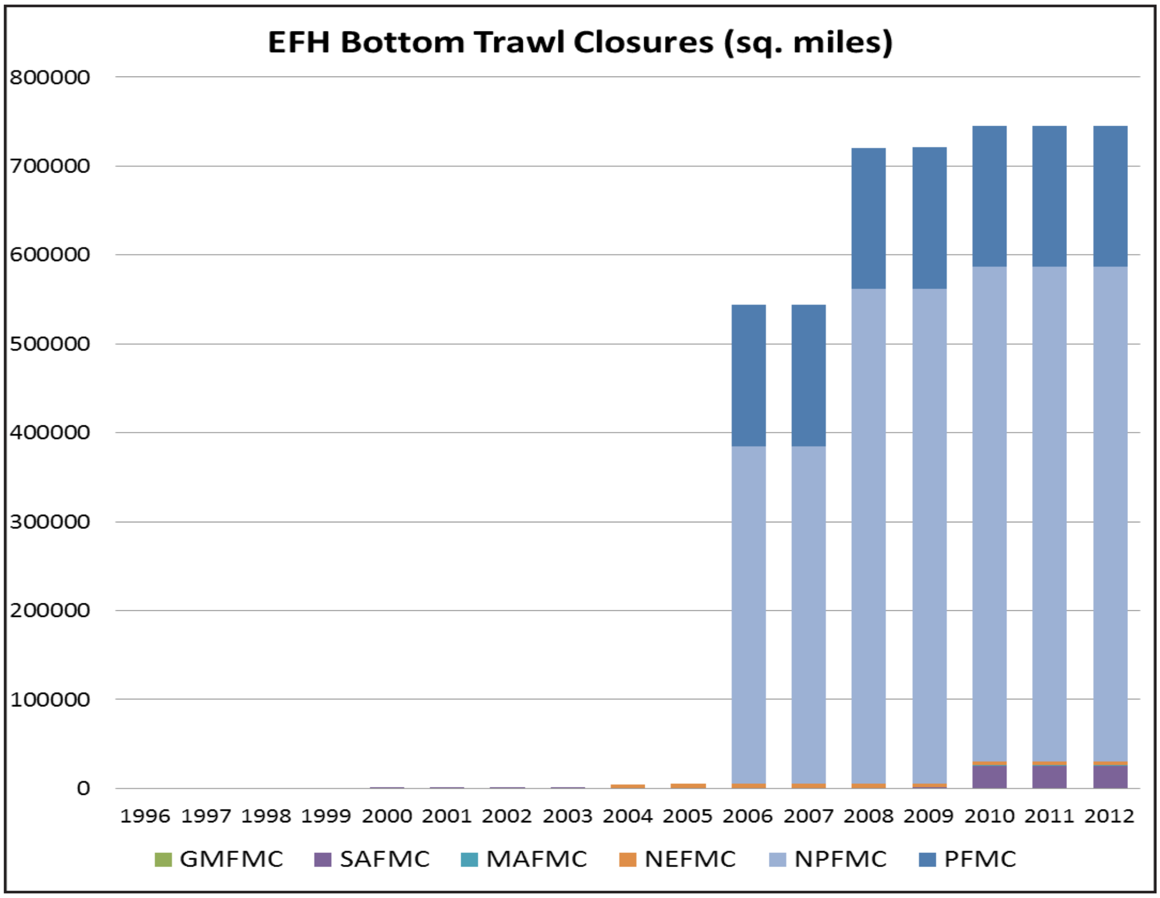
Beginning around 2005, the Councils used their MSA EFH authorities to develop region-wide approaches to habitat conservation on a scale commensurate with ecosystem management. These actions have made the United States a world leader in protecting vulnerable benthic habitats from the adverse impacts of certain fishing gears. Key approaches were pioneered by the North Pacific and Pacific Fishery Management Councils and became effective in 2006, ten years after the EFH legislation. These actions relied primarily on closing areas to bottom trawling—the fishing activity deemed the most likely to damage benthic habitats (Fig. 1).

Topographic features such as ridge systems (e.g., Bowers Ridge and Mendocino Ridge), portions of undersea canyons (e.g., Monterey Canyon), and banks (e.g., Heceta Bank) were protected from bottom trawling. Such habitats are often associated with hard substrata known to be colonized by corals, sponges, and other fauna. Certain habitats deemed particularly vulnerable, such as deep-sea coral "gardens" in the Aleutian Islands and seamounts in the Gulf of Alaska and off the West Coast, received a higher level of protection and were closed to all bottom-contact gear (bottom trawls, pots, and bottom-set longlines and gillnets).

A particularly innovative aspect of the measures recommended by both Councils was to apply a precautionary management approach prohibiting the use of bottom trawl fishing gear in deeper areas where such gear had not yet been heavily used, while allowing historically-fished areas to remain open to such fishing. This approach to "freeze the footprint" of bottom trawling was designed to allow existing fisheries to thrive, while preventing expansion into unsurveyed areas that might contain deepwater corals, sponges, and other vulnerable hard-bottom habitats. This approach was exemplified by the Aleutian Islands Habitat Conservation Area, which covered nearly 370,000 square miles and represents the largest single effort to conserve relatively undisturbed bottom habitats in U.S. waters.

Such ecosystem-scale habitat measures, blending targeted protection with a precautionary approach, have since been applied by the North Pacific Council in the Bering Sea and by the South Atlantic Council in protecting snapper-grouper habitats and over 24,000 square miles of deep-water Coral Habitat Areas of Particular Concern. A similar approach is being considered by the Mid-Atlantic and New England Councils.

Figure 1. Marine benthic EFH areas protected from impacts of bottom-trawl fishing gear. The figure shows the cumulative area in square miles protected by NOAA Fisheries and the Fishery Management Councils since the 1996 Sustainable Fisheries Act. (Note: The Western Pacific Fishery Management Council protected the entire exclusive economic zone under its jurisdiction from trawling and certain other bottom-contact fishing gears in the early 1980s, prior to the EFH amendments. Bottom-trawling does not occur in the Caribbean Council region. In addition to these EFH-specific closures, there are additional closures in place to reduce gear conflicts and other purposes, which also benefit habitat conservation.)



Non-Fishing Impacts

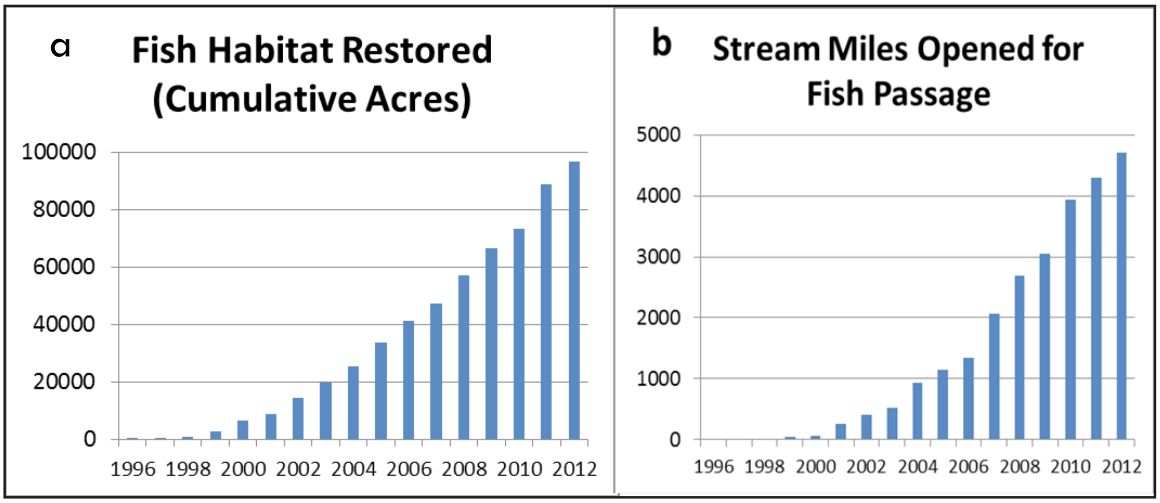
Addressing the fishing impacts to EFH in Federal waters is fully under the authority of NOAA Fisheries and the Councils. In contrast, the primary responsibility for protecting and restoring EFH degraded or destroyed by non-fishing threats most often lies with other agencies, often multiple agencies at the state and Federal level. Nearshore, estuarine, and riverine habitats are also subject to a greater number and variety of impacts than are offshore habitats, adding complexity to the decision-making process and making conservation progress more difficult to measure.

Despite these constraints, we are convinced that NOAA's efforts have had a significant impact on improving habitat for fisheries species. Endangered Species Act and EFH consultations with other Federal agencies are an important tool to address non-fishing impacts. In 2012, NOAA Fisheries was able to reduce or avert impacts to 364,000 acres of habitat through its EFH consultation authority. In many cases, through reviewing permit processes and hydropower licensing, consultations have resulted in revisions to originally-proposed actions that have reduced, averted or mitigated negative impacts to habitats. For example, NOAA Fisheries has used the EFH consultation process to influence plans for proposed open-loop liquefied natural gas facilities in some of the most biologically productive areas in the Gulf of Mexico marine ecosystem. These open-loop facilities draw in large volumes of seawater to regassify the liquid natural gas, potentially putting at risk commercially and recreationally valuable fish like snapper and red drum, as well as the organisms on which they feed. NOAA's consultations and the engagement of the fisheries and environmental communities have resulted in the redesign of several facilities to closed-loop systems to avoid entrainment and impingement of marine organisms. In another example, based on advice from NOAA Fisheries and the

New England Fishery Management Council, in 2010 the U.S. Army Corps of Engineers denied a permit requested by the Commonwealth of Massachusetts to use 500,000 cubic yards of sand and gravel from a 103-acre offshore site in Massachusetts Bay for erosion control on Winthrop Beach. The material would have been removed from an area of the Bay designated as EFH for 26 Federally-managed species, including valuable Atlantic cod. NOAA advised the Corps on alternative sources of material that would avoid the negative impacts of the proposed project and helped to support cod recovery efforts in Massachusetts.

NOAA also conducts habitat restoration targeted at improving habitat for fisheries species. On the restoration front, NOAA has restored nearly 100,000 acres of coastal, marine and Great lakes habitat since 1996 (Fig. 2a). This includes 69,000 acres of habitat through 2,300 community-based restoration projects and 8,000 acres of coastal wetlands in Louisiana. Through our work, more than 200 dams and other barriers have been removed since 1998, opening up more than 4,000 stream miles for fish passage (Fig. 2b).

Figure 2. *Fish habitat restored through NOAA Fisheries-led activities since the 1996 Sustainable Fisheries Act. (a) Cumulative area in acres of coastal, marine and Great lakes habitat restored. (b) Cumulative miles of streams opened for fish passage.*



Unfinished Work and New Challenges

Despite this progress, habitats essential for healthy fisheries are still at risk. Estuaries support fish and shellfish species that comprised approximately 46% by weight and 68% by value of the U.S. commercial catch landed nationwide from 2000 through 2004 and approximately 80% of the U.S. recreational landings over the same period (Lellis-Dibble et al. 2008). Yet 53% of the estuaries (by area) in the lower 48 states are considered at high or very high risk of current habitat degradation (National Fish Habitat Board 2010). Between 2004 and 2009, marine and estuarine intertidal wetlands declined by an estimated 84,100 acres (Dahl 2011), and the loss rate of intertidal salt marshes increased to three times the previous loss rate between 1998 and 2004. Freshwater wetlands in coastal watersheds provide important habitat for anadromous marine fish such as herring and salmon, and contribute to the overall health of the estuaries lower in the coastal watersheds. Yet despite an overall increase in wetlands nationally between 1998 and 2004, there was a net loss of wetlands in coastal watersheds adjacent to the Atlantic Ocean and Gulf of Mexico of more than 385,000 acres, or more than 60,000 acres per year (Stedman and Dahl 2008). The primary causes of these habitat trends range from development in upland watersheds, polluted run-off and other effects of urbanization and agriculture affecting estuaries, and coastal storms, land subsidence, and sea-level rise impacting intertidal wetlands.

Up until now, the extent to which these coastal habitat trends have affected recreational and commercial fisheries has likely been masked by overfishing. Our historic success in ending overfishing may open a window on understanding the linkages between habitat and fisheries productivity. In a review of NOAA Fisheries rebuilding plans, Milazzo (2012) found that effective, lasting and well enforced controls of fishing mortality resulted in evidence of stock recovery in two-thirds of the rebuilding plans for which we have adequate data on fishing mortality and biomass levels. However, certain stocks appear to respond poorly and/or belatedly to rebuilding measures. These include certain demersal species (Atlantic cod), many rockfish stocks, diadromous species (such as salmon), stocks in the snapper-grouper and reef fish complexes, and deep-sea species. Many of these species are known to be tightly associated with particular habitats. For these species, controlling catch and fishing effort alone is not enough, and rebuilding plans need to address other factors such as habitat that may be bottlenecks to recovery. The nation's success in addressing overfishing should allow us to better identify stocks whose recovery depends on restoring and protecting habitat.

Steps Toward Integrating Habitat into Ecosystem-Based Management

So where do we go from here? It seems to us that there are several practical steps that offer an opportunity to make progress. The following suggestions build on recommendations from policy groups such as the U.S. Commission on Ocean Policy (2004) and the Ecosystem Principles Advisory Panel (1999), as well as a NOAA Habitat Blueprint Symposium we sponsored at the 142nd Annual Meeting of the American Fisheries Society in August 2012.

Identify and Delineate Priority Habitats and their Vulnerability to Fishing and Non-Fishing Impacts

NOAA and the Councils have made progress in identifying EFH, sometimes based on limited habitat data, but we have been less successful in prioritizing among habitats. If every habitat is "essential" then no habitat will get the attention needed for successful conservation. For example, our EFH consultations on non-fishing habitat impacts have been extensive (more than 4,000 per year), but often not focused on priorities most likely to achieve measurable benefits for achieving sustainable fisheries. Likewise, small and dispersed habitat protection or restoration activities will likely fail to achieve large-scale, measureable results. Focus becomes increasingly critical in a time of diminishing financial resources.

From the fisheries management standpoint, we must be explicit in the identification of those habitats where we can achieve measurable benefits that will support priority fish stocks. This effort will benefit from improved scientific information linking specific habitat improvements to fishery productivity. NOAA Fisheries has developed a Marine Fisheries Habitat Assessment Improvement Plan (NMFS 2010) that defines the agency's role in pursuing habitat science and establishes a framework to coordinate habitat research, monitoring, and assessments in support of our fishery management responsibilities. Among other goals, it is explicitly designed to reduce habitat-related uncertainty in stock assessments, support assessments of ecosystem services, and contribute to ecosystem-based fishery management and integrated ecosystem assessments. The plan deals with managed stocks and stock complexes within fishery management plans, with particular focus on the 230 stocks in the Fish Stock Sustainability Index. NOAA Fisheries has also initiated a regional process to further prioritize needed habitat assessments. The process results in two prioritized lists; the first identifies specific stock assessments that are most likely to benefit from improved habitat assessments and the second identifies stocks for which habitat assessments will most advance EFH identification and conservation. The pilot process was implemented in California in 2012 (NMFS 2012), identifying a number of priority stocks in both categories. The majority of these stocks were anadromous salmon (e.g., Chinook and coho stocks) and rockfish (e.g., bocaccio, canary rockfish, and cowcod) stocks, and there was a nearly complete agreement between the priorities for stock assessment and those for other habitat science. A similar process will be conducted in the other regions to help NOAA focus its habitat research.

However, these information gaps should not prevent us from dealing with habitat conservation problems. Fishery stakeholders agreed on this point almost ten years ago at the first Managing Our Nation's Fisheries conference (Kurland 2004). We still need to identify and act on our management priorities now, while we work to improve our science base. We also need to broaden our approach from species-by-species, to identifying habitats that benefit multiple species and those that provide additional ecosystem services that we value. In 2005, the U.S. Commission on Ocean Policy recommended that NOAA Fisheries change the designation of EFH from a species-by-species to a multispecies approach and, ultimately, to an ecosystem-based approach that includes consideration of ecologically valuable species that are not necessarily commercially important. While there is a growing body of science-based analytical methods that could support such designations, we suggest that there is already scientific and societal consensus on the importance of certain habitat types based on their contributions as fish habitat, biodiversity and ecosystem services. These include tropical coral reefs, coastal wetlands, seagrass and kelp beds, and deep-sea coral communities. This would be a practical place to start focusing our attention and, as we discuss below, will facilitate building alliances beyond the fisheries management community.

Set Habitat Conservation Objectives

Successful management depends upon translating concepts into specific objectives and measurable targets. In single-species fisheries management, these targets have generally been target stock sizes that will avoid overfishing. Success in ending overfishing has benefited from a focus on overfished stocks; clear targets established through mandates and regulations (e.g., National Standards, determinations of maximum sustainable yield/optimum yield, allowable catch levels, accountability measures, etc.); and the ability to measure progress (i.e., through stock assessments).

In a similar manner, a key aspect of an ecosystem approach to management is developing indices of ecosystem health as targets for management (Ecosystem Principles Advisory Panel 1999). A number of authors have identified the difficulties in setting performance measures for a small selection of fisheries ecosystem metrics, however nearly all approaches identify the centrality of habitat. While in most cases, the extent and quantity of habitat that is needed to contribute to increased productivity of a particular fisheries stock, or to a "healthy ecosystem" cannot be determined exactly, suspected tipping points may be inferred, and prudent managers will set targets that are likely to avoid degradation.

Table 1. Selected examples of existing quantitative habitat conservation targets. (Source: NMFS 2013)

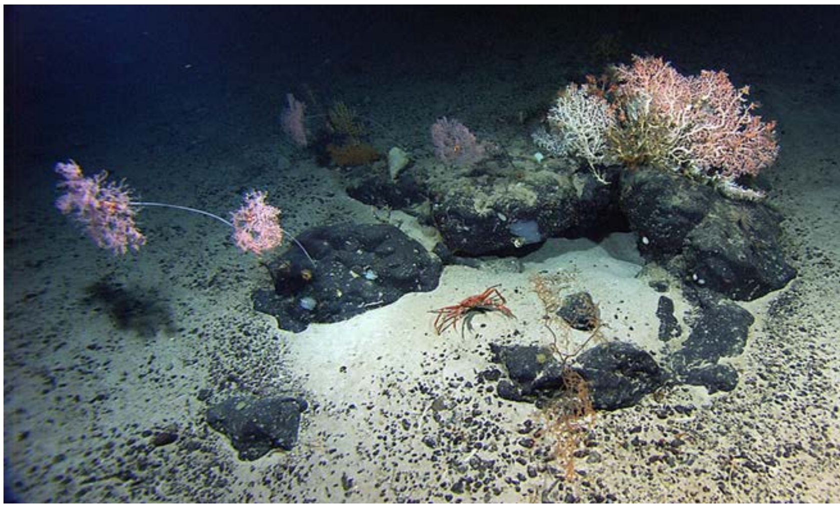
Program	Goal	Target	Reference
Chesapeake Bay Program	Restored oyster populations in priority tributaries	50-100% of restorable bottom in tributary restored.	http://www.chesapeakebay.net/
		15 to 50 oysters/m2 covering at least 30% of the reef area	
San Francisco Bay Sub-tidal Habitat Goals Project	Conserve ecosystem services provided by eelgrass beds	Protect eelgrass habitat through no net loss to existing beds (3,700 acres in 2009).	http://www.sfbaysubtidal.org/
		Increase native eelgrass within 8,000 acres of suitable intertidal/subtidal habitat	
Puget Sound Partnership	Wild Chinook salmon population recovery	10% of bluff-backed beaches with high sediment supply or priority nearshore habitat facing development pressure are protected	http://www.psp.wa.gov/

There are examples from existing habitat programs that are successfully using habitat objectives or indicators to identify habitat priorities and set management goals through their planning processes (Table 1). A variety of approaches have been used to set habitat objectives for both freshwater and marine fish species. There is a role for both qualitative and quantitative objectives and targets, and both can serve to measure progress and influence decisions about investing resources to affect a desired outcome for fisheries (NMFS 2013). However, we should strive to develop quantitative targets and measure progress to reach these targets.

Setting habitat objectives and targets that can enhance fisheries management requires understanding the ways in which habitat bottlenecks can constrain fish productivity, for example dams impacting access by diadromous fishes to spawning areas. It also requires the ability to delineate priority habitats and clearly identify their vulnerability to fishing and non-fishing impacts. While it remains a challenge to parse out specific effects of multiple human activities, particularly in nearshore and freshwater areas, there are methods that can be employed to systematically identify and prioritize the human activities that are the strongest drivers of ecosystem change (e.g., Altman et al. 2011). In most cases habitat objectives will measure the extent and quality of the habitat. As improved habitat assessments begin to yield habitat-dependent fishery productivity rates for priority habitat-dependent stocks, we will come closer to a being able to provide information to stock assessments using the same units.

Integrate Habitat Conservation Explicitly into Other Aspects of Fisheries Management

Habitat conservation efforts still remain relatively separated from traditional fisheries management approaches. We need to identify and build upon the synergies between fisheries habitat objectives and other aspects of policies and processes of fisheries management.



There are immediate opportunities that NOAA Fisheries could take to incorporate habitat as the Regional Fishery Management Councils develop ecosystem-based fishery management plans and by working with Councils to incorporate these efforts into regional ocean planning constructs such as those under the National Ocean Plans. As another example, both the U.S. Commission on Ocean Policy (2004) and the Pew Oceans Commission (2003) Reports stressed the need to address the broad ecosystem impacts of bycatch. When considering biogenic habitats, reducing bycatch of habitat-forming organisms such as deep-sea corals and sponges translates directly into reducing impacts on priority habitats. The North Pacific Council explicitly identified the link between its 2005 Groundfish EFH amendments and the goal to minimize bycatch of benthic habitat-forming invertebrates. Strengthening both bycatch monitoring and bycatch reduction of deep-sea corals and sponges will benefit habitats and the fishes that depend upon them (NOAA 2010).

The Councils, as governing bodies which include state representatives, offer unique opportunities to strategically partner with states on specific, priority coastal and offshore habitat protection issues. The formal and consistent engagement of the Councils in consultations on non-fishing impacts to EFH can improve the conservation of habitat for commercially and recreationally important fish species (NMFS 2013). The North Pacific and Mid-Atlantic Fishery Management Councils have already used their fishery management public process for some discrete habitat conservation activities. For example, the North Pacific Fishery Management Council used the public fishery management planning process to determine priorities for establishing Habitat Areas of Particular Concern.

Expand Partnerships and Build Alliances

Identifying habitat priorities, setting management objectives, and implementing management actions all require a public policy dialogue with affected stakeholders, many of which will be outside the traditional fishery management groups. In certain cases, as when the primary threats to high-value habitats in Federal waters are due to fishing impacts, the responsibility to protect these habitats rests clearly with NOAA Fisheries and the Councils. Fishery participants and managers will only have credibility with other stakeholders to the extent that we effectively address habitat impacts of our fishing activities, particularly bycatch and gear impacts. In most cases, however, both the threats and the solutions are outside the direct control of fisheries managers. In these cases we have the opportunity to find common ground with others and build alliances to protect our priority habitats.

These partnerships need to be approached from the local, watershed, state, regional, national and international level. For example, through the National Fish Habitat Partnership and its network of regional partnerships, NOAA is able to work with state and Federal agencies, non-profit organizations, and fishing industry representatives towards achieving our mutual goals for fish habitat conservation using voluntary and non-regulatory approaches.

We encourage the Councils to become more actively engaged in both selected consultations that affect our identified priority habitats, as well as in other fora—e.g., regional ecosystem and marine spatial planning with an influence over activities that influence priority fisheries habitat. We should also further engage states through the interstate commissions that serve vital roles in coastal waters, estuaries, and rivers that are integral components of an ecosystem-based approach.

A Blueprint for Conserving Habitats and Rebuilding Fisheries

As we explore these and other options for integrating habitat in ecosystem-based fishery management, the primary mechanism to achieve this objective is through the NOAA Habitat Blueprint. This is the "lens" for how we set programmatic and operational priorities. The NOAA Habitat Blueprint is a forward looking framework for the agency to think and act strategically across programs and with partner organizations to address the growing challenge of coastal and marine habitat loss and degradation. It is a centerpiece in our efforts both to integrate habitat into ecosystem-based management and to strengthen the partnerships that will benefit from the conservation of habitats important to fisheries. These efforts are expected to yield benefits for marine fisheries, as well as for protected resources and coastal communities. Many of the themes mentioned above are mirrored in the guiding principles of the Blueprint:

- Prioritize resources and activities across NOAA to improve habitat conditions;
- Implement innovative place-based habitat solutions to address coastal and marine resource challenges;
- Make natural resource management decisions and recommendations in an ecosystem context that considers competing priorities;
- Foster and leverage partnerships;
- Integrate and improve the delivery of habitat science across disciplines to facilitate conservation actions; and
- Anticipate and address changes to coastal and ocean habitats due to development, climate, and other pressures.

These guiding principles are being executed through three primary approaches: establishing Habitat Focus Areas; implementing a systematic and strategic approach to habitat science; and strengthening policy and legislation. Through these Blueprint approaches we aim to better integrate habitat considerations into NOAA's management activities in order to achieve the multiple outcomes of sustainable and abundant fish populations, recovered threatened and endangered species, and resilient coastal communities. The concepts we are proposing in this paper are key to achieving these goals.

We are currently selecting Habitat Focus Areas in each of NOAA's regions. The goal of establishing these Focus Areas is to prioritize long-term habitat science and conservation efforts, and concentrate resources in a place where by working collaboratively we can achieve measurable benefits for marine resources and coastal communities in a three to five year timeframe. The first Habitat Focus Area has already been selected, the Russian River watershed in California, and others will be established across the country over the coming year.

The science approach of the Blueprint is strengthening the linkages between habitat science and decision-making needs. We are prioritizing our research and using a more integrative approach for planning and conducting quality habitat science. The concept of ecosystem services provides a common denominator for prioritizing habitats and building partnerships. This will enable us to address the greatest needs and ensure that the information necessary to incorporate habitat into ecosystem-based fisheries management is in place.

The NOAA Habitat Blueprint challenges us to better use NOAA's habitat conservation authorities in the MSA to achieve sustainable fisheries. To do so we will explore the development of habitat conservation objectives for fisheries management and develop policies that better integrate habitat considerations into fisheries management decisions. This will involve a culture change within NOAA Fisheries, challenging us to become a nimble, dynamic and cohesive organization to achieve the tenets of the Blueprint, partnering more across NOAA and with other Federal agencies.

Conclusions

The Managing our Nation's Fisheries 3 conference offers an important forum to discuss these and other steps that could further integrate habitat considerations into existing fishery management efforts, and integrate fisheries (and fisheries habitat) into broader ecosystem-based management. While we believe that many of the steps outlined above can be accomplished within existing legislative authorities, we are also interested in beginning a dialog on areas where additional authorities might benefit our habitat and fisheries goals.

With the Blueprint as our framework, NOAA Fisheries is committed to working together with the Councils and other partners to protect and restore habitats that support vibrant fisheries and coastal communities. If we are successful, improved geographic focus, clearly defined habitat objectives, improved integration with mainline fisheries management and expanded partnerships will provide a number of benefits:

- Protection of the most important habitats from fishing impacts and more targeted and effective agency conservation recommendations for non-fishing impacts;
- Councils that are better able to determine when to engage in consultations on non-fishing impacts to habitats essential for priority stocks;
- Direction in establishing Habitat Areas of Particular Concern;
- Focus for NOAA's habitat research;
- Increased effectiveness of our habitat conservation programs to rebuild and maintain sustainable fisheries;
- Clearer opportunities to partner with states and others proactively on shared habitat conservations needs, including those related to fisheries managed by interstate commissions; and
- Focus for decisions on funding opportunities related to habitat restoration, stock dynamics, socio-economics, and other NOAA Fisheries programs with benefits to our MSA mandates or our state partnerships.

Over the last ten years, NOAA Fisheries and the Regional Fishery Management Councils have made significant progress in addressing overfishing and the adverse impacts of fishing gear on vulnerable benthic habitats. The stage is set to consolidate these gains and further incorporate habitat into the nation's goal of adopting ecosystem-based management as a foundational principle for the comprehensive management of the ocean, our coasts, and the Great Lakes.

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DISCUSSION SUMMARY AND FINDINGS
Session 2 Topic 3

Integrating Habitat Considerations: Opportunities and Impediments

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Discussion Summary and Findings:

Integrating Habitat Considerations: Opportunities and Impediments

Background

Healthy habitats are fundamental to healthy and productive fisheries, as recognized by the 1996 reauthorization of the Magnuson-Stevens Act. The Act and implementing regulations direct Regional Fishery Management Councils to identify and describe essential fish habitat (EFH) in fishery management plans, minimize adverse impacts to habitat from fishing, identify other activities that may adversely affect EFH, and recommend actions to avoid, minimize, or compensate for these effects. The Act also requires Federal agencies to consult with NOAA Fisheries when Federally permitted or funded activities may adversely impact EFH, and provides Councils with the discretionary authority to comment on these activities as well. More recently, NOAA Fisheries has undertaken initiatives to coordinate, advance, and invest in habitat science and policy in support of sustainable fisheries through the Habitat Assessment Improvement Plan and the NOAA Habitat Blueprint.

Despite this progress, participants and speakers in this session felt that we are still falling short of our potential to reverse habitat loss and decline, achieve targeted and effective habitat conservation, and link habitat conservation to sustainable fishery outcomes and successful rebuilding programs. While legislative solutions—primarily a National Standard for habitat conservation—were discussed, this discussion focused primarily on policy and regulatory changes and "best practices."

Summary

With management increasingly oriented toward ecosystem-based decision-making, habitat conservation must likewise be focused at the landscape or ecosystem level. In this context, habitat conservation will require NOAA Fisheries, the Councils, and the interstate fisheries commissions to collaborate and build partnerships that extend beyond the fisheries sector, while fully utilizing existing habitat authorities and refining their guidance and implementation. In particular, the EFH designation serves a useful purpose but at present is so broadly defined and compartmentalized by species and life history stage that meaningful habitat conservation has been difficult to apply and evaluate. Habitat conservation in support of healthy fisheries will benefit from bringing an ecosystem perspective to the meaning of "essential," establishing clear objectives tied to the fishery as well as ecosystem productivity and resilience, developing metrics for impacts and success, and evaluating tradeoffs relative to achievement of optimum yield.

Potential Legislative Changes: Should There be a National Standard for Habitat?

The primary legislative change considered in this session was a National Standard for habitat: "Minimize adverse impacts on essential fish habitat to the extent practicable." While participants recognized that healthy habitats are fundamental to sustainable fisheries and fulfilling the mandates of the Magnuson-Stevens Act, participants and speakers held divergent perspectives on whether a National Standard is the ideal course for achieving habitat conservation goals.

A National Standard for habitat would explicitly elevate habitat conservation to the level of consideration afforded to the fundamental management goals recognized by the existing ten standards, and help support fishery management plan objectives including rebuilding programs. A National Standard for habitat could also empower NOAA Fisheries with greater authority to influence and monitor non-fishing activities that may adversely affect EFH, and shift the burden of proof to permitting agencies to demonstrate no adverse impact. Additional reasons for considering a National Standard could include elevating the importance of EFH, supporting Councils in refining habitat objectives, refining habitat research and monitoring, and establishing the value of habitat with regard to ecosystem-based management and coastal and marine spatial planning initiatives. Potential downsides could include the investment of time, information, and personnel needed to comply with an additional standard. The habitat conservation benefits of a National Standard for habitat would also depend on the wording and interpretation of terms such as "minimize" and "to the extent practicable."

Some participants were supportive of a National Standard for habitat conservation, while others expressed concern that this would increase the potential for litigation and slow the FMP amendment process. Further discussion focused on alternatives to legislative changes, which could include strengthening, refining, and fully utilizing existing habitat authorities. Specific ideas related to EFH authorities included evaluating whether the EFH guidelines are up-to-date and being fully implemented, assessing whether the conservation recommendations resulting from EFH consultations are effective and properly implemented, and strengthening the Council role in EFH consultations. More generally, the group recommended integrating habitat into other aspects of management, and taking a more strategic approach to designating and making decisions regarding "essential" fish habitat. These ideas are discussed in greater detail below.

Policy, Guidance, and Best Practices for Habitat Conservation: Think Comprehensively to Act Strategically

In the course of discussion, the group identified two broadly important values related to habitat conservation. First, while healthy fish habitats are essential to healthy fisheries and those who depend on them, habitats for all species are part of a broader marine ecosystem that is impacted by activities other than fishing. Effective habitat conservation, and the concept of "essential" habitat, must recognize that species are linked to one another within this broader ecosystem, and address non-fishing activities that impact fishery and ecosystem productivity and resilience. Second, given limited resources, habitat research and actions should be strategically aligned with the Councils' legal mandates and decision-making needs. Effective habitat conservation should support clear objectives and measurable benefits to fisheries, while taking into account the tradeoffs and range of considerations associated with achieving optimum yield.

Consider an Ecosystem Perspective on "Essential"

EFH is broadly defined, yet compartmentalized by species and life history stage. The meaning of "essential" could be re-envisioned to better recognize linkages between and among life history stages and species. A more efficient and comprehensive approach to protecting "essential" habitat could focus on maintaining and restoring productivity at the ecosystem level. Ecosystem-level habitat conservation is critical for building resilience to impacts from non-fishing activities and the effects of a changing climate. There is still a need and purpose for species-specific habitat protection measures, which can be complementary to an ecosystem-oriented habitat conservation approach.

Strengthen the Essential Fish Habitat Designation

The group suggested strengthening the scientific basis for EFH designations, to help refine EFH as a tool for focusing habitat conservation, and to maintain the coordinating function and "seat at the table" that EFH provides for the fishery sector to interact with other Federal agencies. First, it was strongly recommended that we improve our understanding of the relationship between habitat and productivity. This information would support informed decision-making at the Council level, including actions to minimize adverse impacts from fishing. Outside the fisheries realm, information about habitat-dependent productivity could lend weight to EFH consultations, and, by extension, to the fishery sector, by clearly demonstrating the value of habitat to a managed fishery. A related suggestion would be to set measurable goals and a timeline for improving the scientific basis for designating EFH; for example, moving EFH designations to a higher level of detail for a certain number of species within a set period of time.

Finally, it will be important to continue exploring and providing guidance on how EFH should be interpreted and applied, and to fully consider the implications (positive or negative) of a National Standard for habitat. Specific suggestions including resolving the status of artificial substrate as EFH, and considering the guidance that relates forage to EFH.

Set Clear Objectives and Establish Metrics

Many ideas and recommendations focused on supporting a strategic, outcome-oriented approach to habitat conservation. A starting point would be to identify priority stocks and the threats they face, and set clear objectives for habitat conservation, protection, and restoration. These objectives might communicate the rationale for why a stock or habitat is considered a priority, as well as clarify the desired endpoint or state and how it compares to past or current conditions. On a related note, a different term could be used to distinguish stock depletion due to habitat-related factors from stock depletion due to overfishing. Finally, clear objectives would help focus and lend weight to the recommendations resulting from EFH consultations.

Objectives must be paired with metrics in order to characterize impacts and track progress toward a desired outcome. Long-term, standardized habitat monitoring would provide valuable information for characterizing long-term trends, cumulative impacts, and the benefits of habitat conservation, as well as enable rapid identification of and response to short-term threats such as oil spills. Likewise, habitat-related closures could be evaluated to determine whether they are meeting their objectives.

This discussion raised an important underlying question about information needs and the burden of proof. Must habitat protection be justified and linked to measurable benefits, or should habitat protection also serve a precautionary purpose? Measuring the benefits of habitat conservation to fisheries and ecosystems, and definitively linking these benefits to specific habitat protection actions, is a challenging prospect given that complex marine ecosystems are impacted by many other activities amid a changing environment. Some participants felt that it is important to be able to proactively utilize precautionary tools and approaches, such as "freezing the footprint" of existing habitat impacts. Other precautionary approaches could include augmenting habitat protection for important or vulnerable areas and/or events, such as spawning aggregations, as an additional precaution for data-poor and/or depleted stocks.

Make Clear and Transparent Tradeoffs and Decisions

Healthy habitats are critical to healthy fisheries that yield benefits to stakeholders and to the nation, yet some level of impact from fishing is often necessary to obtain these benefits. The mandate to "minimize to the extent practicable adverse impacts…caused by fishing" is challenging because this language references the range of considerations, including social and economic impacts, associated with National Standard 1 and optimum yield. Additional guidance on the interpretation of this language could support Councils in articulating an acceptable level of impact, and considering options for minimizing adverse impacts. Related to the discussion of objectives above, metrics for impacts could help characterize cumulative impacts, as well as inform options for minimizing adverse impacts. Furthermore, Councils could adopt a risk management approach to minimizing adverse impacts that more explicitly considers risks, consequences, and outcomes to avoid relative to an acceptable level of impact.

Building Effective Habitat Networks and Partnerships

In order to sustain productive fisheries and ecosystems through habitat conservation, it is necessary to support engagement with agencies and entities beyond the Federal fisheries sector. Participants and speakers spoke to the importance of collaboration at the Federal level, among Federal agencies, specifically noting the Bureau of Ocean Energy Management, Environmental Protection Agency, and U.S. Army Corps of Engineers. Speakers and participants spoke to the value of improving coordination between statutory authorities including those that pertain to inland and coastal activities impacting marine fish habitat, such as the Clean Water Act, Farm Bill, and Atlantic Coastal Fisheries Cooperative Management Act. Also important is ensuring complementary habitat conservation efforts at the state and interstate level. Finally, the interests of stakeholders within the fishery sector, including industry and communities, may translate to other issues, such as energy exploration and siting of activities.

As stated, there were divergent perspectives on whether empowering NOAA Fisheries with greater regulatory authority is the most effective way to support coordination at the Federal level. It will also be valuable for NOAA Fisheries to identify shared values and synergies, build new partnerships, and find new ways to engage with other agencies and ocean users. Strengthening the scientific basis for designating EFH, and setting clear objectives and metrics, could also support increased engagement with other ocean users and agencies. Better defining and valuing the role of habitat relative to the benefits derived from fisheries could also support the fishery sector in an ecosystem-based management and coastal and marine spatial planning context.

In addition to looking outward, NOAA Fisheries and the Councils can take action to engage and build support for habitat conservation within the fishery sector, including commercial and non-commercial sectors and stakeholders, communities, and tribal nations. The group emphasized that many of the ideas discussed above–particularly setting clear objectives, linking habitat protection to measurable outcomes, and evaluating the effectiveness of habitat-related closures—are important for building stakeholder support and reinforcing a perception of strategic, objective-oriented habitat decisions. Participants also proposed periodically revisiting assumptions about gear impacts, providing for tools other than spatial closures for addressing adverse impacts from fishing, such as gear modification and innovation, and engaging in cooperative habitat research.

TWO FRIENDS LUG A COOLER FULL OF FISH. PHOTO: GJ CHARLET III, FLICKR CREATIVE COMMONS.

INTRODUCTION

Session 3
Providing for Fishing Community Stability

TOPIC 1 RECREATIONAL AND SUBSISTENCE FISHERY CONNECTIONS

TOPIC 2 INTEGRATING COMMUNITY PROTECTION, JOBS EMPHASIS, AND SEAFOOD QUALITY ASSURANCE

TOPIC 3 ASSESSMENT AND INTEGRATION OF SOCIAL AND ECONOMIC TRADEOFFS

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The Magnuson-Stevens Fishery Conservation and Management Act (MSA) sets out multiple responsibilities for the National Oceanic and Atmospheric Administration (NOAA) and the Regional Fishery Management Councils. Through legislative authority and national standards, NOAA and the Councils are obligated to conserve the country's living marine resources and simultaneously provide for communities' sustained participation in fisheries. These responsibilities are often cast as in conflict (jobs vs. rebuilding stocks), each an impediment to the other. This conflict, real or perceived, stands as a challenge to effectively managing fisheries in general, and specifically in providing for fishing community sustainability. Placing greater emphasis on community sustainability in our national fisheries policy will require a combination of legislative, policy, and regulatory change. The three topics chosen for this session illuminate the challenges of managers working to advance community stability while balancing the diverse goals and objectives of different communities. A fishing community is defined in law as "a community which is substantially dependent or substantially engaged in the harvest or processing of fishery resources to meet social and economic needs, and includes fishing vessel owners, operators, and crew and United States fish processors that are based in such community." We commonly see application of the term "community" modified based on type of fishery, such as commercial, recreational, or subsistence fishery. Not only are there multiple types of fishing communities, but many individuals may be members of more than one fishing community.

The strong focus of managers on commercial fisheries remains an important social and economic priority for the nation, as it has been since the inception of the country. However, recreational fisheries are also a high priority of contemporary society, with historic cultural and increasingly substantial economic benefits to the nation. Obligations to indigenous cultures and customary subsistence fisheries add to this multiple-objective challenge to policymakers. The factors that motivate and satisfy the objectives of recreational and subsistence fishing sectors are different, and their social and economic drivers and measures of successful policy outcomes differ. The first focus topic in this session looks at recreational and subsistence fishery connections and how they can optimally be managed in the future to enhance fishing community sustainability, including identifying any necessary legal, policy, and

process changes necessary to reconcile competing goals and objectives between all fishery sectors.

The second focus topic drills deeper beyond the policy level. It highlights specific tools, methods, and means to protect the integrity of fishing communities in general, emphasize fishery-related jobs, and assure domestic seafood quality in the face of future transitions in fishery management, ecosystem, and economic conditions. The session will focus on opportunities to adopt "community-friendly" tools and the legislative, policy, and regulatory changes necessary to apply them in the future.

The final focus topic zeroes in on measuring our fishery management performance, and the degree of community sustainability success, in the context of how such measurements can be better integrated into decision-making on the relevant tradeoff choices. There are different perspectives for monitoring and evaluating the attainment of the greatest overall benefit to the nation, and specifically fishing community sustainability. This session will identify findings related to how Councils and NOAA can better evaluate the social and economic outcomes of policy choices.

Session 3 Topic 1

Recreational and Subsistence Fishery Connections

In the last few decades, great progress has been made in meeting ambitious goals for conservation and sustainability of fish stocks. While there is still much to be done, the U.S. leads the world in eliminating overfishing and rebuilding overfished stocks. Although all fishing sectors benefit from sustainable stocks, fishery management has affected commercial, recreational, and subsistence fisheries differently. Some believe that shifts in management resulting from a focus on the status of fish stocks have not fully considered the viability of recreational and subsistence fishing. This topic looks at requirements for fishing community sustainability from recreational and subsistence fishery perspectives, and evaluates impediments to, and opportunities for, collaboration to advance community sustainability across all fishery sectors and groups.

As noted in the session description above, recreational and subsistence fishing sectors are motivated by different goals, and their social and economic drivers and measures of successful policy outcomes differ. One objective of this topic is to look at these differences and identify legal, policy, and process reforms that may be necessary for reconciling competing goals and objectives.

The session will be informed by the results of the April 2010 NOAA Recreational Saltwater Fishing Summit (NOAA 2010a). Participants highlighted a range of issues, including better catch, effort, and economic data, improved and more regular communication regionally and nationally, and more consistent inclusion of recreational interests in management processes. Participants also asked to focus on management approaches that recognize the distinct needs of recreational anglers for improved access, more time on the water, and quality fishing experiences. The resulting National Action Agenda for Recreational Fishing (NOAA 2010b) laid out a strategy to address priority concerns of the recreational fishing community. In addition to reflecting on the Summit references and progress made to date, the current session will access results from a 2012-2013 NOAA nationwide survey of anglers to provide insight on angler perceptions of management, management preferences, and expectations for the future.

Discussions during this topic included perspectives on how recreational and subsistence fisheries could be managed to enhance fishing community sustainability, including both impediments and opportunities. Speakers and participants were challenged to identify findings for legal, policy, and process changes necessary for reconciling competing goals and objectives.

Trigger Questions

1. What are the key attributes of a successfully-managed recreational or subsistence fishery?
2. How will recreational and subsistence fishery sector requirements change over the next 10 years?

3. Where is there conflict and where is there convergence on the future of fisheries among recreational, subsistence, and commercial sectors?
4. What changes in legislation, policy, or regulations are necessary to satisfy the essential elements of a sustainable multiple-fishery fishing community?
5. What is the greatest impediment to increasing recreational and subsistence fishery sector satisfaction?

Session 3 Topic 2

Integrating Community Protection, Jobs Emphasis, and Domestic Seafood Quality Assurances

Management innovations in controlling or rebuilding fish stocks, such as annual catch limits, require balancing innovations to address the social and economic needs of fishing communities. Annual catch limits and rebuilding programs designed for fish population sustainability often require short- and long-term adjustments to fishing capacity in both commercial and recreational fisheries. However, fishing controls to improve biological outcomes may conflict with employment and distribution of income goals for the fishery.

Some biologically-derived management policies limiting catch or effort do not adequately account for unintended social and economic consequences; this may also be true for other policies designed specifically for social or economic efficiency, such as catch share programs. Undesirable community or employment outcomes in commercial fisheries could include unchecked consolidation, disproportionately negative impacts on small-scale and geographically-limited fisheries, and impediments to future entry into the fishery. In recreational fisheries, examples might include closures of small support or ancillary businesses such as charter fishing operations, fishing tackle stores, restaurants, or hotels. In some areas, fishery management can be argued to have resulted in significant changes in permit values and other access costs for existing fishermen and new entrants, shifted fishing participation away from local fishermen and communities, resulted in declines in the small-boat owner-operated fishing fleet, and exacerbated the loss of working waterfront infrastructure and "shirt-tail" businesses.

The effects of fishery management policies must also be considered in the broader context of changing market forces (globalization, increased consumption of seafood in Asia), the full range of tools to produce seafood including aquaculture, and economic competition for coastal land (tourism, real estate development).

Thus, there is a need to protect fishing communities from adverse social and economic effects of fishery management decisions, with an emphasis on preserving jobs and ensuring seafood quality. Why jobs? Because an active labor pool helps a business' access to capital, whether it is used to finance a vessel, gear, fishing permit, or the purchase or lease of quota in a catch share program, and because the amount of jobs related to fishing is inextricably linked to the communities' overall wellbeing. Why seafood quality? Because quality seafood products help to ensure entry into the marketplace, and seafood quality is a primary determinant of ex-vessel price.

Discussion during this focus topic included whether and to what degree "community-friendly" tools and legislative, policy, and regulatory changes were necessary, as well as how to apply them. Examples included tools, methods, and means to protect the integrity and infrastructure of fishing communities, and to seek optimum yield in the face of future transitions in fishery management and changes in ecosystem and economic conditions. The discussion included potential responses to changing market forces; possible adoption of new management tools that could broaden the economic base of seafood communities, such as integrating aquaculture with fisheries; and exploring the appropriate roles and responsibilities of communities, government, and private sector third-parties in finding ways to support and improve fishing community sustainability.

Trigger Questions

1. Are there new ways for fishermen to organize their business and improve access to permits and quota to ensure benefits flow back to active fishermen and into communities reliant on the resource?

2. What changes in community capacity and innovation in financial capital, improved product quality, and value-added/value-chain seafood products will accelerate fishing community sustainability?
3. What innovative financial and business approaches, including fishing community organizations, can help create and protect sustainable local fisheries?
4. What fishery management tools are available and effective in maintaining fishery jobs, especially in small fishing communities?
5. How can the health of fishing-dependent communities be better preserved when developing fish stock rebuilding programs?
6. How can aquaculture serve as a "community friendly" tool to enhance the integrity of fishing communities and to secure employment and seafood supply objectives?

Session 3 Topic 3

Assessment and Integration of Social and Economic Tradeoffs

Measuring degrees of community sustainability in relation to fishery management performance requires the integration of social and economic metrics. Many of these data are currently unavailable, in some cases due to decisions made by Councils and National Marine Fisheries Service not to require submission of such information. The task is made more difficult because there are many different perspectives on what constitutes the greatest overall benefit to the nation and, more specifically, how fishing community sustainability is defined. However, there is no question about the need to improve the assessment and integration of social and economic tradeoffs in order to improve fishery management decision-making relative to community sustainability.

As the governmental stewards of the nation's living marine resources, the Councils and National Marine Fisheries Service are tasked with ensuring that long-term environmental benefits in terms of goods and services are not compromised by short-term management activities. However, the bulk of our scientific data and analysis is focused on the biology of fish, not the social and economic conditions of human populations; social and economic impacts are usually given secondary attention. Without sufficient social and economic data and a relevant analytical framework, it is extremely difficult to resolve the following commonplace public policy choices:

1. When should local culture and custom take priority over national interests?
2. How much should the nation invest to make fishing communities more resilient to environmental, economic, and policy threats?
3. Does the incremental economic benefit to the nation of a five-year extension in a 40-year rebuilding plan for a long-lived fish species outweigh the long-term benefits of a shorter rebuilding period?
4. Is advancing wild-caught seafood a higher priority than recreational fishing trips?
5. Is the value of U.S. jobs more important than inexpensive imported fish to consumers?
6. What is the value of passing on a fishing way of life to the next generation?
7. What are the trade-offs to coastal communities between aquaculture and capture fisheries?
8. Are the economic benefits of ecosystem-based fishery management being properly integrated into policy decision-making?

It is relevant to determine whether we have the right policies, tools, processes, and priorities in place to evaluate social and economic tradeoffs that can provide for greater assurances of sustainable fishing communities in the future. Given the competitiveness in the allocation of Federal budgets in at least the near future, considerations for higher-priority assignments to social and economic data integration need be discussed in the context of the many other ocean uses and values besides fisheries, and in the context of competing needs within the fishery management system. This session discussed the need for improvements, and focused on identifying findings to improve current approaches or legislation.

Trigger Questions

1. Do we have clear social and economic objectives in regional fishery management plans? What are the social and economic performance metrics of a sustainable fishery? What data and methods are necessary to measure such success?
2. What is the appropriate role of socioeconomic objectives in fisheries management?
3. How can/should socioeconomic objectives be identified and established?
4. Where socioeconomic objectives have not be identified or included, why haven't they? What are the concerns with reporting socioeconomic data?
5. How can socioeconomic objectives be better integrated into decision-making?
6. How should fishery management be conducted when it is impossible to maximize all sustainable and beneficial uses of the marine environment and there is no clear optimization plan?
7. Do we have the necessary and sufficient authority in the MSA to succeed?
8. Are there alternative means to pay for the future challenges of fisheries management, and do they require statutory, policy, or regulatory changes?

References

NOAA. 2010a. Recreational Saltwater Fishing Summit. http://tinyurl.com/b7fl2tm

NOAA. 2010b. Recreational Saltwater Fisheries Action Agenda. http://tinyurl.com/2fkcykv

TRIBAL DIPNETTING AT CELILO FALLS ON THE COLUMBIA RIVER BETWEEN OREGON AND WASHINGTON. CELILO FALLS WAS A FISHING, GATHERING AND TRADING HUB FOR THOUSANDS OF YEARS BEFORE IT WAS INUNDATED BY CONSTRUCTION OF THE DALLES DAM IN 1957. PHOTO: BONNEVILLE POWER ADMINISTRATION.

PAPERS

Session 3
Providing for Fishery Community Stability

Topic 1
Recreational and Subsistence Fishery Connections

Advancing Sustainable Subsistence Fishing Communities

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Introduction

Fishing communities, and specifically the subsistence and recreational fishers within these communities, will continue to face tremendous challenges over the coming years. Without change, competing interests will continue to reduce the size of these fishing groups, through obstacles such as severely reduced ocean access rights and mandates that do not account for community priorities or traditional values. Several steps can be taken to reincorporate community needs and to consider regional priorities within the management process, increasing the sustainability of fishing communities that have existed for millennia.

Background

Before comparing recreational and subsistence fisheries, we must first examine the meaning of the terms. A subsistence fishery is the fishery that mankind has known since the dawn of time and is practiced by artisans. The purpose of a subsistence fishery has been and will always be to provide for the basic human need: food. In communities, fishers were no different from other artisans: those that had excellent skill-sets provided food for the community and those who did not, moved on.

For the most part, the subsistence fishery has taken a real beating in today's economic and cultural standards for a couple of reasons. The first reason results from a misconception or a misunderstanding; subsistence fishers are too often lumped into the commercial category. "Commercial" is the designation used to describe any fisher who sells fish—even one fish in order to pay for vessel safety requirements—in a one-size-fits-all world. This general application of commercial does an injustice to subsistence fishers, especially since all commercial fishers are subject to an expensive array of safety rules and regulations that are unaffordable to subsistence fishers.

Similarly, by going fishing, the intent of the subsistence fisher is not to profit, but rather to perpetuate a community tradition while maintaining a standard of living comparable to others in the community. Traditions do evolve, but they do not become any less meaningful in the process. Would the celebrating of Thanksgiving be any less traditional today since turkeys and ham are purchased at supermarkets, as opposed to eating fresh game?

When man first provided marine life to the community, it was for personal consumption. From there, a bartering or exchange society slowly evolved. Fish were traded for clothing, starches, and other such basic necessities. Today, bartering is a practice long gone and, as with all other artisanal expertise, it has transitioned to a cash-based exchange. Still, the intent of subsistence fishers has not changed. The change is just with how modern, basic needs are met. Subsistence means "the minimum necessary to support life," at least according to dear old Mr. Webster. By today's standards, unless you are Amish, that means: running water, electricity, cable TV, cellular phones, bank loans, taxes, medical services, and so forth. A person cannot logically say that because one fish is sold, it is a commercial endeavor. Does changing the oil in the family's car mean that you are operating a service station?

For tens of thousands of years it was the basic need for marine food that established this group of artisans. Not everyone was or is capable of becoming a hunter, fisher, carpenter, doctor, lawyer, or even the President of the United States (while the latter may be debatable). Even within the fisher group, fishermen differ in their capabilities, as they utilize various types of fishing and gear.

Recreational fishers have a different intent and are not defined by their skill-sets in the same way that a subsistence fisher would be. As a designation, "recreational fishery" is rather general and can be applied to a vast majority of fishers who seek pleasure through the act of fishing for a multitude of reasons. Recreation is basically a refreshment of strength and spirit after a toil; there is a grand difference between it and subsistence. For most recreational participants, the age-old experience is just to catch a fish for bragging rights, to have stories and experiences to talk about, to display a trophy catch, to have fun, or just because the opportunity presents itself. Ultimately, all of the reasons include a sense of accomplishment and all provide some form of pleasure.

While the recreational fishery has evolved and travelled a separate path from subsistence fishing, for the most part, the two are still similar. Except for the likes of Jimmy Houston, a large number of recreational fishers eat their catch and charter boats eat or sell what is caught. The charter vessel and its captain affords the angler with a once-in-a-lifetime opportunity. Private boat owners are also part of this universe of pleasure seekers or adventurers. Some refer to them as weekend warriors, fishing when disposable time is available, though hardly out of any necessity. Yet, at the end of the day, both user groups stem from the same community and both are consumers of marine life. Is there a difference between the two worlds? Yes. But, are they alike? Yes.

Fishery Management Requirements

A successfully managed subsistence or recreational fishery would incorporate the following methods

- True stakeholder involvement: Some may be puzzled by the term "true stakeholder involvement." The true stakeholder is the fisherman. To use a coined phrase, they are "the first stewards," but too often true stakeholder involvement is not what occurs: everyone else is also included. The subsistence fisher, with calloused hands and a weatherbeaten face, is destined to face the elements without care just to meet his family's and the community's needs. As another true stakeholder, we have the recreational fisher clothed in the latest fashion in search of the fish to mount over the mantle. Both have interest in the health of the marine ecosystem. The fishery management councils are a great example of true stakeholder involvement. However, like any process affecting fisheries, the voices of the stewards of the sea are like the whispers at a rock concert, mouths moving but they cannot be heard.
- Cooperative scientific research: This type of scientific approach should be the method used in fishery management. Fishermen should be consulted during the analysis of fishery data. Fishermen should also be consulted on the use of visual analysis tools, such as underwater cameras or other scientific technology to weigh in on their efficacy. Fishermen may suggest a research project for the scientist to consider, but may receive a response like, "Sorry, no funds are available, but guess what? What we do have is the "best available science," so your annual catch limit is cut by fifty percent."
- A holistic or ecosystem-based approach to fishery management: In determining annual catch limits or harvest levels, the parameters by which a fishery is analyzed are one dimensional, based on historical catch. Weather, moon phases, water conditions, salinity, acidification, the age of fishermen, vessel operations, and most especially, human factors should all be included in the analysis.

The Future of the Fisheries

In the coming years, both recreational and subsistence fisheries will continue to decline due to industrialization, the use of mandates to pursue agendas, competing uses of the marine environment, and the changing demographics of fishers.

Over time, communities, including subsistence-based communities, will increase their purchasing power and purchase from supermarkets as the industrialized harvesting provides inexpensive marine products, such as pre-packaged meals, canned tuna, frozen gassed tuna loins, or even artificial crab meat, with Maine lobster probably the next product of chemistry. But, after all is said and done, it will be the ever-rising cost to operate a subsistence or recreational vessel that will largely ensure the demise of the fisheries.

In terms of attempts to preserve traditions, the cultural value of marine resources will be overwhelmed by agenda-driven conservation concerns. The assault on small fisheries is not coming from a single front, but through the use of various mandates. The Endangered Species Act (ESA), the Marine Mammal Protection Act (MMPA), Sanctuaries, and marine protected areas all have been used where fishery science has prevailed. This was demonstrated when the Hawaii-based longline fishery was shut down due to concerns over the extinction of seabirds and sea turtles. This was reasoning enough to shut down the fishery. In the end, a Biological Opinion allowed for incidental takes of the two species and the fishery re-opened. Then, lo and behold, whales were added to the list of concerns and, for the nearshore troll fishery, dolphins were added. Will it ever end? No. And, will these mandates make an impact on a global scale? No. The transferred effect lives on.

Other uses of the marine environment will be prioritized above fishing and perhaps even habitat concerns. Fishing ports will become development areas for condos. Coastal marine spatial planning will set priority use areas. Military training areas, shipping lanes, habitat areas of particular concern, high recreational use areas (paddle clubs, jet skis, windsurfers, etc.), marine protected areas or Sanctuaries, and so forth, will all be part of the mapping scheme.

In addition to all of these challenges, for subsistence fishing, the ultimate factor may be the continued decline in the number of fishermen. The average age for a fisherman in Guam is 50 years. What is it for the nation? Probably the same; age, coupled with the ever increasing cost, and subsistence fishing will have a featured section in the Smithsonian.

Recommendations

To perpetuate the fisheries and to satisfy the essential elements of a sustainable, multi-sector fishing community will require changes to legislative mandates, the establishment of clear and concise policies, and a change in priorities used during the development of new regulations. Several steps can be taken to help ensure the survivability of America's fisheries.

Legislatively, mandates need to be reviewed and the process for creating new legislation needs to be revised to include regional considerations. Reviews of the ESA and MMPA are needed, which includes evaluating the legislations' impacts on communities, especially fisheries. Reviews are also needed on the use of the Sanctuaries Act and Antiquities Act, which have been used to advance an ideology without the approval of the people affected. Finally, all future legislation should incorporate the Regional Fishery Management Councils as partners when addressing concerns affecting the marine environment. The Coral Reef Conservation Act is an example of a time when Councils were excluded from the legislation development process, despite fisheries having been a focal point of the greater part of that exercise.

Similarly, clear and concise policies are needed. A review of previous and future actions taken by agencies is needed to ensure that agencies' actions adhere to the Administration's policy directives. One example of this is the National Oceanic and Atmospheric Administration's (NOAA's) effort to establish regimes which would adversely affect U.S. fisheries, while the President continues to emphasize the need to keep Americans employed and the economy growing. Does this not apply to fishers? When creating new policies, the process should be community-driven, not agenda-driven. More effort on rebuilding America is necessary, one community at a time.

To ensure the sustainability of a multiple sector fishing community, the process for developing regulations should also be revised. Regulations should be promulgated to minimize wanton waste of marine resources. Regulatory discards have no logical place in fishery management, especially when the catch is already dead and can be consumed. As with policies, regulations should be community-driven. They should be based on the community's input and their preferred management regimes.

Recreational and Subsistence Satisfaction

There are a multitude of impediments to increasing the satisfaction of the recreational and subsistence sectors, but the greatest impediment is the ever-shrinking access to marine areas. The reduction in access rights includes an array of impediments. One such issue has been the lack of expansion of marinas and boat ramps, coupled with a rampant loss of existing amenities. As with commercial fisheries, shore-side amenities available to recreational fishers are slowly being swallowed up by all sorts of development interests. One of the only funding sources for marinas or boat ramps is the U.S. Fish and Wildlife Service's Sport Fish Restoration and Boating Trust Fund. There is a need for Federal funding to address the needs of this community on a national basis. With the exception of high-end marinas, where the users are financially able to pay moorage fees, the majority of boaters are subject to purchasing gas guzzling 4x4s and boats on trailers.

Traditional ocean access areas are now highly valued property areas, where access is no longer allowed and large no trespassing signs are posted. The once free roaming fishing areas lining the coast are now part of the Coastal Marine Spatial Planning exercise, with the fishing user group receiving little acknowledgement. Designated navigational areas, areas containing habitat areas of particular concern or critical habitats (regularly situated outside of a high end beach front housing area), marine protected areas, Sanctuaries, marine mammal avoidance areas, military exercise areas, Homeland Security Zones, and so forth, will all receive increased consideration. Another impediment to user satisfaction results from overcrowding in the marinas by other expanding user groups, such as sailboats, yachts, live-aboards, and recreational vessels, as well as fishing vessels of all means. Coastal fishing areas have been inundated by large numbers of Jet Skis, paddle boats, windsurfers, swimmers, beachgoers, and many others. There was a time when the only vessel one would see on the water would be a fishing boat, a cargo ship, or maybe a passenger liner. That is certainly not the case today.

At a more general level to the impediments stemming from issues with access rights, the rules of engagement for all of the impacted user groups are complicated and cumbersome, which reduces fishers' satisfaction. If one were to compile all of the fishing and marine regulations into one book, it could probably only be viewed at the Library of Congress.

Conclusion

In closing, there is room to perpetuate the traditions, both old and new, that once made America great. It just requires the political will to return this country back to the people and its resources back to the community through the establishment of community and culturally managed areas for the benefit of such.

Advancing Sustainable Recreational Fishing Communities Through Improved Communication and Collaboration

Ken Franke
Sportfishing Association of California

Navigating through life has its triumphs and pitfalls. We seek one and avoid the other. Every once in a while we hear something that strikes an unforgettable chord, something that sets the stage for the sought-after triumphs. It happened to me about fifteen years ago when I was listening to a presentation by Jack Hawkins, a well-known pastor in California. He had a gift of reaching into your thoughts and triggering the creation of what he referred to as *guardrails:* simple rules to apply in life, to protect you and those around you from pain and conflict. My wife Karen and I often look at each when we hear something bad happening and say "they needed some *guardrails.*"

A key element, according to Pastor Hawkins, was to avoid putting one's self in a position of preventable risk and to "seek to understand." He closed the equation with the following comment: "*Rules without relationships lead to rebellion*." Since hearing that speech I have found truth, leadership and courage buried within their meaning. The implications can be applied to relationships with our children, friends, coworkers, and those we do business with. I have personally experienced a history where these words have had meaning in how I perceive the future path of managing our nation's oceans.

With the implementation of the Magnuson-Stevens Act thirty-seven years ago, U.S. fisheries changed. We began the long process of developing *guardrails*. Boundaries were set, species were measured, gear was identified, allocation was quantified, science was advanced—and so it started. Much of this effort was focused toward managing fisheries from a commercial fishing perspective. In the absence of foreign vessels, they now controlled the playing field.

A lot has changed during the past four decades. Technology, markets, access, and the impacted parties have transitioned. There is more accountability and structure coming out of the regional Council processes, and the Councils' associated recommendations. However, input to the Council process is a direct product of data and input by those with the knowledge and understanding of how the system works. In the absence of participation, a party with no representation and/or understanding of the process can be left out in the cold. I often wonder in how many cases anglers don't even know there is a Council process affecting their future? How many parties with an interest in our nation's ocean resource have a true comprehension of how it is managed, especially in the case of the recreational angler? How do we get them to the table?

With few exceptions, recreational fishing has long been on the periphery of the management process. Scientists, the commercial fishing industry, environmental organizations, and regulatory agencies on the other hand have typically been better informed as to the management processes. The average recreational angler simply wants to enjoy the family fishing experience while enjoying the ocean's beauty. Furthest from their mind is to be engaged in rule making, heated discussion over access, or any of the many points of potential conflict. Absent organized fishing clubs or industry associations, the recreational community usually does not engage or communicate with the management process.

Ironically this relatively peripheral group does have a significant economic impact on the national economy. In a 2011 National Marine Fisheries Service Economic Impact Report[1], recreational saltwater anglers reportedly made 71 million fishing trips, 60 percent of the 357 million marine recreational fish caught were released, and $19.5 billion was spent by anglers, representing $73 billion in total economic impact and supporting over 327,000 U.S. jobs.

On average, 12 million recreational anglers[2] fish annually in the United States. The recreational fishing community has an important stake in the future. With this impact on the resource and economy it is important to ensure that recreational fishing community is fully engaged, as all impacted parties should be, as we proceed into the re-authorization of the Magnuson-Stevens Act.

A Matter of Perspective

When you are seated in a stadium watching a ball game, your perspective varies with your location in the stands. In this instance our stadium is the nation's oceans, and the ball game is managing our living marine resources. Our perspectives will all be different, supplemented by varying levels of education, geography, and experiences. Depending on where you sit, you could make the right or wrong call. Behind the catcher you may see balls and strikes better. Sitting in the bleachers down the right field line you may make the right call about a foul or fair ball. The point is that each one of the seats is important to the ultimate outcome of the game. All seats (bleacher and box-seats) and all views are important (whether commercial, recreational, environmental or scientific) in getting the right answer.

All would agree the future effectiveness of our oceans policies will depend on incorporating balanced and reasonable input into our policy design. The way we conduct fisheries in the future will be based in part on lessons learned from the past.

From my perspective on the southwest coast of California, I would like to share a lesson that involves both travesty and triumph. It applies to our future rulemaking efforts and is focused on process.

Case Study: Bocaccio

Fifteen to twenty years ago, recreational fishermen in the southwest had little interaction with NOAA or policy issues. It was a relatively open ocean and they fished with a sense of freedom. I doubt if many of them knew what the Council was or did. I admit I was one of the many. I suspect most of the local commercial fishermen were right there with us in our world of blissful ignorance.

Lightning struck, and we were suddenly thrust into the world of closures, limits, and access restrictions. Bottom-fishing restrictions put boats and landings out of business. One fish in particular that caused extreme pain to the recreational and commercial fishing fleets was the bocaccio rockfish, which is managed under the Pacific Fishery Management Council's groundfish fishery management plan.

From the scientists' perspective, bocaccio were in serious trouble. Their stock assessment and other data points said so. From the managers' perspective, since the scientists said the health of this species was in decline, area closures had to be put into place immediately to protect this fish. As a result, almost every fisherman lost their winter schedules of fishing. There was little time to react.

From the fishermen's perspective, bocaccio were everywhere. One indicator, the fleet's catch records, did show a reduction in the number of bocaccio being caught. From the fishermen's experience, however, they knew bocaccio had worms when caught in shallow water, and the customers did not want them. By using sidescan sonar technology and experience, fishermen were good at avoiding them intentionally, explaining the reduced catches. The fishermen were not organized enough to convey this information, and frankly few understood how the regulations happened

1 http://stateofthecoast.noaa.gov/rec_fishing/welcome.html
2 http://stateofthecoast.noaa.gov/rec_fishing/saltwater_anglers.html

or what process shut down operations. They were simply "closed for business." The fishermen were angry, especially because there was almost no warning.

Out of this mess, several leaders moved into the show. A meeting of the minds was scheduled at the request of our past Sportfishing Association President, Bob Fletcher. Captains from the fleet, scientists from the California Department of Fish and Wildlife (CDFW), and scientists from NOAA sat down to put on the table their views of what was occurring in the ocean. Each had a different seat in the stadium. The science side explained the process and the belief the resource was in trouble. The fishermen came armed with video of anglers catching large bocaccio and sidescan displays depicting massive schools under their boats. Objectively, the scientists recognized the fishermen did have some good information they had not tapped into. Somewhere in this process there was a serious disconnect. Anecdotal as they were, it was tough to discount the observations of the fishermen, seen on a daily basis.

From that first meeting the problem was clear: the science community and fishing community in this instance had *no working relationship*. Until then they had not been talking, and each was doing their own thing when their paths collided. The discussion at that meeting was difficult at first, but was constructive. The end result was the fishermen would participate in a hook and line survey and that a boat would be outfitted to support a NOAA remotely operated vehicle (ROV) and sonar array.[3] The fishermen were going to get a chance to show the scientists what they were seeing on the ocean.

I give credit to those first CDFW and NOAA scientists who worked with our fishermen. They went to sea and spent months on the water each year looking at the ballpark from our seats. Eventually the fleet presented awards to Dr. John Butler (ROV Leader) and Dr. David Demer (Acoustic Leader) for their exemplary work with the fleet.

Thousands of miles of ocean were mapped, and hundreds of transects with the ROV were conducted. The information flowed in two directions. The fishermen learned what the scientists' concerns were and about the management process, and the scientists received generations worth of fishing knowledge. Fishermen from throughout the fleet provided extensive habitat data to NOAA acoustic scientists to speed up the learning process for multi-beam and acoustic data collection. After all was said and done, it was determined the bocaccio "crisis" was not as bad as initially thought, and access was restored after a few years. They continue to be avoided.

Out of this difficult time a relationship grew between the fishermen and scientists in the Southwest Region. Everyone has recognized the importance of collaborating, learning from each other, respecting views, and sharing a common goal. At this point, trust has been built between the fishermen in our region and the NOAA/CDFW scientists. It was exemplified when a new acoustic/ROV survey method began the peer review process stemming from work on the fishermen's boats. A visiting scientist made a comment to a group that fishermen would be mistrustful of the new acoustic/ROV methods. They would consider it "voodoo" and not support rules stemming from it. A fisherman stood up and said, "With all due respect, sir, we worked with the scientists for many years at sea to develop this process. They have our trust." A conclusion can be drawn from that comment that "rules with relationships lead to solutions." I would be remiss in not mentioning that the product of this relationship may be a new standard in how to survey bottomfish in high relief areas so no harm to habitat or fish is caused by the acoustic/optical process.

The moral of the story is we need some good g*uardrails* as we manage our nation's oceans. This example put at risk millions of dollars of economic impact and thousands of people's livelihoods. Had the relationship been in place earlier, the science community may have had more information, their *guardrail*, to work with when providing the Council their advice on the stock's condition.

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3 http://tinyurl.com/l63mvyx

Engagement

It is vitally important for all constituency groups to be represented at the table and engaged in the process of developing appropriate and reasonable rulemaking. For this to be effective the leadership of NOAA needs to continue its efforts to seek out all impacted parties in their efforts to develop policy. This will take extraordinary work. Identification of impacted parties should be Step 1 as we move forward, followed by establishing large and varied communications with those parties. This includes social media and developing critical communications infrastructure. Putting a website online as a standalone accomplishment is not acceptable.

From a recreational fishing industry perspective, we have struggled to get our stakeholders involved in management. Awareness has grown over the past ten years as to the need for active participation, but it is a work in progress. The recreational fishing public needs to make connection a high priority. For the survival of our marine recreation industry, our future requires that we establish solid and frequent dialogue with NOAA and the Councils. We, the community, need to help identify our fellow impacted recreational fishermen. Successful policy making needs these critical relationships, and the public needs to be connected to the process. The challenge is how to get that connection established with the angler on the beach or at the end of the pier.

NOAA has been making good strides to connect with recreational anglers. They conducted a Recreational Fishing Summit[4] to help mobilize the recreational constituency's interaction with the agency, appointed a National Recreational Policy Advisor, initiated Regional Coordinator Positions, appointed a Recreational Fishing Working Group to support the Marine Fisheries Advisory Committee[5] (MAFAC), and are scheduling regional workshops. Also, MAFAC just completed a detailed visioning document (Vision 2020)[6] to help NOAA see through the eyes of affected parties. This group of volunteers meets biannually to provide advice to the Secretary of Commerce and NOAA on behalf of representatives of the environmental, recreational fishing, commercial fishing, aquaculture, and conservation communities.

The responsibility to help build relationships is not only NOAA's, but also belongs to resource user groups themselves. It is important that all stakeholders plug into the communications pipeline so that there is informed consensus as policy making proceeds. This may even involve cross-pollinating interests, with opposing interest groups working in concert.

Case Study: Barotrauma

The evolving development of barotrauma solutions is a good example of such cross-pollination. In this instance the collaboration is comprised of NOAA, CDFW, fishermen, and several environmental groups. The project goal is to study and implement the use of descending devices to counter barotrauma[7] mortality. Because of the relationships that now exist, scientists and fishermen are expediting the placement of acoustic receivers to track the movements of fish released with descending devices. The scientists and fishermen have tagged and released rockfish using the devices (provided by World Wildlife Fund, or WWF) and are studying their long-term effectiveness using the receivers.

The fishermen in turn are working with WWF and the San Diego Oceans Foundation to educate and encourage the public in the use of such devices. The early results have been so astounding that every commercial passenger sportfishing vessel in California is now voluntarily using the devices to save fish. Fishermen have also asked CDFW to place a checkbox on their logbook form to demonstrate they are voluntarily using the devices, and CDFW has agreed. We now have a self-imposed *guardrail* where anglers are releasing fish in healthy condition at depth. This will

4 http://tinyurl.com/b7fl2tm
5 http://tinyurl.com/lod5ye6
6 http://tinyurl.com/bla3ab
7 http://swfsc.noaa.gov/barotrauma/

positively affect rulemaking on ocean access in the near future. It is another step toward ensuring the sustainability of our fishing community.

Conclusion

For the sake of our nation's oceans I hope that the scientists, fishermen, and other affected parties continue to seek each other out and to seek opportunities where a shared goal can be targeted. From a process standpoint, all future policy development should articulate a requirement for such collaboration. As a starting point the foundation of such articulation could be policy embedded in the reauthorization of the Magnuson-Stevens Act. The intent would be to make such a process a new way of doing day-to-day business in our efforts to manage our ocean resources.

Back to that statement, "rules without relationship leads to rebellion." Seeking out all impacted parties at Step 1 saves us from the "rebellion." The question needs to be posed, "How much litigation could be prevented with good relationship building?" Speaking *with* constituents before action is taken and not *at* them after it is taken can save millions of dollars in wasted litigation expenses. This is where good leadership comes in. No shortcuts. Establish good *guardrails*. Do the due diligence right out of the gate. Involve everyone. *Seek to understand and really listen*. It will protect government agencies and the affected parties from pain and conflict. Build the relationship and make sure the staff of your organization is doing the same thing. Build a robust ocean for our children to enjoy!

It all starts with a relationship...

Saltwater Recreational Fishing: Management for What It Is—Not for What It Was

Mike Nussman
President and CEO
American Sportfishing Association

Introduction

There's a reason why each year Americans spend $646 billion on outdoor recreation: because spending time in the outdoors is *fun*. Despite a litany of time constraints and competing activities, each year, more than 140 million Americans find time to head outdoors. Fortunately for the U.S. economy, outdoor recreation is big business, supporting nearly 6.1 million jobs. Annually, the dollars that consumers spend on outdoor recreation are more than what is spent on pharmaceuticals and household utilities combined, and are on par with financial services and insurance.

In addition to its role as an economic driver, outdoor recreation also plays a significant role in the conservation and management of our nation's natural resources. For example, recreational fishermen contribute nearly $1.5 billion annually to fisheries conservation and environmental successes through fishing license purchases, the Federal manufacturers' excise tax on fishing equipment, the excise tax on motorboat fuel, and direct donations.

Despite its economic impact and paying for the bulk of conservation efforts, outdoor recreation is not often thought of in economic terms. The economic expenditures are both diverse and diffuse, including lodging, apparel, fuel, food, vehicles, entrance fees, licenses, and more. But because the economic impacts aren't as readily apparent as many commercial activities, outdoor recreation is typically viewed simply as a pastime or hobby. In that same vein, even natural resource managers tend to take the "partakers" in outdoor recreation less seriously and do not focus adequate attention on facilitating and promoting outdoor recreation, particularly among Federal agencies. Perhaps nowhere is this more apparent than in Federal saltwater fisheries management.

The Landscape of Marine Fisheries Management

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) was originally passed in 1976 amid a variety of other landmark environmental laws, such as the Clean Water Act, prompted by decades of unfettered industrialization. The primary purpose of the original law was to extend the U.S. exclusive economic zone to 200 miles offshore and eliminate competition from the foreign fishing fleets off our coasts. At that time few, if any, in the Congress or the Administration gave much thought to management of marine recreational fishing. Boating and fish-catching technology were, by today's measure, relatively primitive. Most anglers stayed closer to shore and were less efficient.

Since then, saltwater recreational fishing has changed dramatically. Substantial technological improvements to fishing gear and boats have made it easier to target and catch fish, allowing anglers to travel further offshore in pursuit of new fishing opportunities. Along with the nation's growing population, saltwater recreational fishing participation has increased substantially as well. In 2006—the last year the National Marine Fisheries Service (NMFS) generated national estimates of effort and participation—24.7 million saltwater anglers took nearly 100 million recreational fishing trips. The 533,813 jobs supported by saltwater recreational fishing is nearly equal to that of commercial fishing (611,372 jobs) when considering non-imported seafood.

Despite substantial increases over the last several decades in recreational fishing participation and associated economic activity, the importance of recreational fishing is still not reflected in the Federal marine fisheries management process, which remains primarily focused on commercial fishing. One explanation for this disparity may simply be the very nature of the commercial and recreational sectors. The number of commercial fishermen is small relative to the number of recreational fishermen. The number of businesses that commercial fishermen buy their supplies from and sell their fish to is even smaller. As a result, the commercial activity moves through a smaller number of hands and is a larger payday in those businesses' pockets. This makes it much easier for the commercial sector to build a cohesive base that secures attention from the agency responsible for collecting the science affecting their sector.

Another explanation for the focus of the fisheries management system on commercial fishing over recreational fishing is the substantial difference in overall take between the two sectors. As a science-based agency, much of NOAA's focus is on the biological interactions of fisheries. Given that commercial fishing is responsible for 98 percent of the overall harvest of marine finfish, and recreational fishing is responsible for only 2 percent, it may seem natural for fisheries managers to focus limited resources and attention on commercially important fisheries at the expense of recreational fisheries.

While these ideas may help explain why we have a commercially-focused Federal fisheries law and management system, they certainly do not justify the disparity given the substantial economic contributions of the nation's 24.7 million saltwater anglers. As the nation's coastal population continues to grow along with interest in saltwater recreational fishing, significant improvements must be made to shape the nation's Federal fisheries system in a way that recognizes and responds to the needs of the recreational fishing community.

Ways to Improve the Status Quo

After decades of focusing almost exclusively on commercial fisheries management, in recent years NMFS has attempted to improve its relationship with the recreational fishing community. In 2010, NMFS hosted a recreational fishing summit to demonstrate its commitment to improving the level of trust between NMFS and the saltwater recreational fishing community. That conference prompted an action agenda that outlined specific goals, objectives, and actions based on feedback received from participants, and many of those actions have been completed. While significant progress has been made, many historic and institutional hurdles must be overcome for NMFS to manage recreational fishing at the same level of focus and attention as commercial fishing.

Throughout the agency, NMFS must recognize the need to better serve recreational fishermen, continue to learn about the priorities of the recreational fishing community, and make an effort to address them. The problems with that have arisen from our Federal fisheries management system from the perspective of recreational fishermen are rooted in three fundamental flaws:

- Recreational fishing activity is generally managed with the same tools as commercial fishing.
- Management strategies assume that sufficient fisheries data is available for all fish stocks.
- Fishery managers lack incentive to reexamine allocations in mixed sector fisheries.

Recreational fishermen have vastly different motivations than commercial fishermen. Commercial fishermen attempt to maximize harvestable poundage as efficiently as possible—a goal shared by very few recreational fishermen. While harvesting fish is an important component of recreational fishing trips, the overall goal of most recreational fishermen is an enjoyable experience that is largely driven by fishing opportunity.

The status quo approach in both recreational and commercial fisheries is to set annual catch limits at or near maximum sustainable yield. While this may be an ideal management strategy for commercial fishing, i.e., where harvesting the most biomass is desired, it has proven frustrating for managing recreational fishing in many cases because it does not manage for the desires of anglers, who are more interested in abundance, i.e., ease of finding fish to catch, size structure, i.e., sufficient abundance of fish of desired size; and lengthy seasons, i.e., ample opportunities to get out on the water. The Federal fisheries management system should look towards examples of terrestrial wildlife and freshwater fisheries management in terms of managing recreational activities for maximizing opportunity, not solely for maximizing yield.

Another part of what makes poundage-based annual catch limits undesirable for many recreational fisheries is that fisheries data on which regulations are based are often not only outdated, but in some cases are completely lacking for recreational fisheries. This applies to both biological data, such as stock assessments, and angler harvest data, which is estimated every few months based on angler surveys. Because data are not readily available, a high amount of unpredictability surrounds fishing seasons and regulations. The quotas for recreational anglers in a fishery may be based on information about a fish stock from one or more years prior, and angler harvest is not available quickly enough to allow managers to make inseason adjustments.

Too often this has led to abrupt fishing season closures once harvest data becomes available that show the quota has been exceeded. Fishing trips must be cancelled, causing severe impacts on businesses that depend on fishing trip revenue. Due to the accountability measures under the reauthorized Magnuson-Stevens Act (MSA), anglers and recreational fishing-dependent businesses may be further penalized with a reduced quota for the following season. Under this system, anglers and the recreational fishing industry are the ones held "accountable" by the mistakes of Federal managers, at severe costs to businesses and coastal communities. Managers must explore and consider alternative ways to set recreational fishing regulations in a manner that provides for greater predictability and confidence in the system, while continuously striving for more and better fisheries data.

However, policymakers must recognize that practical realities make it impossible to have sufficient data on all Federally-managed stocks. Of the 528 Federally-managed fish stocks, only 119 are considered adequately assessed. And while improvements have been made to the saltwater angler harvest data collection system, now called the Marine Recreational Information Program, real-time harvest data will never be possible given the nature of recreational fishing taking place from millions of boats, piers and shorelines across the country. These data limitations, combined with the unique goals of anglers, require that a different approach for managing recreational fishing—one that is based on opportunity rather than solely on yield—be explored and considered.

For the numerous recreationally-important fisheries that also have a commercial component, allocations have been, and will continue to be, a point of contention that fishery managers must address. The projected growth in recreational fishing participation will further heighten the degree of competition for limited fisheries resources both within and between sectors. In order to better maximize the economic benefits of these fisheries to the nation, fishery managers must periodically reexamine how fisheries are allocated, but no such approach has been developed to date.

Most fishery allocations are based on decades-old criteria and do not reflect current socioeconomic or conservation conditions. Unfortunately, the current fishery management framework lacks any incentive for managers to address these outdated allocations. The current guidance in the National Standard 4 of MSA simply calls for allocations to be "fair and equitable," which can be interpreted so subjectively as to lack any real meaning. Because allocation discussions are inherently contentious, and because there are a litany of other important issues to address, fishery managers consistently delay or ignore addressing allocations.

Clearly, the current framework has succeeded only in solidifying existing allocations in perpetuity (which may be considered a success by some). The recent report conducted for NMFS by George Lapointe, "Marine Fishery Allocation Issues: Findings, Discussion, and Options," highlighted that neither the Councils nor NMFS view themselves as in charge of comprehensively addressing reallocation. A new approach is needed that requires the Councils to examine if all current allocations are truly in the best interest of the nation, and if not, conduct a process to reallocate. Formal guidance that describes criteria Councils should consider during potential reallocation decisions is needed to guide the process and ensure consistency and transparency.

Conclusion

There is not a single entity or individual with a clear vision for the future of saltwater recreational fisheries management, which makes it nearly impossible to determine success. Many in the recreational community are good at saying what they are against, such as restricting access or seemingly arbitrary closures of important fisheries, but the community has a harder time defining what it wants. What constitutes a well-managed recreational fishery? And how do we get there? Because recreational fishing has never been a priority for NMFS, the agency does not have these answers either.

During most of the 20th century, before saltwater recreational fishing achieved the current high level of popularity and impact on the resource, managers were able to get by with managing recreational fishing secondarily under a system designed for commercial fishing. While this approach has worked adequately in some instances, in many others it is clear that a new approach is needed that recognizes the values, motivations, and impacts of recreational fishing. It is time to collectively develop a vision for what constitutes a well-managed recreational fishery and how the fishery management framework can achieve that vision across the country.

DISCUSSION SUMMARY AND FINDINGS
Session 3 Topic 1

Recreational and Subsistence Fishery Connections

Speakers

MANNY DUENAS, PRESIDENT, GUAM FISHERMEN'S COOPERATIVE
KEN FRANKE, PRESIDENT, SPORTFISHING ASSOCIATION OF CALIFORNIA
MIKE NUSSMAN, PRESIDENT AND CEO, AMERICAN SPORTFISHING ASSOCIATION

Panelists

STEVE JONER, FISHERY BIOLOGIST, WEST COAST TREATY TRIBES
ANDY MEZIROW, OWNER/OPERATOR, CRACKERJACK SPORTFISHING, SEWARD, ALASKA
CRAIG SEVERANCE, EMERITUS PROFESSOR, UNIVERSITY OF HAWAII, HILO T.J. TATE, EXECUTIVE DIRECTOR, GULF OF MEXICO REEF FISH SHAREHOLDERS' ALLIANCE

Rapporteurs

JOHN BUTTERFIELD, POLICY INTERN, OFFICE OF POLICY, NOAA FISHERIES SERVICE
HEIDI LOVETT, POLICY ANALYST, OFFICE OF POLICY, NOAA FISHERIES SERVICE

Moderator

MARK HOLLIDAY, DIRECTOR, OFFICE OF POLICY, NOAA FISHERIES SERVICE

Discussion Summary and Findings: Recreational and Subsistence Fishery Connections

Although great progress has been made under the Magnuson-Stevens Act (MSA) in adopting and achieving ambitious goals for conservation and sustainability of fish stocks, management measures have not always fully considered the structure and viability of recreational and subsistence fishing. This topic examined fishing community sustainability from the recreational and subsistence fishery perspectives, and provided an opportunity to evaluate impediments and opportunities to advance community sustainability across all fishery sectors.

The invited speakers and panelists were selected to represent the different factors that motivate and satisfy participants in the recreational and subsistence fishing sectors, each with different social and economic drivers, and different measures of successful policy outcomes. Individual and regional examples of recreational angling from an individual participant and business perspective (e.g., fishing for-hire) were provided. Customary and traditional uses of fish and fishing as part of the cultural traditions, heritage and community norms for food, celebrations/holidays, barter and gifts were described. Together these descriptions demonstrated and exemplified the many differences, but also the similar goals and concern for healthy and sustainable fisheries that fishermen share.

While fishing access may be a common goal among recreational, subsistence, and commercial fishermen, the reasons or motivations for wanting fishing access can be very different. The discussion highlighted that even within the wider recreational fishing community, there is not a single, unified vision or goal of what saltwater fishing should look like that everyone, from hobbyists to guides to charter fishermen, can support. Some of the motivations include fishing for sport, having an enjoyable experience on the water, catching fish to eat versus catch-and-release, or supporting customary or ceremonial needs. There was recognition of the importance for the recreational community to work together to develop a clearer vision of what "success" might look like.

Additionally, there was a common message from the speakers that participants in the management process needed to work to identify legal, policy, and process reforms that could help reconcile competing goals and objectives and promote collaboration and cooperation across sectors. Most importantly, there was a strong desire to promote greater trust and collaboration between scientists, managers, and fishing constituents.

Major Themes from the Discussion

Following the formal presentations, the speakers, panelists, and audience weighed in on a range of interrelated topics. The discussion raised several issues, revealed some best practices, identified gaps in socioeconomic data, and opportunities for improvement. These are summarized below as a series of short points. The observations do not necessarily reflect a consensus, nor are they listed in order of priority.

Recognize and Define Subsistence Fishing in the Magnuson-Stevens Act

There was general support for formal recognition and definition of subsistence fishing in the MSA by speakers, panelists, and the audience. How subsistence fishing should be defined needs further discussion, since it meant different things to different participants. Subsistence fishing in indigenous communities, and motivations for engaging in it, was not the same as subsistence fishing for non-indigenous communities. It was described as incredibly valuable to communities for supporting cultural, customary, or ceremonial purposes and generally not for "profit," but as a means of value-exchange in trades of goods for services.

In one example, a subsistence fisherman had recently received three requests for marlin for spring graduation parties. These 300-pound fish will feed hundreds of people. The fisherman did not plan to sell the fish, but will be providing it to the families. Next year, when he might need a load of dirt for his yard, he will get a load of dirt in exchange for sharing his fish. However, he might sell a fish occasionally to pay for fuel or tackle, so that he can continue fishing. This participant has been classified as "recreational" for the purposes of management plans. However, the Western Pacific Council has recently adopted the term "non-commercial" to distinguish this type of subsistence fishing from other recreational fishing. In other regions, subsistence fishermen may be fishing strictly for their own food.

One recommendation encouraged formal recognition of subsistence fishing in the MSA along with the caveat that Councils can operationally define what it means in their region. Another participant suggested the MSA should require subsistence fishing representation on Councils.

Expand Non-Market Values Research and Incorporation of Qualitative Information

Building on these discussions, a need was identified to quantify the value that fish may have for a community in a non-traditional way. A new term, "fish-flow," was introduced and described as a research methodology recently devised to understand post-harvest distribution of fish and how fish flows through and is shared in a community on Western Pacific islands. Better understanding of the non-market value of such fish is important in any allocation discussion that might include subsistence fishing. However, it was also noted that beyond the Western Pacific region, it was difficult to identify any Council decisions that were based on qualitative information. The role of qualitative or descriptive information varies a lot between Science and Statistical Committees. Participants generally agreed that the MSA focuses on counting fish and dollars, and has continually expanded to involve more metrics through past reauthorizations. It provides limited focus on qualitative information and analysis, thus the issue was raised that its inclusion in a reauthorization should be considered.

Improve Recreational Data Collection

Although participants were aware of the improvements underway with the NOAA Marine Recreational Information Program, participants discussed the continuing need for improvements in recreational data collection, real-time data, and accountability. Dockside surveys do not adequately capture all angler effort. There was interest in improving information on fish caught and released, for example. Where data are used to monitor regulatory compliance, additional improvements are also needed since recreational quotas are still exceeded in certain fisheries. A few participants endorsed adopting regional strategies similar to requiring a duck stamp for hunters to collect better data on recreational catches of particularly popular or highly-regulated species, such as red snapper. Another example provided was the Angler Action program of the Snook Foundation in Florida. It is working with the Marine Recreational Information Program and the state of Florida to standardize data collection methodologies. Recreational fishermen are invited to log in to a web-based database to record trip and catch information, including relative sizes, numbers, locations, and if fish were harvested or released, explaining that the effort fills a critical data need in fishery management.

Overall, those discussing the topic felt that fishermen are open to reporting and helping to gather data, particularly when they understand and have confidence in how the data will be used. Additionally, there was overwhelming support and emphasis placed on cooperative research efforts for data collection.

Utilize More Cooperative Research and Other Collaborative Research Activities

Cooperative research efforts help empower fishermen and promote "buy-in" and better acceptance of the data used in stock assessments, models, and other assessments. Engaging fishermen directly in research efforts provides legitimacy and builds and strengthens trust between scientists, fishermen, and the managers who use the data.

Scientists can gain important information from the observations of fishermen who spend large amounts of time on the water. Additionally, many fishermen want to be able to review the data collected to ensure its quality. In Guam, fishermen were confused when they heard scientists report that princess snapper only reproduces at 7.0 pounds and during summer months. The fishermen catch princess snapper year-round, and had seen gonads in fish much smaller than 7.0 pounds; the smallest reported was 1.7 pounds. The fishermen asked the NOAA Fisheries Science Center to cooperate in data gathering efforts, and fishermen now collect weight, gonads and other measurements.

Off California, recreational charter captains work with scientists on acoustic and optical survey work. Cooperative research can be a cost-effective best practice that when planned correctly, has multiple benefits and can be replicated and expanded to other regions.

Promote Fisherman-to-Fisherman Cooperation

In addition to cooperative efforts between fishermen and scientists or fishermen and managers, several examples of fisherman-to-fisherman cooperation were noted by panelists and participants as exemplifying a best practice. The Gulf of Mexico Reef Fish Shareholders Alliance, a predominantly commercial fishing organization, had reached out to subsistence fishing communities such as the Gulig Gichi Tribe in South Carolina. They invited community members to meet Texas fishermen, exchange knowledge, learn from one another, and identify common objectives. In Alaska, a grant was obtained to investigate "compensated reallocation" as a way to engage willing sellers and buyers to shift allocation from the commercial sector to the recreational/charter sector. In this example, the charter industry was allowed to charge a small fee that goes to a common pool for recreational anglers to purchase limited amounts of halibut quota from commercial fishermen each year.

Risk pools for the West Coast groundfish fishery are another example of cooperation. Fishermen cooperate with each other and share in the risk to avoid hotspots of prohibited or undesired species. By avoiding bycatch, fishermen can continue fishing for target species. Working together, particularly across sectors, benefits local or regional fisheries, provides positive examples, builds bridges, and helps assuage the finger-pointing that persists between recreational and commercial fishermen.

It was also noted that opportunities for collaboration are the very reason it is important to have representatives from all fishing sectors—commercial, recreational, charter, and subsistence—sitting on the Regional Fishery Management Councils. If they are not on the Council itself, some other process needs to be identified to improve cooperation and communication, beyond social media and limited public testimony periods.

Tailor Management Strategies to Meet Sectors' Needs

Managers need to use different tools to manage recreational fisheries. Since the motivations of each stakeholder group are different, identifying these goals earlier and more clearly while developing management measures will improve acceptance of management strategies. Participants noted that some methods used to manage freshwater fishing and hunting may also apply to saltwater fisheries. It was argued that to many recreational fishermen, maximizing fishing encounters is more important than maximizing yield—they go fishing if they expect to catch fish, and won't if that expectation is not there. Several participants and speakers referred to the presentation by Dick Brame in Session 1, Topic 1 (annual catch limit science and implementation issues) on this issue.

For fisheries that are primarily recreational or have a high value to recreational fishermen, Brame recommends managing to a fishing mortality rate and not absolute removals. This would be based on abundance and age structure, which maximizes encounters, not yield. Poundage-based annual catch limits are rooted in past harvests, and are not timely enough for recreational fishing, since fishermen respond to the current population abundance—as populations increase and fish become easier to catch, more anglers are drawn into the fishery and effort increases. This often causes overages to their quota and a "yo-yo" effect to the management regime, further frustrating anglers. Ideally, the management approach described by Brame would smooth out the data year to year and reduce wide swings. It would benefit from annual updates on relative fishing rates, similar to the annual surveys currently performed for waterfowl.

Provide Opportunities for Local Management at the Council Level

Examples of local fishermen's engagement in fishery management demonstrated the advantages of improving fishing community sustainability. In one example, fishermen in the North Pacific recreational halibut fishery realized their industry would be better served, and could improve year-to-year management, if recreational fishermen from all areas were better engaged. This was done by developing a matrix of potential management options, and allowing the fishermen themselves to select the best way to restrict their harvest to stay within their allocation. Allowing industry to determine which reduction action would be workable was much more palatable than having others decide for them. Tribal fishery management was provided as a second example. Following the Boldt Decision in 1974, Northwest tribes were provided the right to co-manage their fisheries, particularly salmon, but also halibut, sablefish, shellfish, and other trawl species. Local management decision-making, working through the Council process, provides tribal fishermen the flexibility to shift fishing effort to take advantage of available species.

Re-set Allocations by Region with the Ability to Change Allocations as Needed

Overall, the recreational fishing participants in this session almost universally voiced a desire to see allocations of species quotas revisited with more regularity and based upon credible scientific data. There is not a one-size-fits-all means to conduct such reallocations, but audience members from the recreational community believed fresh economic data should be used and should consider the jobs that can be created per pound of fish available to be fished. Consensus was not reached on whether the charter industry should have its own allocation separate from the recreational allocation. There were regional differences of opinion on this issue. Participants from Alaska and many from the Gulf of Mexico region were generally opposed, while those from California voiced support for providing allocations for charter fishermen.

Continue to Improve Outreach and Engagement Between Managers, Scientists and Fishermen

The need for clear, honest, respectful talk and open communication between sectors, groups, Councils, and Federal managers was a recurring theme. Several times it was noted that there is significant value in fishermen engaging directly with other fishermen to share ideas and work toward solutions (see the examples in "Promote fisherman-to-fisherman cooperation," above). Rather than policy administrators conducting outreach to fishermen, messages from plain-speaking people such as the conference guest speakers were seen as being more easily understood. Participants noted that "disconnects" happen but should be avoided. A NOAA recreational fisheries coordinator wanted to attend a big recreational fishing event in Anchorage, and to save costs, shared a booth with NOAA Enforcement. Unfortunately, attendance at their booth was low because of their association with Enforcement. Managers also need to be mindful of the timing of outreach and education efforts, which should not be scheduled during the height of a fishing season.

A 2006 PACIFIC FISHERY MANAGEMENT COUNCIL DECISION ON KLAMATH SALMON DRAWS A CROWD. PHOTO: PFMC

PAPERS

Session 3
Providing for Fishery Community Stability

Topic 2
Integrating Community Protection, Jobs Emphasis, and Seafood Quality Assurance

Elements of Fishing Community Sustainability: Local Lessons for the Nation

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The Magnuson-Stevens Act, including the 2006 reauthorization that ushered in catch limits and accountability measures, has been hailed as the foundation for landmark fishery management accomplishments. National Oceanic and Atmospheric Administration (NOAA) has declared an end to overfishing, though the details show a more complex story. On a national scale, we have moved a substantial number of stocks from the "overfished" status to "no longer overfished."

Something is wrong, however. Right now, many U.S. coastal fishermen and their fishing communities are in jeopardy, compromised by depleted resources within the range of their boats, consolidation caused by the monetizing of fishing rights, loss of voice in Federal management and inability to navigate the current Federal management regimes to gain adequate access to a diversity of species needed to sustain themselves over time.

This matters. It matters to the communities, many of which are rural and isolated, with few employment options. It matters to the seafood-consuming public, who increasingly ask who caught their fish, and where and how. The Act itself makes it clear that fishing community sustainability is part of Congress's vision of the public interest for use of these public fisheries resources. In this paper, fishing community is defined as those geographical communities whose economies and livelihoods are dependent on fishing for the resources within small or day-boat reach of their harbors. The business strategy of these fishermen is not highly mobile; it is dependent on the specifics of their geography and is often highly diversified rather than specialized in one, more industrial scale fishery. In many cases, fishermen in these communities fish in both state and Federally-managed fisheries. And throughout the U.S., the nearshore waters where these communities fish contain the most important fisheries habitat in the nation. The problems in these coastal fishing communities are a bellwether.

The upcoming reauthorization of the Act provides a win-win opportunity to enhance the effectiveness of Federal fisheries management and at the same time establish a framework for sustainability for these communities. The Act should be amended to affect change in three areas. First, to change science guidance in the Act to require an ecosystem approach based on management of areas at multiple scales. Second, to establish Federal processes that permit accountable delegation and partnerships to give the Federal management system greater and more rapid feedback about resource conditions. The Federal system would thus become an adaptive, learning system with the capacity to be resilient in the face of climate change. Finally, to add coastal community fishermen as a vested constituency for participation in Federal management regardless of whether they are current active Federal permit holders. This would provide a way for the knowledge and observations of fishermen who fish high value coastal habitats to inform Federal decision-making. Much has changed over the last 40 years in marine ecology and in our understanding of complex systems and natural resource management. Integrating these advances into the Federal management structure would achieve improved fisheries conservation and create a constructive role for community fishermen in participatory management.

Fishing community problems, of course, are not limited to management-related issues. Many other factors besides availability of fish directly affect fishing profitability: energy prices, changes in the organization of the U.S. food system, national and regional economic events and changing demographics. The fundamental challenge for a coastal fishing community is and will always be to prosper within the bounds of the resources nearby. As the ocean and markets and fuel prices change, business strategies must adapt as well, a process that occurs primarily in the private sector. Because fishing is based on a natural resource, the health of specific fisheries can be expected to fluctuate. As a result, a resilient coastal fishing business is one that has diverse fishing and market options. National Marine Fisheries Service's (NMFS) actions in both fisheries management and in business support programs should facilitate these businesses' capacity for ongoing adaptation.

Alternate Vision

This paper proposes that it is possible to actually *increase* the productivity of the nation's fisheries if the Federal system is able to empower local participation in monitoring and feedback into the system, supplementing the current Federal processes. Furthermore, it argues that, given what has been learned about marine ecology over the last 35 years, sustainable fishing will not be possible or feasible without this approach. The vision turns upside down the traditional trade-off that assumes fishing community sustainability requires lowered expectations for resource conservation. Instead, good conservation should become part of a community's long term plan for adaptation to a changing environment. Good conservation comes from good information, appropriate restraint, and appropriate and timely course correction. As we shift toward place-based, ecosystem management, this vision calls for creating a vital role in science and management for those fishermen who fish areas of the ocean that are critical to species productivity in order to enhance knowledge and decision-making for their fishery.

The nation is faced with a changing climate and a changing ocean. We are learning that single-species catch limits, alone, are not always enough for good conservation: that a shift into ecosystem management—taking care of places in the ocean—is warranted. Faced with change and additional complexity, we propose that the optimum approach for managers, fishermen and fishing communities is to learn collaboratively, in something close to real time. The NMFS Cooperative Research Program, which originated as merely a way to supplement fishermen's incomes, is the platform from which the collaborative learning and better scaled management can emerge.

This level of collaboration is difficult for many managers and fishermen to conceive of, given the zero-sum game that fisheries management has become over the last 35 years. However, in a changing climate and changing ocean, this is the only approach that is appropriate.

New Science Should Inform Magnuson Changes

When the Magnuson-Stevens Act was drafted in 1976, the drafters knew the ocean was complex but at the time, some good, linear approximations (Beverton and Holt 1957) were the best science available. The Act was built on the idea (maximum sustainable yield) that restricting or expanding fishing to the correct catch limits was the key to the future health of fish stocks. Since the reauthorization in 2006, most Federally-managed fisheries are now managed with catch limits based on Federal stock assessments. But now it is recognized that catch limits, set at large, regional scales, are not enough and may, as in cases like Atlantic cod, inadvertently create incentives for serial depletions of localized spawning components and collapse (Wilson et al. 2012). Furthermore, many forces besides fishing effort affect fish stock size and as climate change becomes visible, scientific guidance is now to "expect the unexpected."

In the years since Magnuson, marine science has revealed a level of previously unimagined complexity in ocean ecology. We have learned that some marine fish populations have natal homing comparable to birds and anadromous fish (Thorrold et al. 2001). Instead of existing as regional-scale, panmictic stocks, we have learned that populations of the iconic and well-studied Atlantic cod have morphometric differences on different reefs (Sherwood and Grabowski 2010) and a quite localized meta-population structure (Ames 1997, 2004). This complexity extends throughout the marine ecosystem. We understand, now, that many anadromous fish are genetically distinct in each river, and in many tributaries. And we are learning that bivalves, like Atlantic sea scallops on the coast of Maine, have genetic diversity at a scale unimagined even 10 years ago. Maine's tiny, 14-square-mile Gouldsboro Bay has scallops that are genetically distinct from those outside the bay (Owen and Rawson 2013). That is a distinct population in an area bounded by just 16 miles of Maine's heavily indented 3,500 miles of coastline.

The New England Atlantic cod fishery is a cautionary example of what can happen inadvertently when the scale of management does not match the ecological scale at which the species exists. The pain of fishing communities is heard clearly in the Northeast Region, where we just recently discovered that our iconic cod stocks are in terrible shape, despite two decades of increasingly stringent limited access and most recently, quota management. Gulf of Maine cod is only 20 percent of its target biomass, and managers now realize was fished at a rate five times higher than the overfishing threshold. This occurred at least in part due to the fact that management didn't take into account the species' complex stock structure. The cod assessment is done for the whole Gulf of Maine, an area from Cape Cod to Canada, from which catch limits are set.

However, in 2004, Ames published a seminal paper based on historical fishermen's data that described four distinct population subgroups of cod in the Gulf, each with separate migration corridors and distinct areas for reproduction and juvenile stages rather than one, Gulf-wide population as had been previously assumed. At that time, the two easternmost cod groups had collapsed. Viewed at a Gulf of Maine-wide scale, this localized depletion was invisible because there was still cod in other parts of the Gulf of Maine. Fishing continued in the southern and western part of the Gulf and tragically, it now appears that the same localized depletion continued, also undetected. By 2010 over 50 percent of the cod catch in the Gulf of Maine came from an area less than one percent of the size of the Gulf and in the end, the assessment showed a complete stock collapse. It appears that because catch limits were set at the wrong, too-large, Gulf of Maine wide scale, fishermen who were fishing within quota and following the rational fishing strategy of fishing where the fish were, pulse fished each sub-stock sequentially, taking out the remaining productive sub-units one by one. It was too late by the time that loss of productivity and the risk was recognized in the Gulf-wide assessment (Armstrong et al. 2011).

Governance Implications of Ecological Complexity

Such ecological complexity presents staggering management challenges. To meet the challenge will require additional, more decentralized layers of governance, a shift to ecosystem rather than single-species science, and creating of a more adaptive management process. Coastal fishing communities can play a pivotal role in making these changes feasible.

Viewed through the lens of a regional Science Center or Council, it is inconceivable to try to manage the marine ecosystem's complexity effectively. However, for guidance we should gain insight from the theory of complex adaptive systems developed over the last 40 years for a variety of applications including governance of natural resources worldwide (Simon 1962; Ostrom 1991; Ostrom and Janssen 2004). This literature indicates that management of such complex systems cannot be done effectively only from a single, high level but instead must be accomplished through a series of nested hierarchies. Translated to U.S. fisheries, the implication is that the current Council and Science Center system must be augmented with finer-scale information and credible feedback loops to provide information at the proper scale. In this way, management can be aligned with the ecological scales of the resources being managed, just as the decision to plow streets is made at a municipal level, not at a state or Federal level, so as to align snow plowing with local microclimates. For snow plowing, this works and does not negate the need for statewide, regional and national transportation planning as well. In fisheries, this need for multiple levels of decision-making is recognized but, we now realize, is not fully accomplished through the regional structures created by the Act.

The ecological complexity also necessitates updating the scientific structure embodied in the Act from one founded on maximum sustainable yield (MSY) to an ecosystem approach based on the ongoing need to learn adaptively, at multiple scales. As part of this, National Standard 3 should be revised to reflect current scientific understanding of the importance of managing fisheries with metapopulation structures to protect individual sub-units in order to protect the productivity of the entire population. The fact is, as the ocean changes with climate change, even NMFS' best assessments, with long time series, may not be able to provide appropriate advice. In this context, it is constructive to view most fisheries as data-poor.

In a data-poor situation, the sensible management response is to shift from the static situation we are in now, where NMFS is meant to have all the answers, to an ongoing process of feedback, learning and adaptation that is collaborative, enlisting the multiple platforms and intimate fine-scale observations of fishermen. NMFS' Cooperative Research Program has started to serve this function. There is literature documenting key elements for successful local involvement in fisheries governance (Gutierrez et al. 2011). And adaptive management structures for other Federal natural resources such as forestry and fish and wildlife can provide perspective on the appropriate legal frameworks to encourage or require NMFS to partner with states, the industry, and/or non-profit organizations in piloting and assessing multi-scale, adaptive management.

State Examples

States provide a useful laboratory of fisheries governance models worth examining in the quest for a more collaborative, decentralized, and accountable Federal approach. Most states don't have the financial resources for rigorous surveys and assessments so many states manage their fisheries essentially as data-poor fisheries, without the possibility of leading with assessment-based catch limits. State approaches that have evolved in these conditions contain two elements: 1) some level of localized governance and 2) active, uncompensated participation in data collection and stewardship activities. In each case, the state has realized more value from the fishery than they would have had they managed at a statewide scale. These models are instructive because they illustrate how localized management can provide for better resource stewardship, allowing the states to realize more benefit from their marine resources, a different view of optimum yield.

Many states, including California with urchins or Maine with softshell clams, have enlisted fishermen and even municipalities in localized science and management. Maine, faced with a lack of resources to enforce thousands of square miles of clam flats along its 3000 mile coast, developed a process to delegate authority and responsibility to municipal clam conservation committees. Accountable to the state, the towns raise funds, hire clam wardens, and tie access rights to dig clams to clam flat assessments and participation in reseeding efforts. Access to dig clams in a town requires both state and local licenses, a nested hierarchy.

Maine's lobster fishery is the most well-documented and successful example of a fishery that is managed the way many data-poor fisheries are, with emphasis on ecological measures plus a combination of traditional and state-sanctioned local authority. After a complete collapse in the 1930s, the lobster fishery was rebuilt based on rules negotiated between the fishermen and state regulators. All of them are ecologically based, such as protecting habitat (traps only), protecting reproduction (returning egged lobsters to the ocean, maximum size to protect large breeders, and v-notching), and protecting juveniles (minimum size, vents.) Rebuilding took place without limited entry or quotas.

In the mid-1990s, additional lobster regulations were added: owner-operator rules, an apprentice-based entry control, trap limits and elected co-management based in seven zones. The reason those rules were able to make it through the Legislature was because they created an additional layer of co-management, the zone structure, that recognized the ecological and socioeconomic differences within the state, and thus within the industry. The zones continue to provide an appropriate geographic/ecological scale for decision-making about the fishery, particularly notable as temperature regimes change in different parts of the coast.

Scallops

Sea scallops in Maine are an example of another, evolving nested hierarchy. Scallops outside state waters are managed by the New England Fishery Management Council, with rules written at a New England-wide scale. Maine manages scallops in its territorial waters, a highly productive area. Scallops are important to coastal communities as a part-time winter fishery for lobster fishermen fishing in 30-45' boats. Faced with a depleted resource, overfished by mobile scalloping that have pulse fished the resource travelling coast-wide to places of abundance. Recently, Maine started a scallop management process that is further decentralizing its statewide management to an ecological scale and providing a framework for ongoing learning and industry participation. The resource is patchy and Maine's scallop survey can, at most, provide an indicator of localized abundance. The ecology of the state's many bays differ and recent science show genetic differences occur at a stunningly local level, even bay-by-bay.

Since 2010 the Maine Dept. of Marine Resources (DMR) and fishermen, together and independently, have discussed strategies for how to open thirteen areas that had been closed to help rebuild the neglected and depleted fishery. An unprecedented 88 scallop fishermen's meetings have taken place. The discussions started with values: do you want to be able to fish near home or travel statewide? And tough questions: How do we avoid wiping out good sets in one season? And science: Did scallops rebuild in the closed areas? Can fishermen ride the state scallop survey boat? How fast do scallops grow? A local non-profit started these, meeting locally, and then DMR continued, meeting at the same local scale (Brewer 2013).

State managers heard and responded to fishermen's reservations about creating a one-size-fits-all plan for re-opening the closed areas as limited access areas. Several industry suggestions for flexible management were adopted by the DMR in a long-term scallop management plan. These included the concepts of rotational management, the use of real-time catch rate measurement to trigger the Commissioner's use of his emergency authority to close an area, and recognition of the geographic differences in fleet behavior and the scallop resource along the coast. Instructively, the recognition of geographic/ecological differences has facilitated understanding among fishermen and with managers because the areas they are discussing are appropriate to the patchiness of the scallop resource along Maine's rocky bottom. This has facilitated collective interpretation of information about resource conditions.

The result—dynamic, in-season closure decisions supported by fishermen's information about catch rates; concerted work by DMR Marine Patrol, sea samplers, scientists and managers. And constant communication between fishermen and DMR: emails, phone calls and texts, not shirking from what it takes, and in the end, learning together, establishing some trust, and getting value from the resource without huge mistakes. The season was a huge achievement. However, the true reward is the development of a collective process toward rebuilding and sustaining the resource. It has deliberately built trust and a learning process that is ongoing and has the potential to build a common understanding of conditions and uncertainty. This is the first year of the new process. Already local fishermen are speaking about developing local stewardship groups that could take on additional responsibilities to enhance the process. The fishermen who live nearby want to work with the state to ensure that, to the extent possible, they can depend on a winter scallop fishery accessible from their harbor.

Applying State Lessons in the Magnuson Environment

The state examples provide an example of the power of coastal fishing community involvement stewardship. Key lessons and recommendations emerge to apply these insights in the Federal, Magnuson environment and create a legal pathway that links the Federal management structure to that local capacity. State experience suggests that once Federal scientists and managers have the ability to work at a local, appropriate ecological scale, mutual learning and understanding will develop that will both advance fisheries science and improve management.

- Scientific guidance in the Act should make the transition from maximum sustainable yield-based concepts to ecosystem concepts. This would allow Federal management to build upon catch levels with stewardship of multiple parameters of the areas and the ecological aspects (size, reproductive behavior, etc.) of the resources within them.

- National Standard 3 should be revised to reflect current scientific understanding of the importance of managing fisheries with metapopulation structures to protect individual sub-units in order to protect the productivity of the entire population.

- Protection of high productivity areas should be prioritized for Federal waters management. With the exception of some offshore banks and atolls that have the same ecological functions, the majority of the reproductive capacity for the nation's fisheries occurs in nearshore areas. These areas warrant additional rules to protect their productivity and a process whereby their complexity becomes better understood. These are the areas, like the cod areas that were depleted in the Gulf of Maine, where localized information and feedback loops can result in better conservation and ultimately far more resources for the industry to catch on a sustainable basis.

- Create a new legal framework for the stewardship of highly productive nearshore areas. This framework would provide the ability for NMFS to engage in partnerships with states, community fishing groups or non-profits entities for enhanced management of the areas. This could include monitoring, providing an authentic pathway for advice about local ecological conditions and proposing ecologically-based measures that would fit within the Federal catch share management. The system would have two-way accountability. These partnerships would function within the region-wide management structure, would franchise a broad range of fishing community members in supporting stewardship and, because of the ecological significance of these areas, are likely to enhance abundance to the benefit of both the community-scale and industrial fisheries.

Coastal fishing communities depend on the health of the marine place where they work. It is in the national interest to facilitate and expect their participation in stewardship of that place. The reward will be community resilience and improved management results for all Federal fisheries.

Access Rights

To be successful, a coastal fishing community not only needs abundant resources nearby; fishermen also need the access rights to fish those resources. The importance of access for fishermen's livelihoods is well understood. However, access performs an important second function in the new context of multiple scale, ecosystem management: access rights actually create a constituency for the resource and a cadre of fishermen to participate in stewardship activities. This becomes even clearer in the context of place-specific ecosystem management. If fishermen are to be enlisted in the stewardship of an area, then access systems need to provide them the hope of being able to fish the resources they are contributing to caring for or rebuilding.

Many of the current problems facing U.S. coastal communities stem in part from allocation decisions that favored full-time, single fishery operators or were based on time periods when those communities faced local depletions. The result has been a steady erosion of opportunities for fishermen whose business plan and community is built on being able to shift among resources as local abundance changes. A policy solution to this is essential if U.S. coastal fishing communities are to survive.

Coastal fishermen's access needs differ from those of more specialized, offshore boats, a fact that has not been accommodated in most Federal access systems. For a coastal fisherman, whose business strategy is to fish whatever resources are within reach of the harbor in a relatively small boat, affordable access rights to diverse fisheries are critical to sustainability. Access for a coastal fisherman is distinct both qualitatively and quantitatively, a fact that many permit systems do not take into account. A coastal fisherman is likely to use access rights to a given fishery either part time, as part of an annual round of fisheries, or at different times during his/her life. Sometimes, this light use leads managers to misinterpret its significance to fishermen's financial stability. In other cases, managers view such permits as a dangerous latent or partially latent version of a full-time, offshore, specialized unit of effort. In fact, fishing community stability would be greatly enhanced if permit systems recognized these differences. Repeatedly, advice from coastal fishermen is that affordable and diverse access rights, even if severely limited as to time, gear, trip limit and area, are the linchpin of their family and community economies. Fishermen want future generations of young fishermen to be able to enter the fishery affordably so that they, too, can fish at a community-scale.

Finally, as climate changes, species distribution will change. Access systems for coastal fishermen need to be structured to adjust as well, most likely through some area access structure. If such adjustment is not possible in a manner accessible and affordable to coastal fishing, it will force coastal fishermen who fish one locale to change their strategy and either join the mobile fleet or go out of business.

Other Models

Again, innovations from non-Federal jurisdictions can provide a useful laboratory for alternate access concepts.

Permit Banking and New Entrants

Because groundfish off the state of Maine collapsed years ago, very few Federal rights to fish for groundfish are left in the state. Three nonprofits and the state of Maine are involved in permit banking, buying permits of retiring fishermen in order to accumulate quota that can be used by the few remaining active fishermen in the state.

One permit bank is paired with a program specifically targeting coastal fishermen who want to participate in the groundfish fishery on a seasonal or part time basis. A New Entrants Program is designed to help coastal fishermen enter the groundfish fishery through business planning and a website that serves as a connector between older fishermen who hold permits with no quota and young people who want to enter using quota from one of the permit banks. The program is specifically designed to rebuild participation in groundfish on a sustainable basis. Participants must be owner operators and must fish with hooks or traps. Existing young fishermen, currently fishing other fisheries such as lobster, who are looking to diversify into groundfish on a part-time basis are the target audience, and the program is linking collaborative fish trap gear development with participants.

Licensing for the Future

A licensing initiative in Maine is tackling the challenge of designing a fisheries access approach that would provide coastal fishermen with a diversified portfolio of fisheries and that could be adaptive to changing climate. Maine currently licenses fishermen, not boats. No licenses are transferable and some fisheries are closed. Some fisheries require apprenticeship (lobster) or courses (dive fisheries.) Penobscot East Resource Center and Maine Sea Grant are collaborating on the project that started with outreach to the industry to solicit values and has held a workshop that attracted New England state fishery managers and social scientists from both coasts of North America. Several important concepts emerged.

- The importance of owner-operator to the sustainability of community-scale fishing. Coastal fishermen and managers from several states and Canada identify owner-operator or owner-on-board as the most highly effective method for regulating scale in nearshore fisheries. The rules inhibit consolidation and ground the access rights within the fishing community, as well as providing a generational link to the health of the local resources. Owner-operator rules work in both transferable and nontransferable systems.
- A goal of one single "fisherman" license with entry to specific fisheries achieved through endorsements. This concept fits within the idea of area-specific ecosystem management and would effectively identify a cohort of local coastal fishermen and allow their access to specific species to ebb and flow based on the status of those resources.
- The irreversibility of transferability and associated challenges it poses to fleet diversity. Maine has no transferability, and managers from Canada and Alaska identified this as an opportunity for Maine to create a new model since it is difficult to innovate once the access is privatized.
- The dangers of entitlement thinking. It is easy for the fishermen currently engaged in a fishery to feel entitled, rather than understanding that they are using a public resource. In turn, government entities tend to become captive to the interests of current active fishermen.
- A goal to design a system that would link fishing privileges with stewardship behavior, including participation in monitoring and management processes, as well as a clean enforcement record. This approach has the potential to fit well with the need for changing access in a changing ocean. It could be used to for a fisherman to qualify for endorsements in a system with one permit or license, and additional with endorsements.

Maintaining Standing in the Management Environment

The largest challenge to addressing coastal fishing community access problems lies in the degree to which the current Federal system has limited participation to those who are active, Federally-permitted fishermen—the issue of entitlement raised above. As many fisheries have consolidated under Federal management, coastal fishermen who have lost their rights to a fishery no longer have standing in everything from limited access privilege program referenda to their comments being taken seriously at a Council meeting. The Act heavily favors "active fishermen" in the Council appointment process and aspects of fishery management plans. Most fishermen who have lost access rights drop out of the Federal management process.

However, as the nation transitions to ecosystem management where care of marine place is the goal, the law should be modified to create a vehicle for fishermen in coastal communities in that area to gain both standing in the management process and responsibility for participation in decentralized science and management. If this is not achieved, the management system will lose the observations, historical perspective and commitment to place that are possible in a resident fleet. One example of this can be seen in the New England cod story. Throughout the 20-year process of cod depletion in New England, coastal fishermen who fished the nearshore grounds where fish return to reproduce spoke up about the loss of fish, first in eastern Maine, then in mid-coast Maine, then in southern Maine and New Hampshire. In each case, because their observations could not be validated at the Gulf-wide scale, the system could not integrate these important warnings into management guidance. In each case, mobile boats did not perceive the significance of the depletion because they could move to follow pulses of abundance. As each set of coastal fishermen lost their fish and stopped groundfishing, those fishermen lost their standing in the Federal system. Their observations and passion for rebuilding those resources were lost from the system.

Changing this, however, is a challenge given the degree to which remaining fishermen are vested and coastal fishermen are not. It is unlikely that this process will be reversed without changes in Magnuson. Instead of viewing this as an allocation wrong to be righted, the changes in Act that should approach this issue as part of establishing a legal structure that will allow ecosystem management to be implemented successfully. Coastal fishermen, commercial, recreational and subsistence fishermen have a role to play that cannot be filled by any other group.

Summary Framework for Coastal Fishing Community Sustainability

The following points lay out critical elements for a policy agenda to secure fishing community sustainability:

1. Fishing communities need abundant and diverse resources—no fish means no fishermen.
    - New science about the complexity of the ocean, combined with uncertainty caused by climate change, creates the need to further develop Federal management policy with multi-scale management and place-based, ecosystem approaches.
    - These systems need to be adaptive, providing rapid, responsive feedback from the field in close to real time, so that good and timely management decisions can be made in a changing ocean.
    - Coastal fishermen have a primary role to play in supporting stewardship and adaptive management of nearshore Federal waters, providing timely information and a critical feedback loop about local conditions in productive areas.
2. Coastal fishermen need access rights to fish for diverse resources at constrained scales, and they need the ability to adapt to changing local resource availability.

- Access issues are different for coastal fishermen than they are for specialized, industrial fishery vessels. Their strategy of lower volume, localized fishing requires access to diverse fisheries. Access for coastal fishermen needs to be affordable and adaptive especially as climate changes.

- Many coastal fishermen are currently predominantly dependent on state fisheries because of the initial allocations of permits and the expense of buying in. Fishing communities need a mix of access to state and Federal fisheries.

- Owner operator rules are widely viewed as critical in preserving fishing at a community scale.

3. Fishermen need multiple paths to economic sustainability for themselves and their communities because small-scale fishing strategies require diversity.

    - Small-scale shellfish and seaweed aquaculture can supplement wild fishery income effectively, but only if rules are sufficient to keep aquaculture small-scale. If not, it could supplant wild fishery options and produce the adverse ecological impacts of monoculture, a less resilient ecological and economic situation.

    - Food system innovations that return higher prices for local and sustainable catches will play a significant role in community sustainability and will produce support for fishing among the general public.

    - Given the intensely local ecology of so many marine species, national sustainability certification efforts should establish a structure to support certification of highly local resources as is done for French champagne rather than attempting to certify at a regional or national scale.

Summary Magnuson Reauthorization and NMFS Policy Suggestions

1. Revise National Standard 3 to reflect current scientific understanding of the importance of managing fisheries with metapopulation structures to protect individual sub-units in order to protect the productivity of the entire population.
2. Revise fishery management plan guidance to require participation and input from non-Federally permitted coastal fishermen (commercial, recreational, subsistence) from communities adjacent to ecosystem management areas, not limited to Federal permit holders.
3. Create a legal framework for adaptive management of nearshore areas that functions within the region-wide management structure:

    - Encourage/require NMFS to engage in partnerships with states, community fishing groups or non-profits entities for enhanced management of the fine-scale ecology of the areas including monitoring, providing advice about local ecological conditions and proposing ecologically-based measures that would fit within the Federal catch share management;

    - Create a mechanism to create a new form of Federal access right for specific high productivity nearshore areas. These rights would be severely constrained: limited to that specific area, to owner-operator vessels, to use of habitat friendly gear, to appropriate catch limits, and most importantly, to participation in stewardship.

    - Two-way accountability;

4. Create provision for both NMFS-led and Council-led pilot projects so that the pace of learning and management innovation is increased.
5. Re-examine the opportunities for participation in the Federal process for coastal fishermen who identify holistically as fishermen, rather than with just one single-species fishery. For coastal fishing to continue, these fishermen need a seat at the table. Areas to examine include Council membership, qualifications for participation in limited access privilege program referenda and Regional Fishery Associations, and Coun-

cil decision-making about creation and management of any decentralized areas or ecosystem-based management mechanisms.

Conclusion

For fishing communities, these changes are not optional. Conservation, and the desired increased sustainable supply of fish for coastal communities, is only possible if there is a mechanism in the Federal system to use local knowledge in additional layers of decentralized management. No matter how draconian any curtailment of effort is, continued single species at a broad scale cannot get the incentives right because it doesn't get the biology right.

Coastal fishing communities cannot and should not be preserved like museum pieces. Instead, as the nation transitions to ecosystem management and as we all cope with a more rapidly changing ocean, the Act should be modified to structure shared, adaptive responsibility for stewardship of critical nearshore places in the ocean. Fishermen have a critical role to play in the feedback loops we need for good governance. The pay-off will be abundance, community well-being, and local supplies of high quality fish that cannot be achieved any other way.

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Toward Healthier Communities

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Introduction

The Magnuson-Stevens Act charges the National Oceanic and Atmospheric Administration (NOAA) and Regional Fishery Management Councils with simultaneously conserving the country's living marine resources and providing for communities' sustained participation in fisheries. While some view these joint responsibilities to conservation and communities as conflicting, they are not.

The most important factor in sustaining our nation's fishing communities and the businesses that support them is to create a stable management system that allows for a stable and healthy fish resource. This creates the best opportunity for a commercial fishery that is more predictable, more profitable, generates better paying and more stable jobs, and may slow the rate of fleet consolidation.

Stability is most likely to come in fisheries managed by annual catch limits, strong accountability measures, and limited fishery access controlled through a privilege system. With these management measures in place, fishing businesses can focus on creating financial and community value through more efficient, less wasteful fishing practices that produce higher quality product better timed to market demand. Recovery of fishing stocks becomes more important as a long run source of improvement rather than an immediate need for community and business benefit.

Those who see conflict between community and conservation outcomes argue that stock rebuilding measures result in more rapid consolidation of the fishing fleet, disproportionately negative impacts on small-scale fishing businesses, and greater difficulty for new entrants to establish themselves in the fishery.

It is not clear that these arguments have been or can be empirically supported. They are particularly difficult to assess given the challenge of establishing a baseline against which to evaluate the changes. Most often changes in fleet structure are compared to history. But there is little agreement on what period of history is relevant or whether it is relevant at all.

Problem and Approach

While any long-term negative impacts of stock rebuilding strategies on fishing communities are uncertain, there is more clarity on a variety of transitional issues that can arise, especially in fisheries that begin the reform process with weak fish stocks. Fishing is a risky, challenging business with or without the added uncertainty of management reform. Even when reform efforts lead to a more stable fishery with more profitable businesses, it creates a transition period during which old commercial patterns and business practices need to change.

To adapt, businesses and entire communities must expend resources to evolve. The challenge of adapting can be greater for smaller-scale fishing operations and smaller communities because they have fewer resources available to them.

To address this challenge, the National Marine Fisheries Service (NMFS) and Councils, without compromising their stock rebuilding objectives, should focus on reducing sources of operational uncertainty and expense for fishermen and facilitate access to scarce resources important to their adapting to change. More specifically, actions should fall into three broad categories:

1. Lower the cost of management programs for the fishing industry
2. Provide smaller-scale operators with better access to critical resources for the development of successful fishing businesses (including investment capital; technical assistance to support business planning as well as operations, marketing and financial management; accurate and timely catch accounting and quota transaction data)
3. Promote innovation and entrepreneurship in the management process by engaging industry and third parties more fully in design, development and operations

Lower Cost of New Management Systems

Fishing businesses generally operate with significant economies of scale. Larger businesses can spread their costs over a much larger business base, giving them a potential competitive advantage compared to smaller businesses.

In fisheries undergoing management reform where stocks are stabilizing and especially where limited access privileges exist, businesses look for ways to gain greater economies of scale to increase profits and business strength. This may include seeking opportunities to land more fish per vessel. Or it may mean looking for ways to collect and use more information about what is happening on the water to plan more efficient fishing trips. In the case of multi-species fisheries, it may mean having access to additional quota for scarce, constraining stocks. And it may mean scaling the business to better handle new management costs associated with catch accounting and trip monitoring.

Importance of Community Fishing Associations

Most often, businesses seek economies of scale through consolidation; one fish harvesting business acquires another, or acquires critical fishing assets such as permits, quota or privileges. Community Fishing Associations (CFAs), alliances or cooperatives can represent a viable alternative to outright consolidation for smaller-scale fishermen to generate economies of scale and pool resources to make the necessary investments to upgrade operations and potentially purchase additional access privileges.

However, CFAs often struggle to establish themselves. Barriers include fishery management rules that make formation and operation of cooperatives time-consuming, complicated and expensive; lack of organizational and management capacity in fishing communities; and lack of experience in functional areas including marketing and finance.

Despite these challenges, there are good examples of different types of cooperative organizations that have formed to help communities of smaller fishermen capture the benefits of scale without accelerating consolidation. These include the Alaskan cooperatives, Central Coast Sustainable Groundfish Association, Fort Bragg Groundfish Association, Gulf of Mexico Reef Fish Shareholders' Alliance, and the Cape Cod Fisheries Trust.

In designing new management plans, NMFS and the Councils should work to facilitate the smooth formation of CFAs where fishermen want to come together voluntarily. Ideally these cooperatives will become partners with the agency to define the most appropriate community goals for the area they represent, and design and implement programs that will achieve them.

Controlling Monitoring Costs

Requirements for monitoring and reporting on fishing activity have increased significantly as management plans have adopted more rigorous annual catch limits and accountability measures. The cost of meeting these requirements has also increased, for both NMFS and the fishing fleet.

Monitoring costs, and in particular human observer costs (either currently or prospectively), represent the largest single management-related cost for fishermen. These costs are proportionately more onerous to small operators who have to support a comparable cost burden with lower catch levels than larger operators.

One of the more valuable steps NMFS and the Councils could take to improve the viability of the small-scale fleet is to encourage development and usage of lower cost monitoring programs. Not only would this improve the profitability of fishing businesses, it would allow a much higher portion of partially covered fisheries to be monitored, increasing overall fishery accountability.

Substantial work has been done recently by NMFS and a variety of industry, nongovernmental and academic collaborators to explore the ability of electronic monitoring and reporting systems to deliver more cost-effective monitoring solutions. While the conclusions vary somewhat fishery to fishery, and it is unlikely that a wholesale replacement of conventional monitoring with electronic monitoring will be the answer, electronic systems should be able to reduce the monitoring costs for the fishing fleet overall and will likely reduce the cost disadvantage of small-scale operators.

Access to Critical Resources for Communities

Cost-Effective Capital

As mentioned above, management reform forces fishing businesses to compete differently to be successful. This often means making investments to upgrade operations. Fishermen may purchase new vessels or refurbish existing ones, switch gear, acquire permits or quota, or upgrade fish handling equipment. Shore-side businesses including offloaders and processors may purchase new trucks, hoists, ice machines and freezers or require additional working capital to support higher revenues and payment to fishermen on better terms.

Many businesses, especially smaller ones, struggle to find the money needed for these critical investments. There are several steps that should be taken to improve the chances that businesses find the capital they require.

Establish a Central Registry

As part of Magnuson-Stevens Act reauthorization, Congress directed NMFS to establish an exclusive central registry system to facilitate lending to fishermen based on the security of fishing permits and privileges. This was never carried out.

A registry is an exclusive system for perfecting title to, and security interests in, fishing permits and privileges. Having a well-functioning registry is critical to making conventional lenders comfortable with taking fishing permits and privileges as collateral for loans. And for fishermen, their permits and privileges, especially in well-managed fisheries, are often their most valuable business assets and therefore their greatest source of collateral for borrowings.

From both a lender and borrower perspective, NMFS should move forward with establishing a registry. This is one of the more important steps to making conventional bank loans available to a broader group of fishing businesses.

Involve Established Lenders in Management Reform Process

As important as capital can be to a successful management reform process, NMFS and the Councils should make a greater effort to engage lenders in the design and implementation of fishery reform.

At a minimum, more lender involvement in the process would give lenders a better understanding of the operational aspects of a fishery management plan, as well as its potential risks and rewards. This information is critical to a lender's credit analysis and, therefore, their willingness to lend to the fishery.

Further, lenders may have input on design features of the management system that would better allow them to manage risk if they were to lend. An example from the Pacific Groundfish Individual Fishing Quota (IFQ) program is lenders' efforts to get an exemption from the control cap, allowing them to take quota in excess of the control cap as collateral for their portfolio of loans. This issue is important to lenders as they need to manage a loan portfolio that is large enough to diversify their investment risk and cover the costs of doing business.

Support Loan Programs for Smaller-Scale Borrowers

Even for experienced fishery lenders, meeting the needs of small-scale businesses and especially new entrants can be difficult. These borrowers typically lack the well-documented operating history necessary for loans, and have not built long-term relationships with lenders. As a result, it can be difficult for them to get the loans they need to improve their businesses.

Dedicated fishery loan programs can play an important role in filling this void. To be successful, these programs must be well structured with clear goals, a well-targeted base of borrowers, and loan products that match the needs of those borrowers. These funds are also most successful when they position themselves as a transitional source of capital, targeting borrowers who will eventually graduate to accessing commercial loans.

Good examples of this type of funding include NOAA's Fisheries Finance Program (FFP) and the California Fisheries Fund (CFF). The NOAA program, administered by NMFS, provides financing for quota purchases as well as vessel purchases, vessel reconstruction and shore side fishery and aquaculture facilities. Under the FFP, IFQ financing may be available for quota purchases at the request of the Regional Fishery Management Councils. The program finances up to 80 percent of the cost of purchasing quota by small vessel operators and first-time quota buyers. IFQ funds have been successfully used in the Alaskan halibut and sablefish fishery and the Bering Sea crab fishery.

The CFF is a dedicated fisheries fund capitalized by the State of California and several private foundations. It makes loans to community fishermen and fishing businesses in California, Oregon and Washington to help them succeed in fisheries undergoing management reform. Loans have been used by fishermen for vessel purchases and upgrades, gear switching and permit purchases; and by processors and offloaders for infrastructure improvements and working capital. Both the FFP's IFQ Loan Programs and CFF are useful models that should be replicated in other regions throughout the U.S.

There is also the potential to better use other existing government loan and guarantee programs including those offered by the Small Business Administration or model new programs based on successes in affordable home and U.S. Department of Agriculture lending. This is an area worth further exploration.

Technical Assistance

In adapting to the changing business landscape, fishing businesses need more than money. They often need deeper business and management skills to run viable and profitable operations. These skills may include business planning, data collection and management, quota management, product marketing and fund raising. Fishing communities looking to form and run CFAs often need assistance with organizational development and governance, leadership training, strategic planning, resource management and fund raising.

These skills and expertise can be in short supply, especially in smaller communities, and can be difficult and expensive to acquire. While the success of NMFS in fulfilling many of its MSA objectives depends on the development of these skills and expertise, NMFS is not well positioned to provide them directly. However, government, as well as private foundation grants, can be critical to facilitating the development of these skills and expertise.

NOAA grants through the Saltonstall-Kennedy grant program and Commerce Economic Development Administration or other government Community Development grants have been mentioned as Federal sources of seed money that may be scaled to meet this need.[1]

National Fish and Wildlife Foundation's Fishery Innovation Fund is a grant program designed to foster innovation in the fishing industry through priorities including community capacity-building. It is an example of an organization with a strong track record of supporting technical assistance programs, and particularly those that benefit CFAs.

Grants provided through a wide range of public and private sources have helped build a growing group of organizations with fishery expertise that work closely with the fishing industry. These include Amplifier Strategies, CapLog Group, CEI, Community Fisheries Network, Future for Fish, Gulf of Maine Research Institute, and Lisa Wise Consulting, among others.

NMFS and the Councils should continue to promote the involvement of non-profit organizations, private companies and industry leaders in providing needed technical assistance to communities. Further, the agency should facilitate access to expertise in finance and business and incorporate these issues early in the process of designing new management plans.

Timely, Quality Information

Access to information, both fishery-independent and fishery-dependent, is critical to NMFS and the Councils for designing and implementing fishery management plans. It is also critical to the fishing industry: to be compliant with management rules, but more importantly, to run efficient and profitable businesses.

Data requirements have increased significantly over time with the increasing sophistication of management plans, more data-driven annual catch limit setting procedures, and greater accountability measures. And NMFS faces significant and expected challenges collecting, warehousing, integrating, analyzing and reporting on this ever-growing pool of data.

Timely access to quality information is critical for fishermen to succeed, especially in catch share fisheries. This is particularly important for smaller-scale fishermen who have fewer resources both to collect third-party information and to absorb the risks that come from poor decisions made with no data or poor quality data.

One example of this is the potentially long lag between when a fisherman records his catch in his logbook and when that information is reflected in his vessel account. During this interim period, it is difficult for the fisherman to plan future fishing trips, not knowing how much fish he has left to catch in that fishing season. Another example is the lack of detailed and current reporting on the market for quota leases and sales. Without this information, it is difficult for fishermen to make intelligent decisions on when to buy and sell in these markets and at what price.

Improving data management should be a priority for NMFS. Keeping costs manageable, both for NMFS and the fishing industry, should be one important objective (as discussed above regarding monitoring and reporting) in this process. Equally important objectives should include improving the quality and consistency of data (both collected and reported), and the timeliness of its availability to the fishing industry.

Improvement could come from identifying and replicating best practices within the agency, evaluating approaches used in other government or private sector contexts, and potentially from outsourcing some portion of this responsibility to experienced third parties.

1 Catch Shares & Commercial Fishing Communities Workshop, January 2011, Topic 7, "Facilitating Community Organization Efforts." http://tinyurl.com/atdes3z

Promoting Innovation and Entrepreneurship

NMFS and the Councils face an especially difficult challenge delivering on their obligations to communities under MSA and the National Standards Guidelines. The issues are complex. The terminology can be confusing; the goals and objectives are not often clearly defined, and there are few reliable metrics to measure and evaluate progress.

Community issues are also very local, requiring fairly unique or customized approaches to properly address them. Every community has its own history, its own set of participants with their own values and priorities.

Against this backdrop, NMFS and the Councils work with limited resources and few tools to address community issues. In attempting to address them, management plans risk creating unintended consequences including reduced operating flexibility and higher costs for businesses. Refinement often gets pushed to a series of trailing amendments that creates greater uncertainty and instability.

To improve this process, new perspectives, tools and approaches need to be brought to designing management plans. A new process must foster more innovation, creativity and flexibility to better craft solutions to the circumstances of each situation.

An ambitious path forward would be to transition NMFS from its current role of controlling design and implementation of most aspects of fishery management plans to a decentralized model with NMFS and the Councils focused on setting goals and performance standards for management plans and enforcing compliance with those standards.

The intention would be to energize consortiums of participants from the fishing industry and the broader fishing communities together with other members of the private sector and nongovernmental community to take greater ownership of the design and implementation process.

The hope would be that this approach generates new solutions that better suit individual community needs and that are more adaptive to the rapidly changing circumstances in fisheries. Further, changing roles and responsibilities as suggested may help to build a greater level of trust and cooperation among fishermen, fishing communities, NMFS and the Councils.

Making this transition could be complicated and difficult, but there are possible models for what it might look like. In the U.S., cooperatives in Alaska and the risk pool created in the Pacific Groundfish Trawl Fishery to manage access to low abundance stocks are both good examples. Outside the U.S., there are other possible examples in developed countries such as Canada (British Columbia) and New Zealand.

Conclusion

Addressing community issues is one of the more difficult mandates the Magnuson-Stevens Act assigns to NMFS and the Councils. This task is clouded by two false points of view that need to be put aside. The first asserts that conservation and communities are somehow pitted against each other. The second claims that the most successful communities will be those that preserve some historical perspective of what communities have been.

To move forward, efforts need to focus on building the strongest possible communities capable of managing the current realities of a changing environment, evolving social priorities and a more demanding marketplace for seafood. While NMFS and the Councils have few tools to work with, there are several steps they should take to help communities, and the businesses that are a major part of those communities, adapt to rapidly changing circumstances.

First, they should keep costs of management reform as low as possible for fishing businesses by taking steps that include proactively adopting new processes and technologies, engaging private sector service providers where possible, and allowing small businesses to work collectively.

Second, NMFS and the Councils should facilitate small-scale operators' access to resources that can help them build stronger businesses. Specifically, they should work with the private sector and nongovernmental community to make available investment capital, technical advice on business and organizational topics, and fishery-related data that businesses can use to operate more efficiently.

And third, NMFS should strongly consider devolving responsibilities for both designing and implementing community-specific programs to the communities themselves in the interest of stimulating new and innovative approaches. Together, these steps can meaningfully improve communities' success, creating solutions that work best for them.

Darden Restaurants' Sustainable Seafood Vision

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Background

Darden is the world's largest full-service restaurant company with more than 2,000 wholly-owned and operated restaurants employing more than 185,000 people. We serve over 400 million meals a year through our eight brands, including Red Lobster, Olive Garden, LongHorn Steakhouse, Bahama Breeze, Seasons 52, The Capital Grille, Yard House and Eddie V's. Darden is also a growth company that expects to open approximately 400 new restaurants in North America within the next four years. This includes:

- Augmenting the number of our traditional brand units
- Optimizing non-traditional opportunities, such as synergy restaurants (two concepts in one building)
- International growth into the Middle East, Mexico, Puerto Rico, and soon Brazil, Colombia, Panama and the Dominican Republic
- Incubation of other business, such as our lobster aquaculture farm in Malaysia

Darden serves a wide variety of foods, but perhaps no food is more integral to our company's history and future growth than seafood, the single largest item in our "food basket." We rank as the largest end-user of multi-species of seafood in the United States, purchasing approximately 200 million pounds of seafood (live weight basis) annually and operating a global supply chain sourcing from 35 different countries. By 2016, we anticipate purchasing about 275 million pounds of seafood (live weight basis) annually. However, demand for seafood as one of the healthiest, affordable proteins available to feed a growing population is fast outpacing supply.

As a significant industry stakeholder, we appreciate the opportunity to offer the following comments and recommendations to Managing our Nation's Fisheries 3.

As a leader in seafood sustainability and an active stakeholder in the health of oceans and management issues, we see two aspects of the industry that, while independent of one another, are interrelated in the provision of a sustainable seafood supply to the U.S. market: the sustainability of the biomass, and the need for U.S. aquaculture.

Sustainability of the Biomass

For Darden, seafood sustainability is not only a social and environmental responsibility; it's a core business issue. Our future growth relies on our ability to remain a reputable stakeholder in the advancement of sustainable fisheries, ensuring the supply of seafood is available, affordable, and meets the quality and safety standards we expect. Investing our time, expertise and resources in the proper stewardship of fisheries supports our growth goals and desire to remain a great place to work.

While the health and productivity of our oceans and water ways are imperative, the manner in which the seafood industry engages the market has implications on business investment, consumer patronage and community development which holistically is involved with sustainability.

The seafood industry and government must be pro-active to address food safety, environmental and social justice concerns for consumers and the guests at our restaurants. Unfortunately, governments have neglected to act on certification standards and have left the door open for various stakeholders to define and to interpret what sustainability is and what science to elect for their standards. This has created a bountiful number of certifications and labels, resulting in inefficiencies in production and added costs with limited, if any, value to the consumer.

For Darden, sustainable seafood has been a cornerstone for our business. In 2012, we released our seafood platform to outline our vision and strategy:

Vision for Sustainable Fisheries

We envision a future where wild fisheries and aquaculture coexist in meeting the growing demand for healthy, safe, secure and sustainable food supply while preserving and enhancing ecosystems now and for generations.

Darden's Sustainable Fisheries Mission

Darden is committed to advancing this vision with a focus on **education**, **engagement** and **improvements** of fisheries.

Education

The concept of sustainable fisheries is complex. While most want to make a positive difference, there is an immense and diverse amount of practices, standards and science that can influence our actions. We may take it for granted, but there are a large number of people that are not aware of the concept of sustainable fisheries or the role that seafood will play in feeding the world. Meaningful groundwork still needs to be laid to ensure that there is continuous improvement and ownership at all levels of the seafood community. Darden believes education can play an important role to:

- Enhance Decision-Making—Darden will continue to learn from and listen to the perspectives of key external stakeholders including academics, government officials, industry leaders and nongovernmental organization. We will develop systematic approaches to better ensure our buyers are informed of the issues.
- Raise Awareness—Darden is committed to raise the awareness level with our employees, business partners and key external stakeholders.

Engagement

Effective supply chains require constructive engagement from a number of stakeholders. Ideally, engagement should focus on efficient and aligned policies, processes and standards to ensure sustainable seafood. Participating stakeholders should use the feedback and learning's to anticipate emerging issues and improve existing efforts. Darden believes a focus on engagement will lead to:

- Effective and Coordinated Efforts—Darden will continue to play a role and use its influence to develop industry standards and policies that support sustainable fisheries.
- Shared Learning—Darden will share our experiences with key stakeholders to help develop their own processes or programs and gain insights for the development of our approach.

Improvement

Darden believes that a holistic approach is necessary for sustainable fisheries. Part of our strategy means we are committed to working with and sourcing from fisheries that are sustainable based on the best science available at the time. While the degree of sustainability can vary from fishery to fishery, we will continue to work with fisheries to enhance their overall sustainability. Our approach will emphasize the importance of integrated managements systems to better ensure sustainable supplier practices and traceability.

- Fishery Improvement Projects—Darden is committed to the "Fishery Improvement Process" and will commit to three new projects over the next three years (see below).
- Integrated Sustainability Management Systems—Darden will develop and implement a sustainable management systems evaluation of our suppliers emphasizing continuous improvement by ensuring sustainability processes are integrated and tracked with incremental improvements in mind.
- Traceability—Darden is committed to have all products required by the Food Safety Modernization Act to be compliant with Global Standards One.

Fishery Improvement Projects

In 2011, Darden made a commitment through the Clinton Global Initiative to rebuild troubled fisheries by developing and launching three fishery improvement projects over three years. The first commitment we announced is in the Gulf of Mexico Reef Fish fishery in partnership with Publix Supermarkets and the Sustainable Fisheries Partnership. This cooperative alliance is working with NOAA and stakeholders in the region to understand the value electronic monitoring systems (EMS) have in reducing bycatch while improving the health of the fishery with improved data collection. After the first six months of study, the research indicates EMS is a viable alternative to observer coverage. This summer, we will enter the second phase of research by installing three to five EMS on boats with our suppliers in the Gulf. Moving forward, Darden intends to announce our second fishery improvement project by the fall and is working with the Clinton Global Initiative to identify the tools and resources other companies need to advance sustainable fisheries through cooperative alliances like the one in the Gulf.

Need for U.S. Aquaculture

The issue of long-term U.S. aquaculture to meet growing global seafood demand is of utmost importance. Sustainability of the oceans and waterways are imperative and the manner in which the industry engages the market is critical for the future growth of the seafood industry. However, global seafood supply and demand challenges offer dynamics that can influence both subjects dramatically.

The United Nations Food and Agriculture Organization has forecasted that the world's population will exceed nine billion people by 2050 and as a result farmers must produce 70 percent more food than today. Along with increased demand from a growing population, the transference of global wealth will have a direct effect on demand.

It is known that the proportion of animal protein in the diet increases with per capita income, with the exception of cultural and religious restrictions. As the gross domestic product (GDP) wealth transitions from developed countries to developing countries, the demand for animal protein will also increase proportionately. The question is: Will there be sufficient animal protein to fill the global demand?

It is understood that wild capture fisheries have plateaued at about 88 million metric tons (mt), and there are no new oceans to be discovered. Seafood demand, driven by population and income growth, is projected to create a supply gap of about 51 mt by the year 2030; with the largest insufficiency being in Asia. Aquaculture is the answer to fill that gap; however, the global aquaculture growth rate is slowing down, despite the fact that aquaculture seafood has the best feed conversion rate of any other animal based protein consumed in the U.S.

As the future GDP is expected to decline in the U.S., economic development is a concern as it relates to managing our future fisheries. Certainly it may be expected that developing nations may not have the same environmental and sustainability concerns that developed nations have today. As their wealth grows and demand for sea based proteins increase, this has the potential of reducing sustainability efforts in exchange for profit.

Additionally, we are beginning to see the effects of reduced income on animal protein consumption, as all animal-based protein consumption in the U.S. has declined in the past four years. There is a clear elasticity curve that has developed to show that as the cost of protein has increased in the U.S., the consumption has decreased. With regards to seafood consumption, it has declined from 16.2 pounds per capita in 2006 to 15.0 pounds per capita in 2011.

There is a growing negative balance of edible seafood exports to imports in both pounds and dollars in the U.S. This may grow as the GDP declines in the U.S., leaving less available seafood for the U.S. population. This is contrary to other animal-based proteins in the U.S. where approximately 14 percent of the seafood for consumption is domestic, while 91 percent of beef is domestic, 99 percent of chicken, and 96 percent of pork.

Aquaculture has the potential to fill many gaps that the U.S. is potentially facing. Therefore, we recommend the U.S. consider the value of a thriving aquaculture industry. The U.S. has one of the largest exclusive economic zones, and aquaculture can strategically fit into this space. With great advances in feed conversions, and energy and water use, marine aquaculture is becoming increasingly favorable vs. other animal-based proteins. The world needs food, and the U.S. requires jobs and support of fishing communities.

The real opportunity is to develop sustainable U.S.-based marine aquaculture. Sustainable aquaculture processes have been developed in Norway, Maine, Washington state, and Louisiana, among others, so it can be done. The focus should be on: a) high value species for fresh market; b) increasing focus on species with low impact that are more sustainable; and c) the revitalization of U.S. fishing communities. Third-party certification systems have been developed to create and certify compliance with standards: Global Aquaculture Alliance, Aquaculture Stewardship Council, and others. The U.S. is the best in the world at mass food production systems through leveraging science, technology, academia, and government resources such as U.S. Department of Agriculture, NOAA and the Food and Drug Administration.

However barriers to investment are numerous. There is an unclear and overlapping regulatory environment (NOAA, Army Corps of Engineers, Environmental Protection Agency, states, etc.). This requires an authority that has responsibility and accountability for an end-to-end, streamlined process. We recommend agencies align to coordinate regulatory requirements.

Marine aquaculture also requires long-term capital investment. However, existing regulations are onerous. We suggest that permits should require hitting key performance indicators or corrective steps each year to maintain approvals, rather than permit expiration and re-permitting.

Politics can negatively impact this effort in environmental, social concerns vs. consumer and business opportunities. We suggest the solutions rest in finding balance with focus on *sustainable development* and building collaborative, bipartisan, multi-stakeholder support.

Strategic focus for industry investment and government support, particularly in finfish aquaculture development, should be on the following: inshore; on-land offshore; technology enhancements; feed and nutrition; species domestication; closed-water systems and farm technology; and stock enhancement strategies.

In conclusion, the major factors effecting the management of our oceans are numerous but not insurmountable. Certification efforts have created inefficiencies, complexity, confusion and unnecessary expense; food security issues in a world with more than nine billion people are likely to increase. However, seafood is a healthy food that can positively contribute to U.S. diets, and our country has a trade balance and jobs problem which can be assisted with aquaculture. Feed conversion, space needs, energy and water use are issues with all food production systems, and are less problematic with aquaculture. Wild harvest and aquaculture can co-exist: marine aquaculture in U.S. waters can contribute positively to all of these key issues. Environmental and social concerns can be addressed through learning from existing sustainable developments; and political concerns can be addressed by creating a multi-stakeholder support team and education outreach.

CUTTING UP THE CATCH. PHOTO: RICH LUHR, FLICKR CREATIVE COMMONS (LICENSE CC BY-NC-ND 2.)

DISCUSSION SUMMARY AND FINDINGS
Session 3 Topic 2

Integrating Community Protection, Jobs Emphasis, and Domestic Seafood Quality Assurance

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Discussion Summary and Findings: Integrating Community Protection, Jobs Emphasis, and Domestic Seafood Quality Assurance

Fishing community sustainability means more than just ensuring the biological stability of fish stocks. Management mechanisms to control or rebuild fish stocks, such as annual catch limits, need to be coupled with strategies that address the social and economic needs of fishing communities.

Used alone, fishing controls to improve biological outcomes often fail to align with employment and community goals, as the former often cause short- and long-term adjustments to fishing capacity in both commercial and recreational fisheries. This is also true for other fishery management policies designed specifically for social or economic efficiency, such as catch share programs. Undesirable community or employment outcomes in commercial and recreational fisheries that can occur as a result of management actions may include unchecked consolidation, impediments to future entry into the fishery, and disproportionately negative impacts on small scale, local, owner-operated, or geographically-limited fisheries. These management decisions may also exacerbate the loss of working waterfront infrastructure. Examples might include closures of ancillary or small support businesses such as ship chandleries, repair businesses, charter fishing operations, fishing tackle stores, restaurants, or hotels.

Despite these potential conflicts, the discussion for this session considered how biological and social goals can be integrated and how the goals can and should complement one another. Communities can play a key role in environmental stewardship and fisheries governance. Abundant resources, and a belief that there will be access rights to these resources now and in the future, were fundamental principles underlying the discussion of community stability. In this session, participants discussed specific tools, methods, and means to protect the integrity and infrastructure of fishing communities. A major focus of the discussion was on achieving optimum yield in the face of future transitions in fishery management strategies, and changes to ecosystem and economic conditions.

The effects of fishery management policies must also be considered in the broader context of changing market forces (such as globalization and increased consumption of seafood in Asia and globally). While the conversation highlighted concerns regarding the use of aquaculture (with respect to finfish aquaculture and the food sources used), there was widespread recognition in the room that wild-capture harvest alone cannot meet the rising world demand for seafood. There is a need to use a range of tools, including aquaculture, to produce seafood.

Discussion during this focus topic centered on whether and to what degree "community-friendly" tools, including legislative, policy, and regulatory changes, are necessary to promote community sustainability. This included elements affecting the infrastructure and working waterfronts necessary to support communities, as well as the tools and processes necessary for their success in the future. Discussion included examples of how these ideas and changes could be applied.

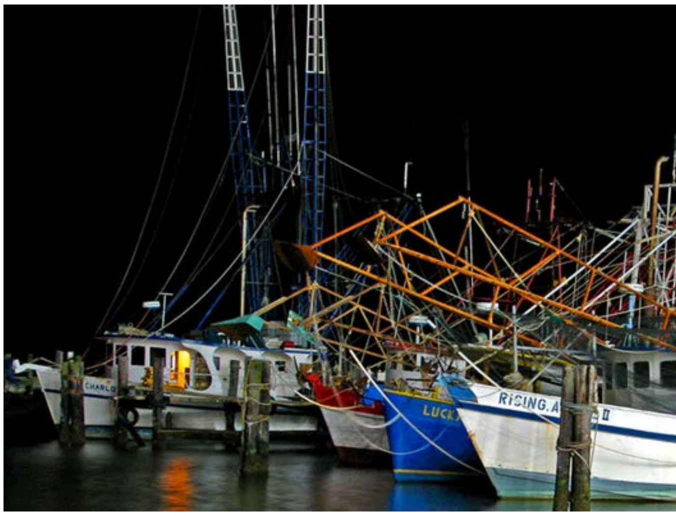
The conversations concluded that we need to move away from the assumption that the best way forward is by preserving the past. The focus needs to be on building strong, resilient communities, not on preventing communities from changing.

The results fell into three main categories: potential responses to changing market forces; possible adoption of new management tools that may broaden the economic base of seafood-based communities (such as integrating aquaculture with fisheries); and exploring the appropriate roles and responsibilities of communities, government, and private sector third-parties in finding ways to support and improve fishing community sustainability.

The following paragraphs highlight major points made by the speakers, panelists or audience participants. They do not represent consensus, but indicate significant ideas or directions for further thought or pursuit of action.

Work to Provide Stable Management

Stable management promotes community sustainability and stable employment. Recognizing that for fishermen, keeping costs low can be more important than high revenues to provide constancy year over year, agencies and Councils should work to keep management reform costs as low as possible. In the short-term, changes to management and regulations may force businesses to change practices, typically requiring more investment and particularly disadvantaging small businesses. The discussion acknowledged that in the short-term, stability of rules may not mean stability of outcomes or of stocks.



Devolve More Responsibility and Accountability to Industry

Devolving management responsibilities and costs to industry stakeholders and local communities was identified as a way to reduce societal costs and stimulate innovation and accountability. In the case of monitoring, higher average costs are more burdensome to smaller operators, as they represent a larger percentage of their revenue. Electronic monitoring is one way for industry to meet monitoring objectives at a lower cost. As an added benefit, electronic monitoring could allow for data to be collected from more vessels. Many examples can be derived from states. For instance, in Alaska, fishermen have taken over the hatchery system and work with the Alaska Department of Fish and Game to manage the system. Additional examples from Maine include the co-management of lobster and sea scallop fisheries.

Set Performance Standards, but Allow Flexibility in the Tools Used

Setting performance standards, while allowing more flexibility in how those standards are met, could reduce costs and offer a way to devolve governance. For example, if the industry is already capturing data, there should be an evaluation to see if these data can be used to satisfy other Federal and state requirements to ensure that effort and costs are not being duplicated. Data collection and management were both identified as opportunity areas. This approach could be applied and standards could be set without requiring the industry or communities to use specific tools or technologies.

Provide Better Access to Data

By giving fishermen more and timelier access to data, they will be better equipped as decision makers. A lack of data transparency can disadvantage smaller operators and new entrants in particular. Addressing confidentiality challenges and making more data available online would benefit multiple groups of stakeholders. These data should also be presented in a clearer, more understandable way. Providing better access to the lease and quota sale market in catch share fisheries would be particularly helpful for smaller operators, as larger operators have better proprietary markets for obtaining this information.

Provide Common Data as a Starting Point for Discussion

Providing stakeholder groups with common data and reports provides a shared framework for discussion. In particular, socioeconomic data should be presented in a clearer way and it should be more clearly tied to biological data. Tying biological data to socioeconomic data would provide an additional way to consider management needs in a more integrated way and to understand that improving indicators in one area does not necessarily require negative effects in the other. At the community level, reliable metrics would be needed to evaluate progress. In a collaborative process, the National Marine Fisheries Service (NMFS) Northeast Region created a set of performance measures that could provide a case study for use elsewhere.

Increase Stakeholder Engagement

While the Magnuson-Stevens Act and National Environmental Policy Act include processes for engaging fishermen and gathering community input, fishermen's and communites' participation in management may still be limited. There is a need to better engage communities in management. The North Pacific Fishery Management Council was recognized as a good example of state, local, Federal and industry partnerships. Other groups may be missing from the Council and Commission process. State-registered fishermen who fish in waters designated as critical habitat for Federally-managed stocks should have a voice in the Federal decision process for that area. As recreational fishermen often fish in areas outside of where they live, their needs should also be considered. Devolution may be one way to encourage participation across different levels.

Link Ecosystem-Based Management Scales to Fisheries Management and Governance

There is growing recognition that there is a need to manage at the local, fine-scale ecosystem level. Federal agencies and Councils have limited tools for managing at the local ecosystem level. This area-based approach may create an opportunity to better engage fishing communities in co-management, and it can result in better biological outcomes by increasing habitat protection, sustaining genetically distinct stocks that are normally managed at the regional level, and by facilitating more holistic ecosystem-based management. To foster more area-based management, National Standard 3 of the Magnuson-Stevens Act should be re-evaluated. In particular, the focus on management units should be evaluated to facilitate management at the sub-regional level.

Providing the flexibility to allow for multiple forms of governance and managing at different levels can also facilitate the use of adaptive management, allowing for quicker management action (e.g., the closing of an area when necessary). A decentralized model, with agencies and Councils setting goals and performance measures, could allow for greater local control. Territorial use rights fisheries could be considered. With these fisheries, an allocation is made for a given area, as opposed to allocating quota. A framework could also be set up to move towards adaptive management in some nearshore areas. This could be done through pilot projects, including public-private or state-Federal partnerships, with some amount of delegation to the sub-regional level. In the case of clams in Maine, one benefit of working at the local level was that it taught fishermen that regulation-setting is a fluid process. You may not get the regulations "right" on the first try, but the approach can be modified to better meet objectives.

Provide Management Tools and Support to Enable Management at Sub-Regional Levels

While there is value in moving towards more local control, local groups will likely need additional resources to achieve management goals. Oversight is also necessary. Participants cautioned that local control on its own does not make management inherently more sustainable or effective. Even in Maine's municipal clamming sector, which has been a major success, access rights can be abused.

Elevate and Promote Best Practices; Become a Learning Organization

By considering what has worked in other fisheries, agencies and Councils could play a role in sharing best practices, evaluating approaches used in different fisheries and regions that might be adopted elsewhere, and providing education. Best practices can then be evaluated, adapted, and applied in multiple areas. Part of the evaluation process should include learning from others. Examples cited included state-managed fisheries, Fisheries Improvement Projects, and projects funded by the National Fish and Wildlife Foundation.

Better Utilize the Cooperative Research and Management Program Provisions

There was strong interest in building a cooperative research program that benefits the industry and scientific community using the existing Magnuson-Stevens Act authorities under Section 318. However, more defined ways are needed to ensure collaboration. Participants noted that Congress has shown interest in supporting cooperative research through funding. Collaborative arrangements that have worked well can be evaluated to determine if they could serve as a model for other regions and fisheries. Collaborative research provides the added benefit of increasing trust in science and providing a learning opportunity. [Editor's note: This last point on improving trust in science through collaboration was also made repeatedly during the Session Three / Topic One discussion on Recreational and Subsistence fisheries.]

Facilitate the Creation of Community-Based Allocations

Removing barriers that make the creation of fishing communities, Regional Fishery Associations (as defined in the MSA), and Community Fishing Associations time-consuming and expensive is one way to strengthen community protections. Creation of these entities could allow for smaller-scale fishermen to pool resources and benefit from economies of scale, potentially avoiding consolidation where it is undesirable. These entities present an opportunity for fishermen to work together voluntarily. When new management plans are being developed, Councils, NOAA Fisheries, and fishermen should partner on defining community goals. In reauthorizing the MSA, consideration should be given to including communities of interest in National Standard 8.

Evaluate the MSA Requirements for Fishing Communities and Regional Fishery Associations

While the MSA has provisions in Section 303A for establishing "Fishing Community" and "Regional Fishery Associations" entities, some stakeholders consider the statutorily-required process to be too complex and the requirements to be too difficult or risky to comply with. The result is some groups choosing to not pursue the creation of these community entities. To date, none of the Councils have set up provisions for establishing Fishing Community or Regional Fishery Association entities within the parameters defined in the Act. There was strong interest in the benefits that could result from use of these entities as a means to hold limited access privileges in a particular fishing port. A determination should be made if additional guidance is all that is needed, or if changes to the MSA are required.

In general, rules should not preclude groups of fishermen from working together, but should facilitate cooperation among fishermen. Risk pools and cooperatives in the Pacific groundfish fishery were cited as examples of how fishermen have been able to collaborate for mutual benefit. Sectors in the Northeast that can also offer positive examples of cooperation. Additional application of the Fishermen's Collective Marketing Act of 1934 should be considered.

Create, Modify and Promote Financial Tools and Training

The fishing industry is unlike most shore-based businesses from an investment risk and business management perspective, and few programs exist to support their development, growth or sustainability. To better enable the fishing industry to run profitable businesses, there is a need for business expertise and business training capacity building. These offerings would be particularly helpful for small and community-based borrowers. Offering training to commercial fishermen or their children on topics such as how to put together a business plan would help them raise capital and lower a barrier to entry.

Develop a Central Registry and Facilitate Lending

Limited access to capital can impede fishing businesses' ability to make necessary investments to stay in business or grow. While some of fishermen's most valuable assets are their permits and fishing privileges, lenders may not accept these assets as collateral for a bank loan. A registry is needed, as prescribed in the MSA, to provide a central database where lenders can validate title to fishing permits and privileges. Another way to facilitate lending would be to engage lenders in the fishery management process. Doing so would allow for lenders' needs to be considered when management plans are being designed and implemented. There are also existing finance programs that could be expanded or used as models to design new programs that would facilitate lending (e.g., NOAA's Fisheries Finance Program and the California Fisheries Fund). Limited access to capital also limits aquaculture business growth. Lease terms that do not allow for enough production cycles before the lease is up for renewal do not give aquaculturists enough time to learn from experience. For example, if a lease is up for renewal before a fish farmer has enough production cycles to learn from experience, the business may be at risk. Longer lease cycles may be needed, depending on the fish or shellfish species being farmed.

Create a Streamlined End-to-End Process for Aquaculture

Businesses need to feel greater security in the regulatory process for aquaculture in order to make investments in the U.S. versus overseas. The regulatory environment is often unclear and includes overlapping rules. More leadership from the Federal government is needed to reduce regulatory challenges. One approach would be to create the authority within a single agency to coordinate the aquaculture permitting process. From an environmental stewardship perspective, there are transfer effects of limiting aquaculture growth in the U.S. when U.S. consumers purchase products from countries with lower environmental and labor standards.

Promote and Provide Opportunities to Diversify into Other Fisheries and Aquaculture

Many fishermen do not identify as being tied to only one particular species (e.g., as only a cod fisherman or a sablefish fisherman). They see themselves generically as fishermen, and are interested in pursuing a diverse set of fisheries that can result in a profit. Ensuring fishermen have access to a diverse set of resources offers security to protect against changing environmental conditions, stock abundance levels, and market levels. Aquaculture represents another way for fishermen to diversify and weather regulatory and environmental changes. Aquaculturists have more control over production costs and can choose when to harvest their product. This added flexibility could allow fishermen to ride out regulatory and environmental changes.

Increase the Value of Stocks

Seafood quality helps to ensure market access and is a primary determinant of ex-vessel price. Fishermen are fishing for the value of the fish, not the quantity. If the price is higher, revenues can stay constant or go up even if fishermen catch fewer fish. From a seafood buyer's perspective, this does not necessarily pose a problem, as sales depend on what the consumer is willing to pay, not just the product's cost. Aquaculture and wild-capture product also do not have to be viewed as in direct competition with one another. In this case, wild-capture product can be viewed as providing a price premium.

Various techniques have been used to increase prices. For Maine lobster, the industry was able to increase the value of the product by changing handling procedures, which resulted in a higher quality product. Alaska salmon offers a good example of a state-supported public-private partnership where groups collaborated to raise the value of the harvest. Alaska transitioned from cans to fillets and used aggressive marketing campaigns. In the case of Copper River red salmon, they also developed a nationwide campaign that allowed for an increase in price.

Increase the Market for More Abundant Stocks

Another option to provide more fishing opportunity and increase revenue is to create a market for more abundant, underutilized stocks. This requires moving consumers out of their comfort zone and educating them about less well-known stocks. One way to do this is through Community Supported Fisheries (CSFs), which are similar to Community Support Agriculture. In a CSF, a group can band together and sell assorted catch directly to consumers at a higher market value than those species would normally have. With a CSF, the consumer does not just know the supply chain; they know the fisherman who brought in the fish. Consumers are exposed to unfamiliar stocks, opening up new markets for fishermen; they are educated about ways to prepare the fish, and are more closely tied to the local fishing community and the source of their food.

Recognize Fisheries Managed Under the Ten MSA National Standards as Sustainable

The discussion highlighted a widespread interest in providing better recognition that U.S. harvested seafood is managed sustainably. This is becoming more important as participation in certification programs is increasingly becoming a requirement for market access. Concern was expressed about third-party certification program requirements that go beyond providing for a healthy stock. For seafood businesses such as restaurants and retail stores, many consumers trust the brand to ensure that the seafood they purchase is sustainable, as a consumer would trust the brand to provide safe seafood. Buyers are looking for consumers to trust their brand. The front-table participants acknowledged the benchmarking approach of the upcoming Global Sustainable Seafood Initiative as one means to level the playing field and protect against market dominance by a particular certifying entity. Another approach suggested was Alaska's use of the United Nations Food and Agriculture Organization's Code of Conduct for Responsible Fisheries.

One suggestion that appeared to have support was to place greater emphasis on the connection between fish managed under the MSA as a sustainable food product through the addition of legislative language during the next reauthorization of the MSA. The need to acknowledge sustainably managed state and local fisheries was also recognized, though they are not managed under the ten national standards.

Ensure There is a Plan to Provide for Future Access to Resources

There should be a plan to allow future generations of fishermen to resume fishing once a stock rebuilds. To ensure that access to resources will exist in the future, plans are needed for dealing with closed areas when stocks are rebuilt and in areas where permits are not transferable. Providing fishermen and communities with assurance that resources will be available in the future promotes environmental stewardship in the present.

FISHING DURING HIGH WATER NEAR THE MISSISSIPPI DELTA. PHOTO: DON PIROLO, FLICKR CREATIVE COMMONS.

PAPERS

Session 3
Providing for Fishery Community Stability

Topic 3
Assessment and Integration of Social and Economic Tradeoffs

Allocation between Recreational and Commercial Sectors in U.S. Marine Fisheries: A Recommended Approach

Jim Martin
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Allocation between recreational and commercial fisheries has always been a difficult issue, fraught with emotion, stress and competing views of economics, efficiency and fairness. In my 44 years of experience in fisheries management, I have found few issues that are as potentially powerful in increasing net economic benefits to regional/national economies and supporting more jobs—and as universally avoided by managers. One of the reasons that allocations are "rusted shut" in current marine fisheries is that there is a lack of forcing mechanisms to regularly review allocations, and a lack of standard practices for proceeding. Thus, very few managers or fishery management Councils are ready to tie up the staff time and agenda time, and willingly submit themselves to the political stresses of a potential reallocation. It is just far easier to allow the status quo to continue until it is so dysfunctional that change is forced upon the manager by political forces.

Background

Many mixed-sector fisheries were once primarily commercial fisheries. In the days before the first Magnuson Act in 1976, many fisheries in state waters were lightly regulated and the concept of a Federal Exclusive Economic Zone (EEZ) did not exist, so deeper water fisheries were largely unregulated. With the establishment of the EEZ and the development of the Regional Fishery Management Councils in the 1970s and 1980s, there was a concentrated effort by Federal government agencies to work cooperatively with commercial fishing interests to develop gear and fishing techniques to fully prosecute fisheries in the EEZ, many of which had formerly been dominated by foreign fishing fleets. Recreational fisheries were largely overlooked and were often impeded by inadequate gear and inadequate interest in these deeper-water fisheries.

Therefore, in the 1990s when many recreational/commercial fisheries allocations were established for mixed-sector fisheries, historical catch percentages were deemed fair and appropriate as a basis for the first formal allocations. These historical allocations were the product of minor and undeveloped recreational fisheries competing with industrial commercial fisheries that had experienced major government support in development. Often these fisheries were operating in a lightly regulated structure or were totally unregulated. Once the shares were set by the Councils, they often continued for decades, deemed as "fair." In the succeeding years there has been huge growth in interest by recreational anglers and the development of gear that allows recreational anglers access to deeper water species that were formerly inaccessible.

Today, many mixed-sector fisheries still have sport/commercial allocations left over from a time when the fisheries were both larger and unregulated. As fisheries are constrained by management, many people recognize that a reallocation of smaller, more modern fisheries could lead to greater economic benefits and support more jobs with a lighter conservation burden, but the stress of reallocation is too much for many managers to take on.

Two notable exceptions have been the reallocation of Pacific coast coho salmon in the 1980s by the Pacific Fishery Management Council and the current effort to examine allocation of the snapper/grouper complex in the Gulf of

Mexico. The reallocation of Pacific coast salmon greatly increased economic benefits, and the same seems likely in the Gulf of Mexico now.

However, these two examples are among the very few efforts by Councils. They point to potential economic benefits in other areas, in other fisheries, that could be realized with a systematic and regular examination of allocation. Most importantly, there is a lack of a policy framework for regularly reallocating fisheries in order to maximize the economic and conservation benefits of these fisheries to the Nation, as was originally envisioned by the Magnuson Act.

Solutions

The first issue is the lack of a forcing mechanism that requires a public review of the potential for reallocation to improve economic and conservation performance of fisheries. Currently, it is up to Regional Fishery Management Councils to decide when and if reallocations will be opened up for review. In many cases, even though the evidence is strong that reallocation could substantially improve results, the resistance by commercial fishing interests and the prospects for a long, controversial, and stressful process causes the Councils to punt and allow outdated allocations to continue. NOAA Fisheries seems to have no opinion on the topic, just allowing the Councils to decide the issue. That needs to change.

A regular review schedule is needed—perhaps a review of all significant mixed-sector fisheries every five years, with a transparent and public decision by each Council as to which, if any, fisheries merit a more detailed and intensive analysis of the benefits and impacts of reallocation. This first level review is what one might call a "scoping review," as opposed to a formal reallocation process, and might summarize current status and trends of economics, demand, substitutes, jobs and conservation impacts.

As a result of such a review, the Councils could report to their constituents and to NOAA Fisheries on which fisheries should continue with status quo allocations and which have are worth a more intensive review and possibly an allocation change. This would allow the public to comment on the scoping analysis and to recommend action.

The second issue is the development of standard practices and criteria by which to evaluate the potential for a reallocation. Currently, there seems to be a lack of standard practices for conducting a reallocation analysis, leaving every interest group to suggest their favorite way of viewing economics, jobs, efficiency and conservation. What is needed is for NOAA Fisheries to develop a checklist of issues to be addressed in any reallocation process, along with standard practices for conducting such analyses. Any analysis should include a comparison of the economic value of recreational and commercial fishing, and an analysis of substitutes to determine if a reallocation would cause a net loss of jobs and economic benefits, or simply force a shift to substitute species or fisheries.

Market Forces as a Solution?

With increased interest in catch shares or individual transferable quotas in many commercial fisheries, some have suggested that the solution to reallocation is to provide ways for recreational fishers to individually or collectively buy quota share from commercial fishing interests. Although NOAA Fisheries has mentioned this potential in its catch share policy, no action has been taken. Recreational fisheries interests believe that while such a mechanism should exist and might provide a solution for misallocated fisheries, this is not a substitute for the public responsibility to regularly review allocations.

Summary of Recommendations

We recommend that NOAA Fisheries, in cooperation with the Councils, develop a schedule of allocation reviews in significant mixed-sector fisheries, covering all fisheries every five years. The Councils would be obligated to take public testimony and recommendations regarding the adequacy of the scoping analysis and whether it is time to reallocate a fishery. We envision that NOAA Fisheries would develop a standard protocol for conducting the scoping

analysis and would provide summaries for Council consideration. Then, if the Councils decide that the evidence and the testimony are compelling enough to take on a formal allocation review, it would be the Council's responsibility to coordinate the more elaborate analysis.

Secondly, NOAA Fisheries should develop guidance on the issues that should be considered when a formal reallocation analysis and potential reallocation decision is considered. Guidance is needed on standard practices for estimating the impact on economics, jobs, conservation and other societal values. By developing standard practices, we might be able to avoid the "dueling economists" problem that plagues this issue and to determine the scope of analysis that should be required to ensure an adequate basis for reallocation.

Such guidance is provided by NOAA Fisheries in other aspects of management, such as the development of annual catch limits and rebuilding plans. This guidance on allocation analyses is long overdue, and its absence makes the process of considering allocation almost an overwhelming hurdle, due to its potential stress and acrimony. Thus, this issue is "rusted shut." The resource, the economy and our communities deserve better.

Value Tradeoffs in Fisheries Management

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Introduction

Fisheries management inevitably involves tradeoffs. Most of these tradeoffs are implicit rather than explicit in management decisions that typically focus on one source of value without regard for others. Economics can improve fisheries management in four ways: 1) provide a framework to make value tradeoffs explicit and transparent, 2) help managers to avoid unintended consequences by studying economic behavior, 3) design new policies that align incentives of fishermen (and other stakeholders) with the objectives of management, and 4) evaluate the causal impacts of policy interventions. I focus on the first of these contributions in this paper.

When a decision implies giving up economic value of one type to gain it for another, economic analysis can help to balance the two. But there are other times when decisions imply trading economic value for something non-economic, such as social considerations. Although in these situations managers may choose not to maximize total economic value, economic analysis can at least quantify what is lost and what is gained. Because most fishery resources are part of the public trust, it is reasonable for citizens to expect this minimal level of transparency.

For decades, economists have had a strong theoretical understanding of fisheries management at a fairly abstract level. Given a single stock of fish with known population dynamics that exists in isolation from other species—both ecologically and economically—and assuming we know market demand and costs of harvest, one can derive the profit-maximizing long-run harvest as well as the short-run transition harvest that gets the stock to its long-run desired level. However, the relevance of this normative guidance for fisheries management is limited because real fisheries do not exist in a stylized vacuum and are fraught with complications. Some complications are technical challenges that highlight how management decisions implicitly trade off commercial fishery values. Much of fishery management is about setting quotas, and biological considerations often tie the hands of managers. Other complications involve broader economic values involving multiple sectors and a mixture of market and non-market values. As fishery managers seek to define "optimum yield" (OY), they must confront these many complications. It is not necessary for managers to buy into the economic perspective on how to define the optimum in order for normative economics to be useful. By quantifying economics values, normative economics can facilitate a more systematic evaluation of potential outcomes of management decisions and improve the transparency of decision-making.

The issues that call for economic analysis of tradeoffs are well known in fisheries management. Most notably, the world's leading fisheries scientists cannot assess fish stocks and estimate population dynamics with perfect accuracy. Some fisheries are more difficult to study than others. In the face of stock uncertainty, fishery management with acceptable biological catch (ABC) control rules implicitly trades off reduced expected harvest against risk of overfishing, a decision that can significantly affect flows of economic value over time. Moreover, no species is disconnected from its food web. Some species serve roles in the ecosystem that may justify leaving more or taking more of the stock. On the economic side, harvest costs are notoriously difficult to measure, greatly complicating the determination of OY. Bycatch and multispecies targeting are economic dimensions that connect species in the water and, like ecological interactions, challenge managers to think beyond single-species management. And economic interactions are not limited to the water; consumer demand for substitute seafood products or other sources of animal protein ultimately connect fishery resources once they are landed. All of these technical features of fisheries introduce tradeoffs, but usually these tradeoffs are implicit in management decisions. Consideration of other types of value—such as commercial values from other uses of the oceans and non-market existence values non-market value from recreational fishing—further reinforces the need for economic analysis to support management decisions.

Economic Value Versus Economic Impact

One of the most challenging issues in fisheries management is the potential for tradeoffs across economic value and economic impact, concepts that are often confused. Value is the net contribution of an economic activity to society, whereas impact is the gross amount of spending from that activity. Pursuit of economic value may actually decrease economic impact. Consider two hypothetical businesses that have different revenues and costs. Business A has $100K in revenue and $60K in costs, whereas business B has $90K in revenue and $30K in costs. Which business would you rather own? Without any other information, it is clear that B is preferred because revenues net of costs are $60K compared to A's net revenues of just $40K. Business B generates more economic value than business A. However, it would appear that business A generates more economic impact. It has higher revenues. Moreover, because A's costs are higher, more money may be churned through the local economy, and A may provide more jobs. Thus, there is a potential tradeoff across economic value and economic impact.

Now suppose these two businesses are fishery operations harvesting the same resource in two different hypothetical worlds. Business A is mildly overfishing in a regulatory system that is highly inefficient and drives up costs (e.g. regulated open access with a total allowable catch [TAC] set too high), whereas B is harvesting sustainably and minimizing costs (e.g. catch shares with TAC set at the right level). In this situation, part of A's greater economic impact is attributable to overfishing. The way we define OY under the Magnuson-Stevens Act (MSA) does not allow us to choose higher economic impact by overfishing. But we can choose economic impact over economic value if we are not overfishing. This means that adjusting the TAC downward in the business A institutional setting, but preserving the otherwise inefficient management regime, is allowed. Managers essentially are allowed to trade economic value of public trust resources to support jobs in a particular sector of the economy. Of course, this hypothetical presumes that there is a tradeoff between employment outcomes and economic value in fisheries management. This issue is much discussed and an emerging topic of research in fisheries economics. What little empirical evidence that is available suggests that employment outcomes are not compromised by managing for economic value with catch shares.

Although the appropriate comparison for employment outcomes is with and without a particular policy and holding all other dimensions of a fishery constant, initial conditions in fisheries management make it difficult for this comparison to be made. Many fisheries managers have inherited overfished stocks and overcapacity, and these starting points greatly complicate the way the forward. Stakeholders grew accustomed to high levels of catches and employment. The stylized normative economic model of harvest presumes that managers can shut fisheries down entirely to rebuild to the desired long-run stock level or, if the stock is above the long-run level, the number of fishing vessels is taken as given. It may not be possible to support historically high levels of employment and number of vessels in some fisheries while avoiding overfishing. But when possible, it may be extremely costly in terms of value to sustain these economic impacts.

While the legal requirements of the MSA limit what managers can do, managers are free to define OY with measures that decrease economic value but concentrate it in local communities as long as overfishing is avoided. In essence, policies are allowed that stimulate overcapacity, such as industry-wide quotas. In the extreme, this management approach can lead to high levels of short-term employment with short seasons and product gluts. My opinion is that society should maximize total economic value from marine resources, but if managers choose to give up economic value in the name of economic impact, this tradeoff should at least be made transparent so that all parties know what is being given up.

An example from my own research serves to illustrate further the distinction between economic impact and economic value, and provides a cautionary tale about the use of economic impact. In two papers, I analyzed the effects of hypoxia (low dissolved oxygen) in the Neuse River Estuary on the North Carolina shrimp fishery. The first paper showed that the environmental disturbance led to a roughly 13 percent decrease in revenues (approximately $1 million/year). The second paper showed that the corresponding lost economic value was between four and five percent of revenues (roughly one quarter of the raw revenue losses or $250,000 per year). The difference is attributable to fleet behavior (specifically decisions about how often to participate) and the cost structure of the industry. Both numbers contribute to understanding the scale of the hypoxia problem, but only the second number is relevant for policy analysis. To illustrate why, suppose that hypoxia only affects the shrimp fishery. If society spent the entire $1 million revenue loss to clean up the environment, the result would be a decrease in net economic value of $750,000 because the gain in value would be only $250,000.

Direct Market Value, Indirect Market Value, and Non-Market Value in Fisheries

Stock Effect

A classic example of direct value in commercial fisheries that would adjust the OY is the stock effect. For some fisheries, the costs of harvest are significantly higher when the stock of fish is low. This can lead to situations in which the desired long-run stock from an economic point of view actually exceeds the stock level that would sustain maximum sustainable yield (MSY). Of course, there are other situations in which the desired long-run stock is below the MSY level. The MSA allows managers to adjust OY to account for the former but not the latter; the stock can be above the MSY level due to economic considerations, but not below it. This creates an interesting asymmetry in that economic value is sometimes but not always allowed to enter into management decisions. Managers' hands are tied on one side of MSY but not on the other.

Forage Species

Some economic value in fisheries stems from the indirect contribution of one species to the harvest value of another. This is the case when multiple fished species interact ecologically. An important current concern is forage fisheries, where forage species are food for higher trophic species that often have higher market prices. The recent Lenfest report on forage fisheries attempts to evaluate tradeoffs across forage species and higher trophic species, but failure to characterize the economic tradeoffs sensibly leads to policy advice that could be misleading. Specifically, the report uses forecasted revenues in different fisheries as the basis for evaluating economic tradeoffs (i.e. using catches weighted by ex vessel prices). Our simple example above of businesses A and B illustrates how misleading this could be if profit margins are not the same across fisheries; it might be possible to increase revenues while decreasing economic value. One might reasonably object that the cost issue could cut either way, but there are some typical differences between fisheries for forage and for high-trophic species. Most notable is that forage species tend to school, which is consistent with low or no stock effects in the cost structure of the fishery. Whether this cost advantage in forage fisheries translates into systematic differences in economic value is an empirical question. Similarly, some fishing gears require dramatically less fuel than others (e.g. purse seine compared to trawling). Thus, the gear types used by a forage fishery and a higher trophic-level comparison fishery could significantly influence costs and value comparisons.

Constant Prices

Treatment of prices can also complicate tradeoffs across species. Using constant prices in modeling tradeoffs across fisheries is a natural starting place, but may not be an innocuous assumption in the context of modeling forage and non-forage species. Suppose managers deliberately reduce harvest of forage in the interest of increasing harvest of non-forage. Elementary economics suggest that the price of forage would increase and the price of non-forage would decrease. One might conjecture that these effects would wash out, and the constant price assumption is close enough. However, the markets for the species are likely to be quite different. Forage species largely are used in fishmeal and fish oil, which are global commodities. A landings reduction in one particular forage fishery may not affect the price because the particular forage fishery is a small share of the world market, whereas markets for non-forage species may be more responsive to quantity increases, suggesting that prices for non-forage will decline. This means that the reduction in forage revenues may be correctly modeled with a constant price assumption, but the increase in non-forage revenues would be overstated. A price response would be expected in a forage fishery with a large market share such as Peruvian anchoveta. The extent to which asymmetric price response matters for policy analysis is an empirical question, but there are strong theoretical reasons to question the policy guidance in the Lenfest report.

Discount Rates

When managers consider species tradeoffs, the time value of money is also critical. In the forage case, rebuilding non-forage species by reducing forage species harvest inevitably will take time. The longer this transition takes, the larger the long-run benefit must be to make sacrifices in the short run. Using the Office of Management and Budget's standard seven percent real discount rate, suppose that forage reductions produce a net loss of 20 percent of profits each year for ten years, and this loss produces a permanent gain in profits starting in the eleventh year. How big does the gain have to be to justify the loss? It turns out that the permanent gain would have to be 19.3 percent of profits to make up for this temporary loss. If the rebuilding took fifteen years, the gain would need to be 35.2 percent. While the MSA requires managers to meet rebuilding targets to eliminate overfishing, rebuilding forage stocks beyond that need to be justified based on OY. These simple calculations illustrate how substantial the hurdle is to justify significant reductions in forage harvest if basic rebuilding goals have already been met.

Marine Reserves

Similar logic applies to justifying the creation of a marine reserve for fisheries management. Spatial oceanographic processes, locations of fishing ports, and the ecology of metapopulations can create circumstances in which a fishery resource can generate more economic value if access is differentially controlled over space. And there are theoretical circumstances in which shutting down fishing entirely in some areas can generate net economic benefits. However, the transitions to these long-run outcomes are important. Long-run gains may need to be large to justify the short-run losses, which are inevitable when eliminating a fishing ground.

Modeling Risk

Indirect value tradeoffs also raise vexing questions about risk. The Lenfest report suggests that leaving more forage fish is precautionary. From an economic point of view, this strategy could be viewed as just the opposite of precautionary in many U.S. fisheries. Increasingly, U.S. fisheries are successful in preventing overfishing under the MSA. Reducing forage harvest would incur substantial risk in this context. In essence, fishermen would be asked to give up a more certain outcome of status quo harvest for a gamble on a potentially higher future harvest of different species with different market conditions. This gamble, which may very well be a good one, relies on ecological model predictions for which parameters are highly uncertain. The precautionary principle applied to economic value suggests that advocates for reduced forage harvest are the ones with the burden of proof. They would need to show that reduced forage harvest is not harmful to the economy.

Market and Non-Market Values

Total economic value of marine resources includes market and non-market values, and some of the most challenging management problems involve situations in which these sources of value are in conflict. The distinction between indirect market value and non-market value can be a fuzzy one. Existence value for the conservation of great white sharks, for instance, would be a non-market value. However, conservation of sharks for their contribution to regulating ecosystems that generate extractive values from non-shark species would be a source of indirect market value. In both cases, the economic problem of attaching monetary value to the resource is a difficult one, but well within the toolkit of the profession. Non-market values by nature do not generate contributions to the market economy. For this reason, it can be difficult for managers to choose these values when they involve tradeoffs of market value. Nevertheless, quantifying non-market values, and the magnitude of tradeoffs, is a way to highlight situations in which potential losses in total economic value are greatest when non-market values are ignored.

Sector Allocations

In contrast to existence values, non-market values in the recreational sector are well represented by the recreational fishing industry. Although individual anglers are the beneficiaries of non-market value (e.g. enjoyment of fishing, harvested fish that they do not purchase), they contribute to the tourism industry through purchases of fishing tackle, bait, food, and hotel rooms as well as through hiring recreational charters. The difficulty for managers is that commercial and recreational sectors often compete for the same resource. Allocating more of the resource to one sector inevitably involves allocating less to the other. And in most cases, the beneficiaries of the allocation are different people. So, any attempt to reallocate in the name of generating more total economic value also redistributes that value.

Non-Fishery Values

Non-fishery uses of the oceans such as aquaculture and offshore wind energy development pose potentially different tradeoffs for fishery managers. In some circumstances, these alternative uses may contribute more to total economic value than using the space for fisheries. Regional Fishery Management Councils may not have the jurisdiction to allocate space directly, but fishery stakeholders are likely to be involved in these decisions. As a society, we still know little about which patterns of ocean development will generate the most economic value: spatial segregation or mixing of uses. As debates about how to organize ocean uses spatially unfold, monetizing the values from different sectors will provide a means to evaluate tradeoffs transparently.

Conclusions

The idealized normative economic view of fisheries management would quantify the wide range of direct market, indirect market, and non-market values from fisheries and other uses of the oceans and then seek to maximize total economic value over time and space. For technical reasons and for political reasons, it may not be possible to define OY in real fisheries according to this vision. As a way forward, economics can help to frame tradeoffs in real fisheries management by exploring complications to the single-species paradigm one issue at a time.

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Assessment and Integration of Social and Economic Tradeoffs—a Mid-Atlantic Perspective

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Social and economic factors are intrinsic components of U.S. fisheries and their management by the Regional Fishery Management Councils and management partners. Many individual fishermen make economic decisions every time they leave the dock. Global market conditions may determine the scale and timing of effort, and landings, in any particular U.S. commercial fishery. Exogenous macroeconomic factors, such as fuel prices and consumer confidence, also have a strong influence on a range of commercial and recreational fisheries, resulting in attendant social and economic impacts. The full suite of measures used to manage U.S. fisheries, from quotas to technical measures to allocations, have direct and indirect social and economic consequences that begin with fisheries stakeholders and affect a wide spectrum of related industries. This paper reflects on the past influence and consequences of fisheries economics in the Mid-Atlantic region and looks forward to opportunities to improve the incorporation of social and economic factors and stakeholder values into the Council decision-making process.

The Council system is designed for Council members to analyze and consider social, economic, ecological, and biological information as they develop fishery management measures and programs that manage fishery inputs and outputs. In fact, fishery managers analyze and predict human behaviors and fisheries characteristics and then design a management approach that will change those behaviors to achieve a desired management objective. These decisions are informed, implicitly or explicitly, by decision-makers' knowledge and comprehension of the fishery's biological, social, and economic dynamics.

For the Mid-Atlantic Council, the last three decades have been largely defined by ending overfishing and rebuilding overfished fisheries. Although nearly all of these fisheries have been successfully rebuilt, many fishing communities in the region have struggled to regain stability and economic viability. Many stakeholders who interacted with the Council during the rebuilding process concluded that the Council process was unresponsive to their input. This sentiment was widespread and led to significant stakeholder disaffection and disengagement, leading many to conclude that economic impacts are not adequately considered or weighted in the Council process. In cases where the Council was rebuilding stocks as required by the Magnuson-Stevens Fishery Conservation and Management Act, the Council considered the social and economic impacts associated with rebuilding but was nonetheless required to set quotas at levels that would rebuild the stocks as required by law. Consolidation also occurred within the commercial fleet and processing sector during the stock rebuilding periods, and there has been significant attrition within some components of the recreational for-hire fleet as well. Low or variable quotas during rebuilding periods have altered U.S. and international market conditions for these fisheries, and for some species, market shares have largely been replaced by other domestic or international substitutes, or otherwise truncated due to a lack of steady supply during stock rebuilding. The challenge of rebuilding Mid-Atlantic stocks has been replaced by the challenge of long-term, sustainable management that recognizes the social, economic, and ecological importance of these stocks to stakeholders and the American public.

The Council has, over the last two years, worked collaboratively with its stakeholders and management partners in an effort to develop a vision and strategic plan for Mid-Atlantic fisheries to address this transitional challenge. As part of this process, and in an effort to better understand the individuals and communities that are affected by our management decisions, the Council has engaged stakeholders through surveys, port meetings, and position letters to get their ideas, concerns, and recommendations for Mid-Atlantic fisheries. Their vision and input will be used in a strategic planning process that will enable the Council to manage the region's fisheries more effectively in the both the near future and long-term by creating more social and economic value from our managed fisheries.

History

The Council's consideration of social and economic factors dates back to 1977 when the Council developed the first Federal fishery management plan (FMP) for surfclam and ocean quahogs. At the time, the Council recognized that surfclam populations were declining and that a long-term stock rebuilding program was necessary. The FMP explicitly acknowledged that such a rebuilding program would require significant reductions in the allowable harvest levels and adverse economic impacts were an unavoidable cost of rebuilding the fishery to sustainable levels.

In fact, most Mid-Atlantic Council FMPs were developed during periods when substantial negative social and economic impacts were imminent as a result of declining stocks. For example, the summer flounder FMP was developed in 1988, a time period corresponding to rapidly declining catches, low stock recruitment, and critically low spawning stock biomass. During the development of this and other FMPs, consideration was given to the economic, cultural, and sociological factors, particularly with respect to allocation decisions required for quota-based management, impacts of rebuilding programs, and permit and gear requirements for these fisheries. Specifically, the Council considered the social and economic effects on stakeholders and their communities and determined the benefits that these rebuilt fisheries could provide, including sustainable seafood products for consumers, domestic food security, and the economic stability of coastal communities.

Over time, the impacts of rebuilding the Council's managed resources have been substantial. With most of the Council's stocks above B_{MSY}, these fisheries are now seeing the benefits of recovered resources. However, sustainable management is not without its own unique social and economic challenges. For Mid-Atlantic Council-managed fisheries, user group conflicts exist between commercial and recreational fisheries, as well as between sub-user groups and between Federal and state fisheries. Additionally, although the Council sets most of its quotas for rebuilt stocks at approximately 81 percent of F_{MSY}, some of the quotas associated with rebuilt stocks (e.g. summer flounder, spiny dogfish) are substantially lower than the landings levels that the industry used to scale its capital investments in the 1980s and 1990s. These levels were unsustainable, leading to stock rebuilding and all of its consequences, and highlighted the need to manage expectations and discuss biological and economic outcomes early in the rebuilding process.

In the Northeast region of the U.S. (Maine through North Carolina), the commercial fishing fleet is mobile and diverse in size, as are ports and processing facilities. The recreational fisheries in the region are highly diverse and include not only private anglers, but also for-hire vessels (i.e., party and charter boats with paying customers) whose business interests may reflect different values and regulatory preferences. With diverse user and sub-user groups over a large geographic area, management decisions produce both winners and losers through distribution of socioeconomic impacts. As such, the integration of social and economic factors in management decision-making is intended to minimize those impacts and differences and is an essential component of successful Council management.

A Vision and Strategic Plan for the Mid-Atlantic Fishery Management Council

In 2010, the Council initiated an effort to engage stakeholders in the development of a vision and strategic plan for Mid-Atlantic fisheries. The need for a long-term vision and strategic plan emerged over the course of several years as the Council achieved many of its rebuilding goals. Despite these successes, the Council faced uncertainty regarding how to best transition from a phase of rebuilding to an era of long-term sustainability and stability. Many communities in the Mid-Atlantic region had experienced adverse social and economic impacts during rebuilding, and as a consequence, many of the Council's stakeholders had become disengaged in the fisheries management process. The Council initiated the Visioning and Strategic Planning project as a way of reengaging stakeholders and developing a long-term, stakeholder-driven plan for achieving biological sustainability for the fishery while promoting social and economic well-being for the fishery's stakeholders.

In September of 2011 the Council launched a two phase project: the first phase focused exclusively on stakeholder outreach and engagement, while the second phase focused on the development of a strategic plan. Over the course of five months, the Council solicited stakeholders' ideas and opinions through surveys, position letters, and small group meetings along the Mid-Atlantic coast. Unlike most public comment opportunities, where the Council requests public input on specific issues, this phase of the project was intended to be a wide-open opportunity for stakeholders to speak their mind. More than 2,000 stakeholders provided input for the Visioning project. As expected, the comments and concerns were diverse, but a large portion of the data revolved around several common themes:

- There is a lack of confidence in the data that drive fishery management decisions.
- Stakeholders are not as involved in the Council process as they can and should be.
- Different jurisdictions and regulations among the many fishery management organizations result in complexity and inconsistency.
- There is a need for increased transparency and communications in fisheries management.
- The dynamics of the ecosystem and food web should be considered to a greater extent in fisheries management decisions.
- Stakeholders are not adequately represented on the Council.
- Pollution is negatively affecting the health of fish stocks.

As the Council nears completion of the second phase of this project, many efforts have already been made to address these stakeholder concerns and ideas. The ongoing strategic planning work related to the Visioning and Strategic Planning project will ultimately identify a variety of ways to systematically organize and utilize socioeconomic information. In addition, as a result of this project, the Council is also engaged in a preliminary investigation of potential tools and techniques to help the Council consider information in a more consistent way at each particular decision point (e.g., structured decision-making, decision matrixes, multidisciplinary models, etc.).

Incorporation of Social and Economic Information

Initial analysis of management programs anticipated that changes in economic welfare (such as changes in income or revenue) were considered adequate measures of community stability and well-being. In recent years, the Council elevated the importance of social and economic analysis in the decision-making process in response to a NMFS policy to conduct social impact assessments. The community profiles developed for the Council in these assessments not only described relevant socioeconomic characteristics of important fishing communities, but also incorporated field interviews with stakeholders regarding the potential actions to be taken by the Council.

In addition, the Council has occasionally contracted out economic analysis of potential management actions due to the specialized nature of the economic methods needed to conduct the needed evaluation. Recently, the Council contracted an evaluation of the current scup allocation system in support of amendment development. The models used in the analysis were developed by consultants in cooperation with staff from the Social Sciences Branch of the

Northeast Fisheries Science Center (SSB).

Council staff currently work with the SSB to prioritize research needs, and improve management plan support provided to the Council. SSB research and products include community profiles, socioeconomic performance measures, voices from the fisheries, social indicators of fishing community vulnerability and resilience, comparative ethnographic analysis, annual cost surveys associated with commercial fishing, and socioeconomic surveys of commercial crew.

Although the Council has always incorporated socioeconomic information into its decision-making process, the use of such information has been limited largely to describing the likely impacts of potentially restrictive management measures on revenues or participation, rather than being used to improve participants' socioeconomic well-being. As a result, over the last four years, the Council has taken a more proactive approach to collecting and utilizing socioeconomic information for decision-making in order to improve socioeconomic outcomes. Several examples are provided below.

Development of Advisory Panel Fishery Performance Reports

The Council's Scientific and Statistical Committee (SSC) began providing recommendations for acceptable biological catch (ABC) for the Council's managed species in 2009 in response to the 2006 reauthorization of the Magnuson-Stevens Act. This was first done for the Atlantic mackerel, squid, and butterfish fisheries, which have limited information about stock abundance and productivity compared to some of the other species the Council manages. In 2010, the SSC considered designating ABCs for squid using an average of recent catch data, and eventually recommended near status-quo quota levels after input from staff and industry.

Following this decision, Council leadership saw a need to institutionalize a way to provide industry input to the SSC for species where minimal biological data was available. In theory, this would help the SSC understand the context of catch histories when such data might be the primary information available for developing ABC recommendations. As a result, the Council established a process whereby the advisory panel (AP) for each species or fishery management plan meets prior to the SSC meeting and develops, with the Council staff, an "AP Fishery Performance Report." This report describes the AP's perspectives on biological and socioeconomic trends in the fisheries and how those trends might be impacting abundance, availability, and catch. The process recognizes that economic decisions and economic factors may directly influence effort and catch, and seeks to systematically incorporate those factors through the AP. It also acknowledges the importance of timely, on-the-water observations of stock and fishery trends, and creates a formal opportunity to incorporate those observations in the quota-setting process. The first of these reports was completed in early 2011 for Mackerel, Squid, and Butterfish, and beginning in 2012 similar reports have been produced for each of the Council's managed species.

The AP Fishery Performance Reports appear to have been useful in several ways. First, SSC members have reported that for data-poor species, the information in the reports has been useful to contextualize catch histories. Second, one or more SSC members typically attend the meetings where the reports are developed, and have reported that attending these meeting helps them to better understand the fishery. Third, the meetings and reports have helped to identify and formally document other management issues that are a high priority to advisory panel members. Often, these other management issues involve concerns or thoughts on how the fishery is managed in the context of biological goals, and seek to improve socioeconomic outcomes within the fishery.

Expansion of Topical Workshops

Building on the stakeholder engagement initiated through the visioning project, the Mid-Atlantic Fishery Management Council has expanded the use of focused, topical workshops to address issues within specific fisheries or with specific constituencies. The Council has held two significant workshops in the past year: one to address values and preferences within the region's diverse recreational fishery, and one to explore responsive harvest strategies and other management issues within the longfin and *Illex* squid fisheries.

The Council has used workshops as an opportunity to explore specific issues in-depth with stakeholders in a facilitated workshop setting. The Council typically utilizes a steering committee augmented with advisors or industry leaders to develop the workshop agenda, logistics, format, and participants. This model has proven to be a highly effective method for engaging stakeholders in meaningful discussions about values and other aspects of fisheries that may be elusive during a traditional regulatory meeting. The meetings have been focused on stakeholder input and dialogue and, importantly, have not been framed around any prescribed outcomes.

The recreational workshop, held in Baltimore, Maryland in December 2011, generated a broad complement of recommendations on how the Council can improve its communication with the region's recreational fishing industry, and provided important perspectives on the diversity of the values and desired outcomes within our recreational fisheries. Many of the communication recommendations are being actively incorporated into the Council's communication plan to help the Council reach a broader cross-section of the recreational public, and to improve both the quality and the presentation of information from the Council. Recreational workshop participants represented diverse perspectives but they identified important themes that were broadly held, including the desire to have stability and access within the recreational fisheries. These desired outcomes will be incorporated in the Council's strategic plan, and will inform our decision-making process and regulatory practices.

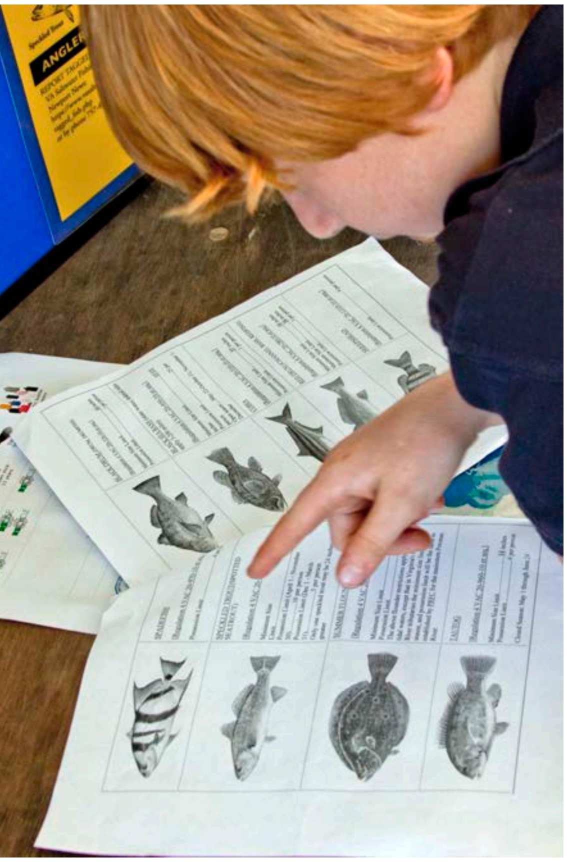
The Council convened a workshop on squid management in January 2013 in Riverhead, N.Y. The purpose of the workshop was to consider whether responsive harvest strategies are feasible and appropriate for optimizing yield in the longfin and/or *Illex* squid fisheries. Participants included fishermen and industry representatives, representing a range of vessel sizes and geographic locations. The group included many of the advisory panel members for these fisheries in addition to a broader group of fishermen, boat owners, and processors. Other participants included Council members, Council staff, and invited speakers from NOAA Fisheries and the academic and research communities.

A primary goal of the workshop was to ensure that any potential management changes would have industry involvement from the beginning, since any move toward real-time management would require significant participation by industry in terms of providing data. Secondary goals were to identify shorter-term actions that would enable industry to operate more profitably within current biological restrictions. There has already been additional work and engagement on both fronts so the workshop appears to have been successful. Some participants noted that if similar meetings were held more frequently, additional progress could be made. In that sense, the real value of the workshop may be as a starting point for continued engagement with these fisheries to optimize fishery socioeconomic conditions under the existing management framework.

The Future

The Council sponsored the Fourth National Meeting of the Regional Fishery Management Councils' SSCs which was convened in 2011 to discuss, in part, the role of the social sciences in the SSC and Council processes. This was the first opportunity for the social science members of the SSCs to discuss these issues at the national level. Perhaps the most important conclusion of the workshop was that the collection and analysis of additional social and economic fisheries data should be made a high national priority. Implementation of the Act has tended to focus on achieving the biological objectives of ending overfishing and rebuilding overfished stocks. As a result, SSC discussions and recommendations have focused primarily on biological issues (i.e., the specification of overfishing limits and ABC), while technical evaluation of the social and economic impacts of maintaining or rebuilding fish stocks has played a secondary role during SSC deliberations around the nation.

Workshop discussions revealed a wide range of engagement of social scientists in SSC deliberations across the country, ranging from full engagement in Alaska to little or no engagement in some regions. The group emphasized the need for social scientists to be more fully engaged in the SSC process through review of Council analyses included in annual specification packages, fishery management plans, amendments, and framework actions. Better integration of social science and economics into the SSC process should help guide the Councils toward more effective and balanced decisions that are more fully accepted by stakeholders. Participants also recommended that the Councils and SSCs develop annual terms of reference for considering economic and social science impacts with respect to Council actions and highlighted the need to encourage greater engagement and recognition of communities and community objectives in the fishery management policy process. The SSCs can identify the information needed to appropriately assess community impacts (e.g. community diversity, capital investments, etc.)



A number of best practices would facilitate incorporation of social science information into the Council decision-making process, including: SSC development of social science white papers; development of a social science section in the Council five year research plans; providing peer review of social science models; providing social science training for new Council members; including social and economic sections in Stock Assessment and Fishery Evaluation documents; and including social and economic considerations in ABC specifications through inclusion of effort data in projections. The social science group also recommended that an SSC Social Science Working Group be formed to build on discussions at National SSC IV. Finally, the group identified the development of Ecosystem-Based Fisheries Management goals and objectives by the Councils as a potential point of entry for social science into the SSC process, especially in the context of the development of national ocean policy.

Conclusion

Achieving a balance between biophysical, ecological, and socioeconomic objectives will continue to be a challenging aspect of fisheries management as the Council works to attain a vision of a healthy, responsive, and sustainable future for Mid-Atlantic fisheries. The greatest opportunity for progress can be found in the evaluation of our past successes and mistakes, seeking insight into the challenges of our present, assessing and understanding evolving dynamics within the marine ecosystem, and identifying opportunities for addressing these challenges in the years to come. The visioning and strategic planning efforts over the last two years have given the Council an opportunity to do just that—identify successes and failures of the past and consider how to translate that knowledge into a better future for our managed fisheries.

The socioeconomic consequences of stock rebuilding have been a dominant concern within the Mid-Atlantic for the past three decades, as quotas were aligned with biological reference points and rebuilding schedules. Looking forward, the Council's managed fisheries face uncharted impacts and consequences associated with climate change and large scale offshore wind energy development. In order to deal effectively with these future challenges, the Council will have to leverage all of its relationships with its management partners and stakeholders, relying on each for their respective expertise and information for possible solutions. Assessing and managing these risks will not happen automatically; rather, it will require diligent planning and close internal and external working relationships at the Council level.

The Council has started on a path to systematically refine and improve the role and consideration of social and economic information in the management process. Based on the strategic plan, it is anticipated that the Council will actively seeking greater stakeholder engagement and involvement in the Council process, set more specific social and economic management objectives, establish more effective review processes for management plans, and improve the transparency of Council operations. Building public confidence in the management process will ultimately require a sustained commitment to excellence and continuous process improvement at the Council level, and a closer engagement with stakeholders throughout the process, from the first point of data collection to final decision-making.

DISCUSSION SUMMARY AND FINDINGS
Session 3 Topic 3

Assessment and Integration of Social and Economic Tradeoffs

Speakers

JIM MARTIN, CONSERVATION DIRECTOR, BERKLEY CONSERVATION INSTITUTE

RICHARD ROBINS, CHAIRMAN, MID-ATLANTIC FISHERY MANAGEMENT COUNCIL

MARTIN D. SMITH, ASSOCIATE PROFESSOR, NICHOLAS SCHOOL OF THE ENVIRONMENT, DUKE UNIVERSITY

Panelists

RICK ALGERT, HARBOR DIRECTOR, MORRO BAY, CALIFORNIA (RETIRED)

COLUMBUS BROWN, U.S. FISH AND WILDLIFE SERVICE (RETIRED)

DOUG LIPTON, SENIOR RESEARCH ECONOMIST, NOAA FISHERIES SERVICE

SHIRLEY MARQUARDT, MAYOR, UNALASKA, ALASKA

Rapporteurs

KARI MACLAUCHLIN, FISHERY SOCIAL SCIENTIST, SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL STAFF

CRAIG SEVERANCE, WESTERN PACIFIC FISHERY MANAGEMENT COUNCIL SSC MEMBER, UNIVERSITY OF HAWAII, HILO

Moderator

MARK HOLLIDAY, DIRECTOR, OFFICE OF POLICY, NOAA FISHERIES SERVICE

Discussion Summary and Findings: Assessment and Integration of Social and Economic Tradeoffs

Annual catch limits and rebuilding programs designed for fish population sustainability often require adjustments to fishing capacity in commercial and recreational fisheries. However, fishing controls to improve biological outcomes can conflict with socioeconomic goals for the fishery. To this point, some biologically-derived management policies limiting catch or effort result in undesirable social and economic consequences. How do we account for these trade-offs and reconcile the different choices facing managers and stakeholders?

Measuring our fishery management performance and its effects on community sustainability requires the integration of social and economic effects of management. Many of these data, however, are currently unavailable. The task is made more difficult because there are many different perspectives of what constitutes the greatest overall benefit to the Nation, and more specifically, what fishing community sustainability looks like. In addition, the oceans on which our fisheries resources depend have many different users, uses and values besides fisheries that NOAA and the Regional Councils have to contend with.

In this session, the speakers and panelists addressed the basis of our current approach to management and science, and asked, are we even posing the right analytical questions? Do we have sufficient data and information to support our stewardship responsibilities? What needs to change in the future? Participants discussed future science and management decisions and how they should influence the data used to evaluate policy decisions.

The following paragraphs highlight major points made by the speakers, panelists or audience. They do not represent consensus, but indicate significant directions for further thought.

Main Messages from the Presentations

This session began with formal presentations by three invited speakers. Each presentation focused on a range of ideas, needs, and observations for improving the sustainability of fisheries in the future.

Find Balance Between Biological, Social, and Economic Objectives

Management decisions should balance biological, social, and economic objectives more effectively. In the late 1970s and early 80s, fishing fleets expanded in the U.S. This caused overcapitalization and overfishing that eventually led to a transition from open access to limited access fisheries. For much of the last 20 years, Councils have focused on rebuilding depleted stocks, often rebuilding multiple stocks at the same time. During this period of simultaneous rebuilding, fishing opportunities were greatly limited. As limits were put in place, it became increasingly difficult for new entrants to join fisheries, and for existing participants to remain in these fisheries. In general, the cumulative effect of these closures resulted in loss of economic resilience for the fleet and coastal communities. This sequence of events forced many fishermen to shift to state-managed fisheries or exit the industry altogether. In the Mid-Atlantic region, for instance, many fishermen who fished for dogfish or summer flounder moved to gillnetting for croaker, or entered the conch fishery, while the "bread and butter" fisheries such as flounder underwent rebuilding. This twenty-year period of rebuilding also destabilized onshore infrastructure and fishing businesses, further reducing the resilience of fishing communities. In biological terms, these efforts have been largely successful, yet they have come at a cost to commercial and recreational fishermen and the waterfront businesses that support them.

While Councils have been successful at achieving biological objectives, they have been less successful at achieving social or economic sustainability.

This imbalance requires exploration and acknowledgement. Looking towards the future, Councils need to find ways to include social and economic objectives in their decision-making process. Past approaches have focused on how to avoid adverse social and economic outcomes, rather than on how to facilitate more positive outcomes. To do this, more and better socioeconomic data are needed.

However, in the absence of new data collection initiatives, there is also a need to make smarter decisions with existing data. This requires better engagement with stakeholders. Some Councils have been successful in engaging stakeholders to improve management outcomes. Efforts such as industry workshops, listening sessions, real-time and interactive data collection efforts, and visioning processes can all be used to make better-informed decisions. The Mid-Atlantic Council's visioning and strategic planning effort stands out as an example of a meaningful engagement effort. The Council met with industry in small group meetings. These meetings were co-hosted with local liaisons who did peer-to-peer outreach to bring industry stakeholders to the meetings. Council staff sat down and talked with participants about the biggest problems in today's fisheries and what participants wanted to see in the future. This information is being used as the basis for a blueprint for future management fisheries management in the Mid-Atlantic.

Anticipate and Prepare for Major Change

Councils, governments and stakeholders need to streamline management and increase adaptability and efficiency. Fisheries managers and policy-makers in particular need to be prepared for major change in the future. Four major drivers of change need to be acknowledged: population growth and demographic shifts in coastal areas; climate change; increasing demand for seafood; and long-term budget cuts. These drivers will negatively affect fisheries and the nation's ability to manage fisheries as they have been managed to this point. To address these issues, managers and policymakers need to find ways to be nimble, adaptable, and proactive.

Four challenges cited in response to these drivers that require immediate attention were: annual catch limit and species assemblage management, new recreational fisheries management tools, habitat conservation and protection reform, and resource reallocations. The way these issues are dealt with now are ineffective and will be less effective in the future under more uncertain environmental conditions. During the discussion on "Improving Fishery Management Essentials," presenter Dick Brame recommended that recreational fisheries should be managed more like North American waterfowl, adopting a long-term harvest rate, rather than managing fisheries with annual hard quotas.

These new approaches could streamline the current management system and improve conservation outcomes. Issues like these need to be addressed in the short term to unclog the management process and prepare for impending change.

Increase the Use of Economic Valuation in Fisheries Decision-Making

A more prominent role for economic valuations in fisheries decision-making is needed. Economic analyses should be used to help fisheries managers and policymakers make informed decisions about complex and contentious issues such as allocations, optimum yield, and rebuilding timelines. These analyses should focus specifically on assessing the economic tradeoffs of decisions in terms of value, rather than economic impact, to help answer questions like: Do the gains of reduced harvest outweigh the costs? Are lower harvests enough to offset lower revenues? Are profit gains in another fishery enough to offset profit losses?

There is a great deal of confusion about the difference between value and impact. Value is the net contribution of a resource, whereas impact is a measure of gross contribution. These two measures are often correlated. For example, a big impact will also be associated with a large value. However, this is not always the case. This difference was

made apparent by way of an example. The North Carolina shrimp fishery is negatively impacted by hypoxic zones (e.g., areas of low dissolved oxygen). These seasonal zones are caused, in part, by nutrient runoff. During years when large hypoxic zones appear at the confluence of the Neuse River and in the Pamlico Sound, the shrimp fishery decreases by an average of 10-30 percent. This suggests that a hypothetical reduction in hypoxia would increase revenues by $1.2 million per year. However, reducing hypoxia in the area would only increase the value of the fishery $0.3 million. Understanding the difference between impact and value is useful because it can help managers make empirically-based management decisions. By incorporating economic valuations into bioeconomic models, fisheries managers and policy-makers can optimize the value of fisheries and more effectively manage towards optimum yield.

Recurring Themes from the Discussion

Following the formal presentations, participants weighed in on a range of topics. The discussion revealed several best practices, gaps in socioeconomic data and modeling, and opportunities for improvement. These are summarized below as a series of short points. The observations do not necessarily reflect consensus or level of priority.

Utilize Legislative Authorities and Policy Tools Outside the Magnuson-Stevens Act

The Magnuson-Stevens Act (MSA) is the primary legislative framework by which Federal fisheries are managed. However, many other legislative authorities positively and negatively affect fisheries. For example, the Endangered Species Act (ESA) has played a critical role in fisheries conservation and management, particularly in the Northwest, where ESA is often lauded for its role in helping to preserve salmon and other economically important stocks. Legislative authorities and policy tools like the ESA need to be more effectively used to address the future fisheries challenges.

Climate change, globalization, population growth and coastal development threats, in particular, need to be addressed through legislative authorities and policy tools outside the MSA. All of these issues pose a major threat to the long-term sustainability of fish stocks and their associated fisheries, but they fall outside the current realm of the MSA.

Establish Mechanisms for New Entrants to Enter Catch Share Fisheries

Catch shares are often used to reduce excess capacity in fisheries. These programs have been largely successful in achieving this goal. However, they have also created new challenges. In particular, unless designed for in advance, catch shares can create an economic barrier to new entrants because the value of quota rapidly increases after privileges have been allocated. To resolve this issue, mechanisms should be put in place to limit consolidation and to help new and small-scale participants gain access to these fisheries. There are many ways to do this. For example, privileges could be allocated to groups of fishermen through Regional Fishing Associations or Fishing Communities as defined in the MSA, or they could be allocated directly to municipalities, coastal towns, and local governments.

Manage Recreational Fisheries like Waterfowl

Despite recent efforts to improve data collection and modeling capacity, many still view recreational fisheries data as unreliable and inaccurate. Collecting recreational fishing data is particularly challenging in the Southeast and Gulf states, where anglers can access fishing grounds via innumerable ports, harbors, beaches, and waterways. The lack of high quality data has major implications for science, and it has also exacerbated the tension over allocation of quota between recreational and commercial sectors. Similar issues have arisen in other sectors of wildlife management and conservation. One way to resolve these issues would be to manage fisheries more like waterfowl, as waterfowl management in the U.S. has a number of similar attributes.

Incorporate Non-Market and Sociocultural Values into Management Decisions

National Standard 1 often takes precedence over other National Standards in the MSA. In practice, Councils determine how to satisfy the biological and ecological requirements that National Standard 1 embodies, and then they choose the alternatives that cause the least direct economic harm to fishing communities. This process tends to ignore non-market and sociocultural values because these qualitative data are difficult to compare to quantitative economic and biological data. To address this issue, emphasis should be placed on incorporating a broader range of data types, including non-market and sociocultural data, into the decision-making process. These forms of data should be described in new guidance on National Standards 2 and 8 (or by creating a new national standard). These data could also be quantified in economic terms and incorporated into bioeconomic models to calculate OY.

Establish a Process to Evaluate Allocation Between and Within Recreational and Commercial Fishing Sectors

Allocations of quota between sectors are typically made to historical users based on past catch history. This approach does not accommodate new entrants, nor does it account for changing social or economic objectives for the fishery or in the broader community. Furthermore, initial allocations tend to be permanent. Rarely are allocation decisions reexamined or quota redistributed between or within fishing sectors, even if strong socioeconomic arguments can be made in favor of change. Part of the reluctance to periodically evaluate allocation decisions is that they tend to be difficult and contentious. To resolve this issue, standard practices should be established to facilitate the review of allocations. These reviews should occur at regular intervals, through an MSA mandate if necessary, and take into account the social and economic benefits of these fisheries.

Strengthen Local Government Involvement

Changes in fisheries regulations and abundance impact marine-dependent businesses, affect economic activity, and alter the marine-dependent infrastructure in coastal communities. These changes affect local governments in a myriad of ways. For example, regulations that reduce fleet capacity may alter a community's tax base or change working waterfront infrastructure. Despite these ties, few local government representatives participate in the fisheries management process. National Marine Fisheries Service and the Councils should work to strengthen ties to local governments. These entities can play a key role in implementing local stewardship and area-based management, translating policy ideas into on-the-ground execution.

Establish a Federal Sustainable Seafood Certification Program

Federal fisheries operate under some of the most stringent management measures that exist anywhere in the world. Regulations are in place to set catch limits, protect habitat, reduce bycatch, and rebuild stocks, yet U.S fishermen do not get credit for maintaining the world's most sustainable and best-managed fisheries. This perspective has social and economic consequences for the industry. Not only does it implicate fishermen, discounting the burden fishing communities have endured to end overfishing and rebuild fisheries, it has also undercut the value of domestic seafood in some cases. To mitigate these effects, industry has turned to third-party certifiers such as the Marine Stewardship Council, but these sustainability programs can be costly. To demonstrate support for the commercial fishing industry and stand behind the sustainability of current MSA management practices, there should be a government seafood certification program.

Invest in Visioning Exercises to Cultivate Shared Goals

Management actions should be driven by clearly-defined objectives. Fishery management plan objectives are not always explicit or clearly articulated up front, making it difficult to know how to prepare socioeconomic information in a way that is useful to decision-makers faced with making trade-offs. Visioning processes, such as the one conducted by the Mid-Atlantic Council, can be an effective way for Councils to clearly articulate their management objectives.

These exercises also provide an opportunity to engage with stakeholders outside the formal Council meeting process. This can be valuable because it allows Councils to interact with stakeholders in a non-confrontational and non-threatening setting in a familiar locale. Having developed clear Council objectives, social scientists and economists can focus their research and analyses to provide better and more informative research and analyses to the Councils. This will help Councils evaluate their management choices and make the most appropriate decisions.

Capacity Building for Social Science Data and Expertise is Needed

Additional capacity in the social sciences is needed in management, including more anthropologists, sociologists, and economists at Councils, regional offices and states. This will improve support for such processes as allocation reviews, mitigation plans to reduce impacts on fishing communities, scoping of management alternatives with different stakeholder groups, and specifying optimum yield. Collecting appropriate data to support socioeconomic analyses needs to advance beyond the planning stage. Any impediments to collecting social and economic data concerning public trust resources may require evaluation or reform of MSA confidentiality provisions, allowing collection and controlled access to data from public trust resource users while protecting sensitive sources.

Conference Findings

The following conference "findings"—128 of them—were developed during the conference discussion sessions. Wording was refined by the session chairs and rapporteurs at the conference, and reported on the last day of the conference.

A "finding" was defined as "a legislative, regulatory, or policy change, or idea for improvement identified by session participants as a priority for advancing fishery management and sustainability. A finding could be an endorsement of a regional idea for consideration as a best practice across multiple regions; a modification to the Magnuson-Stevens Act (MSA), other law or policy, to improve an outcome, to remove an existing impediment, or establish a new management tool; a regulatory strategy or implementation guidance to improve an outcome under existing MSA requirements; and/or change in behavior or process needed to improve fisheries management."

The findings are listed as they were presented at the Managing Our Nation's Fisheries 3 conference. They are not in priority order and are not intended to reflect or imply consensus among the panelists, and may therefore be complementary or contradictory.

Session 1 Findings: Improving Fishery Management Essentials

TOPIC 1: ANNUAL CATCH LIMIT SCIENCE AND IMPLEMENTATION ISSUES, INCLUDING MANAGING "DATA-LIMITED" STOCKS

- Consider multi-year minimum stock size thresholds and annual catch limit (ACL) framework
- Phase in ACL changes
- Constrain large inter-annual changes in ACLs
- Do not base overfished determination on single year estimate
- Allow and provide guidance for using the mixed stock exemption
- Use management strategy evaluation to evaluate the performance of harvest control rules
- Provide better guidance on setting ACLs for transboundary stocks where no international treaty exists and only U.S. removals are known

DIFFERENT TOOLS AND STRATEGIES FOR MANAGING RECREATIONAL FISHERIES

- Eliminate hard quotas managed in-season for recreational stocks. Adjust pre-season input controls (e.g., bag limits, seasons) to stay within ACL (based on numbers of fish, not poundage)
- Manage with long-term mortality rates for more stability (e.g. eliminate wide fluctuations in catch limits)

ASSESSMENTS AND DATA-POOR STOCKS

- Prioritize assessment of target stocks over non-target stocks
- Set minimum data quality standards for stock assessment
- Do not require ACLs for data-poor stocks
- Improve data-poor assessment methods
- Consider default buffer (e.g., 75 percent maximum fishing mortality threshold)
- More than one indicator species in a complex leads to better estimate of stock status

TOPIC 2: REBUILDING PROGRAM REQUIREMENTS AND TIMELINES

- Revise rebuilding time requirements
- Always set T_{MAX} equal to T_{MIN} plus one mean generation

- Set exploitation rates less than F_{MSY} and rebuilding will occur naturally over time
- Refine and include the mixed stock exception in the Magnuson-Stevens Act (MSA); harvest of one species at its optimal level may result in overfishing another stock, only if strict criteria are met
- Stocks later determined to have never been overfished should no longer be subject to rebuilding requirements
- Replace the term "overfished" with "depleted" (status may not be due to excessive fishing)

MODIFY MSA TO PROVIDE FLEXIBILITY

- Establish a standardized process for reviewing rebuilding progress
- Maintain an existing rebuilding plan when minor changes occur in estimated T_{TARGET}
- Address social and economic issues (e.g., "possible" to "practicable")
- Extend annual species exemption to short-lived species
- Allow a transboundary exemption when a significant proportion of the stock is outside U.S. jurisdiction
- Increase the frequency and quality of stock assessments and rebuilding analyses and incorporate ecosystem dynamics; recognize limitations of science
- Don't chase noise: Assessments and projections will always be uncertain; develop smoothing strategies to provide stability
- Utilize management strategy evaluation tools to evaluate stock rebuilding approaches
- Develop harvest control rules that incorporate rebuilding provisions; early investments increase the probability of success

TOPIC 3: INTERNATIONAL FISHERIES MANAGEMENT: LEVELING THE PLAYING FIELD

INTERNATIONAL COOPERATION AND ASSISTANCE

- Help developing countries build fishery management and enforcement capacity
- Support immediate adoption of appropriate target and limit reference points by regional fisheries management organizations (RFMOs)
- Environmental nongovernmental organizations should continue to leverage compliance with RFMO conservation measures (e.g. through supply chains)

COMBAT IUU FISHING

- Increase support for at-sea and in port monitoring and enforcement
- Broaden trade sanctions domestically and within RFMOs to address non-compliance
- Implement stricter imported seafood labeling requirements in the U.S. market
- Ratify Port State Measures Agreement
- Amend MSA to change "vessels" to "vessel" in the illegal, unreported and unregulated certification section

PROMOTE MEASURES TO REDUCE OVERCAPACITY

- Fishery rationalization (e.g., catch shares)
- Restrict national subsidies for fuel and vessel construction
- Limit vessel numbers by RFMO member states

COMMUNICATION AND STAKEHOLDER ENGAGEMENT

- Improve communication among U.S. delegations across tuna RFMOs (e.g. Western and Central Pacific Fisheries Commission, Inter-American Tropical Tuna Commission, International Commission for the Conservation of Atlantic Tunas)
- Maximize participation of fishermen and other stakeholders in U.S. RFMO delegations

OTHER FINDINGS

- Consider a national sustainable seafood certification program
- RFMOs should consider transfer effects when developing conservation and management measures
- RFMOs should adopt measures that reward compliance (e.g. quota allocations)

Session 2 Findings: Advancing Ecosystem-Based Decision Making

TOPIC 1: ASSESSING ECOSYSTEM EFFECTS AND ADAPTING TO CLIMATE CHANGE

- Evaluate ecosystem productivity change
- Evaluate effectiveness and utility of closed/fixed areas
- Engage across disciplines and increase coordination between National Marine Fisheries Service (NMFS), Councils, Science Centers, stakeholders, other governmental agencies
- Increase reliance on industry while shifting Councils' roles in evaluating effectiveness
- Consider broad range of ecosystem services
- Build capacity throughout the fishery management system to use new tools to advance ecosystem-based decision-making
- Establish ecosystem Scientific and Statistical Committee at the Council level.
- Invest in ecosystem-based management (i.e., advancing scientific models, training staff) and identify and remove impediments to the transition from single-species to ecosystem-based management

ASSESSING ECOSYSTEM EFFECTS AND INTEGRATING CLIMATE CHANGE

- Address the root causes of climate change, as MSA is a limited tool and addresses mainly symptoms
- Increase coordination between and across jurisdictions to address changing species distribution and ecosystem change (Regional Councils, states, and international)

PRECAUTIONARY AND ADAPTIVE MANAGEMENT

- Flexibility to respond to spatial, allocative and distributional effects of climate change
- Address rebuilding requirements when environmental conditions may be a predominate factor in a stock's decline
- Assess barriers to adaptation (fishing communities and fish stocks)
- Utilize a precautionary approach for developing/emerging fisheries
- Recognize and manage in response to ecosystem productivity change
- Develop a comprehensive national plan and tools which facilitate development of regional management strategies
- Incorporate environmental trigger mechanism to initiate management action/measure
- Evaluate effectiveness and utility of closed/fixed areas
- Modify reference points as climate changes (precautionary vs. recalibrating maximum sustainable yield [MSY])
- Endangered Species Act: Base listings on actual trends rather than projected trends of climate change
- Assess the efficacy of the National Ocean Policy as a vehicle to address climate change

INTEGRATED ECOSYSTEM ASSESSMENTS

- Integrate Integrated Ecosystem Assessments and all component models into management process
- Derive less data and resource intensive tools for use in management process
- Develop ecosystem models, tools and assessments at a regional level that:
    - Synthesize existing data from non-fishing sources and incorporate socio-economic as well as ecosystem parameters
    - Respond to changing parameters
    - Predict future ecosystem states
    - Provide short- and long-term guidance
    - Account for cumulative impacts of climate change
- Develop decision support tools that allow councils to develop responses to a wide range of uncertainty (such as management strategy evaluation)

TOPIC 2: FORAGE FISH MANAGEMENT

- No changes to MSA are necessary to sustainably manage forage fish
- Establish a new National Standard to ensure adequate forage base
- Require explicit consideration of the impact of forage fish to the ecosystem and fishing communities to inform optimum yield (OY) and ACL decisions
- Prohibit new forage fisheries until scientific and management evaluation are conducted
- Define forage at the Regional Council level
- Use threshold harvest control rules to adopt ecologically-based reference points

- Implement real time data collection to inform adaptive management
- Require scientists to provide managers with an index of key forage species abundance
- Establish an ecosystem Scientific and Statistical Committee at the Council level
- Invest in ecosystem-based fisheries management

BEST PRACTICES

- Improve inter-jurisdictional collaboration and coordination on forage fish management.
- Use meta-analysis/global studies and rules of thumb as a starting point in discussions for forage fish management or as a guide in data poor situations
- Advance tools and develop methodologies to:
    - Evaluate tradeoffs between uses of forage
    - Account for the needs of predators when doing stock assessments and ACLs;
    - Estimate the varying and complex economic value of forage fish;
    - Measure localized depletion; and
    - Evaluate effects of climate change on forage

TOPIC 3: INTEGRATING HABITAT CONSIDERATIONS: OPPORTUNITIES AND IMPEDIMENTS

- Consider a National Standard for habitat: "Minimize adverse impacts on essential fish habitat (EFH) to the extent practicable"
- Build partnerships to achieve landscape and ecosystem level habitat improvements
- Improve understanding of relationships between habitat and productivity to support identification and evaluation of tradeoffs
- Resolve status of artificial substrates with regard to EFH designation
- Establish a timeline for improving the scientific basis for designation of EFH for key species and habitats
- Maintain and strengthen the EFH designation process by developing objectives and metrics for successful habitat protection
- Define "essential" habitat more broadly
- Shift interpretation of EFH from single-species to multispecies and ecosystem focus
- Set measurable conservation objectives and utilize a "common currency" to evaluate adverse and cumulative impacts
- Identify priority habitats that benefit fisheries, focus habitat research
- Provide guidance on "minimize to the extent practicable adverse impacts…caused by fishing" and consider relationship to OY
- Strengthen EFH consultation process and ensure compliance with and effectiveness of existing laws and recommendations
- Develop a long-term, standardized process for monitoring and evaluating habitat to es-

tablish a baseline, assess long term impacts, and support rapid response to non-fishing habitat impacts

- Provide tools other than spatial closures for addressing adverse impacts from fishing

Session 3 Findings: Providing for Fishing Community Stability

TOPIC 1: RECREATIONAL AND SUBSISTENCE FISHERY CONNECTIONS

- Idea to be replicated/expanded: Scientists can learn much more from fishing community via greater use of cooperative research. This promotes buy-in, empowers fishermen, and can be more cost-effective
- Fishermen want to be involved with data analysis as well—provides legitimacy to the process and helps build trust
- Councils and NMFS need new creative communication strategies and investments to reach, engage, and support underrepresented fishermen's participation in process
- Goals specific to each sector and stakeholder group need identification, early in the process, to customize development of a suite of fishery management strategies
- Allocations are not "permanent." Need to be more proactive in routine review and modification as needed. Decisions should be left to the regions, and creative solutions may result from constructive dialog between sectors
- Recreational and subsistence considerations need higher priority in fishery management policy choices, and in other policy arenas that affect fisheries (e.g., alternative energy)
- Define subsistence fishing in the MSA, and expand recognition of tribes and indigenous people engaged in subsistence fishing
- Qualitative information vs. quantitative. Need more thought/guidance on how to utilize both in fishery management decisions
- Need better data. Target ledger-type submissions and other data collections as condition of access/use of a public trust resource

TOPIC 2: INTEGRATING COMMUNITY PROTECTION, JOBS EMPHASIS, AND DOMESTIC SEAFOOD QUALITY ASSURANCE

- Create, modify and promote financial tools and training to support small and community-based borrowers (e.g., NOAA Fisheries Finance Program, California Fisheries Fund)
- Resolve institutional impediments to fisheries commerce (e.g., establish central registry to facilitate lending; improve aquaculture permitting process)
- Link ecosystem-based management scales to fisheries management and governance (e.g. revise National Standard 3 [management unit])
- Link fishery participation to stewardship obligation
- Need policy statement on devolving governance
- Preserving the past is not always the best path forward

- Diversify Council management actions to accommodate differences between small and large-scale operators (e.g., mobility of fleet, business models, supply needs)
- Anchor quota in communities (utilize ecosystem-based management, Community Fishing Associations)
- Devolve more responsibilities and accountability to communities and industry, engage in science via cooperative research
- Elevate and promote best practices; become a learning organization (e.g. state examples, Fisheries Improvement Projects, National Fish & Wildlife Foundation funded projects)
- Modify Council process to improve participation of small-scale and community sectors
- Cooperative research results needs to be more fully incorporated into management
- Recognize certification of U.S. fisheries that meet the 10 MSA national standards
- Need end-end streamlined regulatory process for aquaculture
- Wild harvest and aquaculture, more similar than different, both needed to meet supply needs, attain economic objectives

TOPIC 3: ASSESSMENT AND INTEGRATION OF SOCIAL AND ECONOMIC TRADEOFFS

- MSA needs to incentivize response to challenges, population growth, climate change, globalization, and budget cuts
- MSA needs to complement other ocean users and relevant statutes that affect fisheries management, such as Endangered Species Act, Clean Water Act
- Give full consideration to impacts from other uses/users for marine resources (non-fisheries)
- MSA should explicitly promote use of adaptive management approaches, particularly for data-poor species where the precautionary approach limits information on stock performance under higher catch rates
- Need to define, identify sideboards and metrics of elements of OY; redefine OY/MSY relationship to no longer be one direction, and social, economic and non-economic values could allow OY to be above MSY
- Expand socioeconomic analysis requirements to include economic value and non-market value quantification
- Trade-off analysis requires giving higher priority than other disciplines for acquiring additional capacity in social scientists including anthropologists, sociologists, and economists at Councils, regional offices and/or externally
- Facilitate cooperation and partnerships with states, local governments, and other agencies
- Improve engagement with competing sectors in scoping process
- Develop mitigation plans to reduce impacts on communities due to management actions

- Reform MSA confidentiality provisions, access to data from public trust resource users while protecting sensitive information

ALLOCATIONS

- MSA mandate for Councils to consider review of recreational and commercial allocations every {x} years after scoping allocations based on a set of objective guidelines
- NOAA standardized methods on how to review allocations
- Improve NOAA support for allocation reviews (contracted analysts/economists)

Reactions Panel Summary

The conference concluded with a presentation of the concurrent session findings to a panel of distinguished and influential persons in the fisheries management arena. This "Reactions Panel" was asked to provide their initial reactions to the conference conclusions, including their views on the merits of the recommendations, the feasibilty of acting on the findings, and ways to improve or clarify the conclusions.

Reactions Panel Summary

Bonnie McCay, Board of Governors Distinguished Service Professor, Rutgers University

SOCIO-ECONOMIC ACADEMICS PERSPECTIVE

We are often reminded that fisheries are a classic case of the tragedy of the commons and thus are in need of governance. However, governance goes beyond simply government, as reflected in the innovations of the Magnuson Act (MSA) and the highly participatory regional fishery management process, where government officials as well as citizens have a voice in fisheries management. A strong message of this conference has been the importance of public/private partnerships, co-management, and community-based initiatives: a "communing of the commons," as Barton Seaver put it, or a recognition of the roles of humans in natural systems, including response to change. "If we can destroy, we can restore and heal."

Management mistakes are often the result of reduced capacity to adapt to change, or arise from a loss of access by those dependent on resources—those with useful knowledge who are in a position to be stewards. The issue of access for economic, social, and cultural purposes is another strong theme of the conference. As we continue to rebuild stocks, we need to ask whether our biological successes have resulted in acceptable economic, social, and cultural outcomes, including fair and equitable access.

The United States is unique and fortunate in having legislation, such as National Standard 8, that explicitly brings communities into the framework of fishery management. Determining the implementation and effectiveness of these provisions raises questions. Do the goals of stock conservation and rebuilding under National Standard 1 take precedence over National Standard 8? How can we improve the assessment and consideration of community impacts in management decisions? Does our strong preference for the best available science create a bias for quantitative biological and economic values and relatively large-scale fisheries and communities? Can the MSA better acknowledge the role and currency of qualitative data and the experience-based knowledge of fishermen?

The emergence of community-based initiatives in marketing, management, and cooperative research, such as risk pools, community-supported approaches, and permit banks is a testimony to the cooperative social roles of local leaders, non-governmental organizations, foundations, governments, and communities: the "comedy of the commons." MSA reauthorization should consider the recurring emphasis at this conference on decentralization of fishery management authority, and should recognize and encourage localized initiatives. A local approach can help protect smaller communities from the adverse effects of market-based management systems and can encourage ecosystem-based approaches at the appropriate small scale. MSA language regarding limited access privilege programs could be improved to make them less onerous and more conducive to local, cooperative, community approaches.

In closing, fishery management should move towards a more local approach with a serious focus on emerging challenges that calls for innovation and action at multiple scales—from the very large, such as response to climate change—down to the very small: the fishing crews and families, the seafood businesses, and local communities that are on the front line of trying to cope, adapt, and innovate.

Bob Hayes, General Counsel of the Coastal Conservation Association and the Center for Coastal Conservation

RECREATIONAL FISHING INDUSTRY PERSPECTIVE

The word "recreation" has been more prevalent at this conference than at any other Managing Our Nation's Fisheries conference, and has appeared more times this week than it appears in the Magnuson Act. This is a direct result of the leadership of Eric Schwaab, Sam Rauch, and others at the National Marine Fisheries Service. There have been many analogies this week to "tsunamis" on the horizon—looming changes in fisheries management. Two significant changes to consider are demographics and budgets.

Regarding demographics, many in the "baby boomer" generation are about to retire, many of them to coastal areas. Although not all retirees will take up recreational fishing, many will. An expanding retirement community, combined with general population growth, will likely add to the pressures on our resources and our Federal fisheries management system.

Budgets have been shrinking and spending has been curtailed, a situation that is not likely to change dramatically in the near future. There will likely be an increase in inflation that will reduce what can be done with already limited funds.

From the perspective of recreational fisheries and with a changing landscape in this country, I would like to offer the following solutions.

We should enhance state management of our fishery resources. There are many stocks that are not directly managed by the Federal government, and this model could be expanded. The time has come to ask who should manage our fisheries. Many species occur primarily in state waters, and yet are unnecessarily subject to the statutory requirements of the Magnuson Act.

The Magnuson Act has largely focused on commercial fisheries for decades, and is only recently beginning to consider the unique role of recreational fisheries. Prevalent thinking for years has been that recreational fisheries were largely state-managed and would not become part of the Federal process. Today, many recreational fisheries are over-encumbered with regulations and policies that were shaped with commercial fisheries in mind.

Prescriptive management requires good data and good data collection systems, for recreational fisheries are expensive. Trying to improve data collection by simply redesigning or renaming sampling programs without significantly increasing available funds is futile; a fool's errand. Recreational fisheries are increasingly held accountable for more detailed information and restricted by quotas, while Federal budgets for increased sampling are slow in coming or do not yet exist. You have to manage to the data you have.

Allocation is currently frozen. Not allocations between commercial gear types or geographic areas; these types of negotiations are relatively common. Allocations between recreational and commercial fishery sectors are in need of review and are often neglected because they are difficult to negotiate without substantial disagreement and deliberation. Therefore, the Magnuson Act should be revised to require routine review and potential revision of recreational and commercial sector allocations.

Lee Crockett, Director of Federal Fisheries Policy, Pew Charitable Trusts

ENVIRONMENTAL NON-GOVERNMENTAL ORGANIZATIONS PERSPECTIVE

First, we should take stock and not lose sight of the conservation successes of the Magnuson Act. Since 2000, 32 stocks have been fully rebuilt and the number of stocks subject to overfishing has been cut in half since National Marine Fisheries Service started publishing the status of stocks. Clearly, we have made substantial progress since rebuilding requirements were added to the act in 1996 and with the annual catch limit requirements of 2006. These successes should not be forgotten as we consider Magnuson Act changes that build on these successes rather than undercut them.

A recurring theme of the conference has been a call for flexibility, particularly in regard to stock rebuilding requirements. It is unclear what is meant by flexibility. Many of the examples put forward this week can be accomplished through policy guidance or modifications to National Standard 1 guidelines. There was a good deal of flexibility in the Magnuson Act prior to 1996, flexibility that allowed stocks to remain depleted and overfishing practices to go unchecked. Flexibility often means lengthy and delayed rebuilding plans. It can be argued that the Magnuson Act already provides considerable flexibility when many of rebuilding targets are in excess of 50 years and the average rebuilding time across all depleted stocks is 19 years.

What is lost in the discussion is the economic and environmental costs of delayed rebuilding. According to National Marine Fisheries Service, the economic benefit of rebuilding all depleted stocks is 32 billion dollars and 500,000 jobs per year. The environmental costs of depleted stocks include increased vulnerability to natural population fluctuations and climate change.

In conclusion, we should build on our successes. The environmental community is supportive of many recommendations we heard this week, including decreased reliance on single-species management, and increased protections for habitat and forage species. As fisheries and resources adapt to climate change, we should take a precautionary approach to the development of new fisheries. We need to change our "fish first and ask questions later" philosophy. Our oceans and the fish in them are a public resource. There is widespread support for the conservation of ocean resources. We all want abundant fish, sustainable fisheries, and vibrant oceans.

Stephanie Madsen, Executive Director of the At-Sea Processors Association

COMMERCIAL FISHING INDUSTRY PERSPECTIVE

Representing commercial fisheries from around the U.S. is a daunting task. Having participated in all three national conferences, it has been interesting to note that this year's conference has not emphasized a strong need for changes to the Magnuson Act. This is not a reflection on the productivity of this conference, but a finding that things are working well and perhaps we need to focus on existing provisions that are not fully utilized or are still in need of implementation. Many of the findings would not require a statutory change and could be addressed through policy or regulatory mechanisms. A good suggestion from the conference is to study these findings thought the lens of the "three i's": intent, interpretation, and implementation.

The economic environment we live in will require us to do more with less. We need to take a hard look at costs: not just to government agencies, but also to stakeholders, communities, and the public. Additional requirements designed to force action, such as the recommendations to establish a National Standard on habitat or to require expanded socioeconomic analyses, should be carefully reviewed because the benefits may not outweigh the costs. These are worthy goals, but existing provisions present the means to achieve them without the burden of costly requirements.

It will become increasingly important to find cost-effective mechanisms to address data and research needs. Cooperative research and management efforts have been discussed and recommended this week, and yet the Magnuson Act already provides the authority for this important tool, and there are examples of effective implementation in Alaska and other areas. It is not about a loss of governmental authority, but rather a cost-effective shared burden with industry for data collection, monitoring, and reporting.

Regional Fishery Management Councils should be in the practice of identifying objectives when recommending fishery policies and programs. Calls for program reviews have been made this week, but the efficacy of a program can be hard to assess if there are not clearly established objectives. The old saying is true, "if you don't know where you are going, any path will get you there."

A strong theme this week has been a call for more responsive and adaptive management in the face of changing environments. However, our regulatory process is cumbersome and in need of streamlining if we are truly going to have an adaptive system. Streamlining our management regime is a challenge because it is difficult to simplify management actions without limiting public input and/or disenfranchising stakeholders.

We have also heard a call for an MSA certification process. Fishery certifications have proven useful, but they come at a high cost and can have limited benefits to a fishery if the certification does not garner wide support from processors and buyers and meet the needs of customers. With limited resources, it would be better to invest in enhanced stock assessment efforts. Assessments are at the core of fishery management.

In closing, we need to maintain the ability to manage in response to regional differences, and we need to align our expectations with the economic realities we are facing.

Ed Johnstone, Policy Representative for the Quinault Indian Nation

INDIGENOUS PEOPLE PERSPECTIVE

Indigenous people have had a difficult history and are proud to participate in the conference and to have a role in the process. The rights and responsibilities the tribes have today are the result of hard fought battles, forward thinking organization, and mutual support between tribes. Coordination and support continue to be one of the keys to maintaining tribal and subsistence opportunities. Subsistence fisheries should have a high priority when setting fishing policy because those communities are not catching fish for sport or for profit, they are fishing to survive. Too often, a gauntlet of fisheries is allowed to proceed ahead of a subsistence fishery that is curtailed to meet management objectives.

The tribes have long been proponents of ecosystem-based management approaches and brought the idea to both the Regional Fishery Management Councils and National Marine Fisheries Service ten years ago. Area management, a broad perspective, and local knowledge have been a large part of tribal resource management over long time spans. The tribes are very supportive of maintaining healthy communities, both tribal and non-tribal. We have a shared responsibility to maintain that economy and to manage our stocks for thousands of years.

The tribes strive to ensure that treaty rights are respected and not forgotten. The tribes of the Pacific Northwest have a proud tradition with the Pacific Council where tribal ideas and concerns are considered, where co-management has been a success. This reality did not come easily and it has been a long struggle, but it has been rewarding to see indifference give way to cooperation.

Randy Fisher, Executive Director of the Pacific States Marine Fisheries Commission

INTERSTATE MARINE FISHERIES COMMISSIONS PERSPECTIVE

The Atlantic, Gulf, and Pacific Marine Fisheries Commissions are heavily involved with data programs in support of fisheries management. Interstate Marine Fisheries Commissions are able to lobby Congress and do so in support of funding for the data collection that is critical to management.

The findings from this week's conference indeed imply that the Magnuson Act has been a success and is not in need of major revision. As it has been noted, many of the findings are important improvements that can be implemented under the existing authorities and provisions of the act. Budgets are a major concern from the perspective of the commissions. Prioritizing and implementing these findings will require tradeoffs, and available funding will be a key factor in that process.

An ecosystem approach to fishery management has been a consistent theme and topic this week. In many ways, the Regional Fishery Management Councils are already engaged in ecosystem-based fishery management. However, the specifics of ecosystem-based management are undefined, and the complexities of such a broad perspective make it difficult to implement on land and even more difficult to implement in our oceans.

Regional differences are important because programs that work in one region may not in another. On the Pacific coast, we are lucky to have strong data collection systems in place for recreational fisheries, but discussions with other commissions indicate that similar systems would be difficult to implement in other parts of the country.

Three words come to mind when considering the need to revise the Magnuson Act: creative, committed and competent. The conference findings have touched on issues that may be best addressed through creative implementation of the existing Act. There is no doubt, as evidenced by the strong work this week, that there are many people committed to fishery management. It is worth noting that the conference has not resulted in a great deal criticism of National Marine Fisheries Service. At the core of our competency is the quality of our data and the degree to which our data is trusted and supports good decisions. Fishery management is becoming more and more complex and detailed, requiring more and more data to support it. In response, expectations are high and we may not be able to meet them with available resources.

Philip Anderson, Director of the Washington Department of Fish and Wildlife

STATE FISH AND WILDLIFE AGENCIES PERSPECTIVE

There is a stark contrast between this conference and the first two Managing Our Nation's Fisheries conferences of 2003 and 2005. The first two conferences focused more on defending the Regional Fishery Management Council system against a multitude of people who were finding fault in the way fishery management was being done. At this conference, we are on the offensive. We are demonstrating our successes, but more importantly we are looking for ways to improve. If we leave this conference with a set of findings that can be chosen to best fit regional needs, the conference will have been a huge success.

The states have played a very important role in the regional fishery management system. Washington participates in both the Pacific and North Pacific Council forums. It has been a successful and mutually beneficial partnership.

Several of the findings jump out an easy choice for improvement. As mentioned earlier, stock assessments are the foundation from which we build our fishery management systems, and increasing the quality and number of stock assessments and developing ways to improve on those stocks that are not data-rich or are unassessed is an obvious improvement. Promoting regimes that reduce overcapacity is imperative, and has been the focus of a West Coast collaboration to implement catch share programs. Coordination between Councils, the Regional Fisheries Science Centers, and the states is particularly important and, as we have learned on the West Coast, takes commitment. If Mr. John Royal, a founding member of the Pacific Council, were here, he would join me in supporting the finding that urges improved international collaboration on forage fish, because John was a strong advocate for better coordination with Mexico on Pacific sardines.

The need to react to climate change and ocean acidification in a timely way is an important finding that will require us to streamline and harmonize our regulatory regimes. It is simply unacceptable that it currently takes 18 months to update harvest specifications for groundfish on the West Coast. It is critical that we find a way to maintain our open and transparent process while adapting our management measures in a more timely fashion. Forage fish management is critical to our success, and fishing must be limited to those instances where we have solid information about those forage fish species and the ecosystem needs of those species before we authorize fisheries, particularly new fisheries.

Despite significant investment and effort, we are losing habitat in the Pacific Northwest faster than we can restore it. Essential fish habitat and its consultation requirements have been largely ineffective at making substantial change. We need to be more effective at influencing those with the regulatory authority to protect, preserve and restore our important habitats.

Finally, as it has been said at this conference that "preserving the past is not always the best path forward." This is true now more than ever. With climate change well on its way, we need to develop ways to anticipate those changes and modify the way we manage. Standing still in the face of climate change will be like standing still on a descending escalator: we will continue to move backward. We can't afford to move backward.

Rick Robins, Chairman of the Mid-Atlantic Fishery Management Council

REGIONAL FISHERY MANAGEMENT COUNCILS PERSPECTIVE

The United States has the strongest fishery management system in the world. We should affirm our core strengths. We have a system that prevents overfishing and consistently rebuilds overfished stocks. Despite these successes, there is lingering sense that U.S. fishermen and fisheries have been vilified. This deserves to be corrected; U.S. fishermen fishing under today's Magnuson Act should stand tall. In a market transformed by globalization, the sustainability of U.S. fisheries needs to be affirmed, and the finding to develop a certification process warrants further exploration.

A recurring theme at this conference has been a call to maintain a big picture perspective, particularly when you consider the strong influence that climate change is likely to have on our fisheries and fishing communities. Our fisheries may be like canaries in a coal mine that we don't operate, but we need to prepare for changing environmental conditions, and we should engage our scientific resources to better understand the vulnerabilities of our ecosystems.

When Council members take their oath of office, they agree to manage fisheries to the greatest overall benefit to the nation. This concept resides explicitly in the definition of optimum yield and lies at the very heart of the Magnuson Act. The concept is broader than biological yield; it includes social, economic, and ecological considerations. It is time to assess whether we are truly achieving the greatest overall benefit to the nation. This week's discussions clearly show an interest in applying greater flexibility, and most agree this can be done through fine-tuning rather than rewriting the Magnuson Act. Collective success in rebuilding stocks indicates that modifications to the current system should preserve its integrity and improve sustainability.

Carefully crafted and targeted flexibility in the Magnuson Act or its implementation could facilitate several important outcomes. Examples offered this week include improving regulatory stability and preventing abrupt disruptions to fisheries by providing more tempered responses to stock assessment results, improving stability in recreational fisheries by managing for a rate of removal and allowing more flexibility in our response to recreational catch estimates, and exploring rebuilding flexibility by gaining a broad consideration of social, ecological, and biological tradeoffs, particularly when ecological forces are impeding recovery. In many cases we have been highly successful at rebuilding stocks when defined by biological terms, but these successes often come at the expense of the economic resilience of our coastal communities.

Many agree that high quality and timely stock assessments are critical to our successful management, but we will need to develop careful strategies in this fiscally-limited environment to ensure we have adequate scientific support.

We need to continue to build on our effective interjurisdictional coordination, not only with the states on domestic fisheries, but also at the international level to ensure positive outcomes for U.S. fisheries operating under the Magnuson Act's gold standard.

There is a growing interest in incorporating ecosystem approaches in fisheries management, but these approaches should be supported through a transparent evaluation of costs, benefits, and tradeoffs, including non-market values.

The U.S. has the strongest fishery management system in the world, and we can make it better. Chef Barton Seaver said, "it's about what we want for dinner." I would add that we need to provide recreational access that sustains a healthy recreational fishing industry and a healthy ecosystem. We need to define and pursue success in terms that result in the management of fisheries to the greatest overall benefit to the nation—not just in biological terms but socially, economically, and ecologically. As strong as the system is, we can improve it by working together to fine-tune the Magnuson Act, its implementation, and our practices.

We can make it better. Let's get started.

Sam Rauch, Acting Assistant Administrator, NOAA

NATIONAL MARINE FISHERIES SERVICE PERSPECTIVE

This has been a successful conference that has been approached by most everyone involved in a professional, constructive, thought-provoking manner. This has resulted in far too many good findings to respond to in the allotted time. Many of the findings do not require any statutory or regulatory changes; they just need to be put into practice. Others require National Marine Fisheries Service to adopt corresponding regulations or policies. And there are a few that may require legislative action. National Marine Fisheries Service intends to meet the challenge head on.

Among the themes we heard this week is the need for sustainability and the wisdom to build on our current successes. The terms "devolution" and "decentralization" have come up several times. These concepts are the hallmarks of the Magnuson Act and the Council process, taking fishery management out of the exclusive hands of the agency and placing it in the hands of the regional Councils, the fishermen, and the states. There may be ways to improve, but incorporating the needs of fishermen and fishing communities through direct participation is something the agency embraces.

We have heard about the need for flexibility in a variety of contexts, but we also heard a call for stability, the notion that without stability we create distrust in the system and we suffer economic loss through our inability to plan. There is tension between being flexible and being responsive to the science while providing stability. This is a challenge, a challenge that the regional Councils address regularly. We need to find a path forward given these seemingly contradictory mandates.

Within the concept of flexibility, we heard a lot about tailoring our management tools to the kind of system we have. Recreational, commercial, and subsistence fisheries have very different needs and challenges. Approaches that work for data-rich species may not work for species with less information, and we need to tailor our management tools accordingly.

Many of this week's findings can be dealt with through regulation. The agency has been working on our National Standard 1 guidelines. Several of the findings mirror comments and issues submitted to the agency as it begins the process of potentially revising the guidelines. The intent is to take the feedback from this conference and to incorporate the findings as appropriate.

In terms of becoming more adaptive to climate change and achieving a better understanding of the role of forage, we have the regulatory capacity to address these issues, but they will require investment in new decision-making tools and research which may be difficult in this budget climate. It is encouraging that the agency's requests for additional funds in support of stock assessments have largely been met while many other funds have been reduced. However, we will not likely ever get to a point where we have all of the science our management systems call for. We should address the problem by finding better ways of aligning available science with our management needs, and by exploring cooperative and technological solutions for more cost-effective information collection.

The critical role of healthy habitats and ecosystems in sustainable fishery management was raised several times this week. Tools exist for developing goals and measurable criteria for assessing and adapting to changes, and the agency is interested in working with the Councils on this important issue. But the agency, through fishery regulation, cannot alone address the problem. Habitat protection requires a broad range of stakeholder input and collaboration.

In closing, two of the great achievements of the Magnuson Act are stakeholder engagement and communication. We have a unique system that provides frequent opportunities for public participation, but communities want to be more involved and there is room for growth and improvement. This conference is about shared governance. The agency encourages everyone's continued participation as these findings are put into practice.

Dave Whaley, Senior Fisheries and Oceans Staff

HOUSE OF REPRESENTATIVES, NATURAL RESOURCES COMMITTEE PERSPECTIVE

It has been a pleasure to see old friends at the conference, and it has been rewarding to meet new people who are getting involved with fisheries management. It was very difficult to decide which of the concurrent conference sessions to attend because there were many good topics and, as evidenced by the many findings, there were excellent deliberations.

It has been difficult to take in all of the findings in a short time, and it will require some time to study the outcomes of this conference and share them with members of Congress. It is great that the conference has generated so many good findings. Chairman Hastings and Senator Begich are interested in looking carefully at these recommendations and in using them as a basis for Magnuson reauthorization.

Some of the findings present difficulties from a legislative perspective. Many of the findings are scientific in nature, and when Congress attempts to address scientific issues statutorily, it doesn't always go well. We will work with the agency on the findings that can be addressed through executive action rather than statute. Other findings represent great ideas, but will be very difficult to put into legislative language. The Magnuson Act provides a desirable regional flexibility, and we need to be careful how legislation is drafted. We don't want to add language that solves one region's problem while creating new problems for other regions.

New mandates have been suggested this week. The Councils have a difficult job with limited resources, and we need to approach new requirements with caution. Mandates can also lead to increased litigation that further burdens the system.

The findings include improvements that are not improvements to the Magnuson Act, but rather to its implementation. As we heard, National Marine Fisheries Service has started a process to review the National Standard 1 guidelines. There are those who feel that Congress should step in and address some issues through legislation. This is a bit of a circular matter where it may be best to allow the agency to revise the guidelines before addressing disagreements through legislation or, conversely, it may be more desirable to make legislative changes in advance of the guideline revisions. Given that these two processes are on different schedules, Congress intends to work closely with the agency as both efforts unfold.

The next hearing scheduled for the National Resource Committee is on data collection. It has been said many times during the conference that with better information comes better management. Funding issues will continue to be a challenge, and it will be important to reduce costs through innovations, efficiencies, and technology.

The panelists this week were asked to share one new idea in their papers and presentations. One issue that has not been addressed this week is the graying of the fleet. We seem to be creating barriers to new fishery participants, and we have policies in place that hinder new vessel construction. If we desire safety and economic efficiency, we need to find long-term ways to bring new participants and new vessels into our fisheries.

Congress is appreciative of recommendations that have come from the conference. We look forward to working through them in greater detail as we approach reauthorization.

Jeff Lewis, Counsel to the Chairman and Majority Leaders of the Senate Committee on Commerce, Science and Transportation

SENATE, COMMERCE SUB-COMMITTEE ON FISHERIES AND OCEANS PERSPECTIVE

The conference has been impressive in many ways, not the least of which is the reasoned and objective way in which the findings were developed and presented. That is not usually the case in the legislative realm. It shows that those in attendance are truly interested making improvements.

Moving new legislation through the Senate can be a difficult task, particularly when substantial changes are proposed. It has been encouraging to hear at this conference that people are in general agreement that the Magnuson Act is working well and that many of the suggested improvements can be initiated through non-legislative means.

It is not possible to speak for the Senate, and the ideas shared today may change, but there a few items to highlight. Management strategy evaluations that bring stakeholders together in the development of a fishery management program with agreed goals and triggers hold promise, but they are expensive. Also, the smoothing of abrupt changes in harvest levels to minimize disruptive events without compromising our sustainability goals is something we should be working towards. Congressional members are interested in further exploring these improvements.

The finding to develop new tools and strategies for the management of recreational fisheries is interesting and appropriate because we should always be thinking about the commonalities and differences between the segments of a multiuse fishery. However, the development of these tools requires a great deal of information and supporting analyses. Many have expressed the notion that recreational fisheries have been underrepresented in Federal fishery management. Although the Magnuson Act itself clearly recognizes the importance of recreational fisheries and their economic contributions, perhaps the implementation of the Act has had a more commercial focus. Recreational fisheries have been described in greater detail in previous reauthorizations, and there is now a call to complete a similar exercise for subsistence fisheries.

Finally, regarding illegal, unreported, and unregulated harvest at the international level, many of the goals recommended this week are included in bills currently in Congress that explore both "carrot" and "stick" solutions to this significant problem.

Bill Hogarth, Director of the Florida Institute of Oceanography, University of South Florida

ACADEMIA PERSPECTIVE

It has been a pleasure to meet with familiar faces this week and to hear from those in a position to address these recommended improvements. The deliberations this week have confirmed for me that it was wise to retire. Seriously, the Magnuson Act is working, and has been implemented well by NMFS and the Councils. Many of the recommendations are concepts that we attempted to tackle in the last reauthorization. At that time, there was a strong desire in Congress for certainty, certainty in our rebuilding efforts and certainty in ending overfishing.

We have to operate and approach our fisheries as a business, one of the largest in the country. We are not currently doing so, and this is an area for improvement. Commercial fisheries operate for profit, while recreational and subsistence fisheries have different objectives. We should therefore be doing a better job of managing to these unique needs.

New technologies will continue to be an important aspect of fishery management improvements. Fishery monitoring and observing are areas undergoing extensive research today with the potential to advance management. Cooperative research and partnerships will be critical to fishery innovations.

Trust is the key, and it is in short supply. This lack of trust often gets in the way of effective management tools, including catch shares. We have to learn to trust each other and to operate our fisheries as an efficient business to get the most from the available resources.

Poster Abstracts

The Managing Our Nation's Fisheries 3 Conference featured 70 posters spanning all three conference themes: Improving Fishery Management Essentials, Advancing Ecosystem-based Decision Making, and Providing for Fishing Community Sustainability. The posters were displayed for two days, allowing for several opportunities for poster viewing and discussion with presenters. In addition to posters, several Regional Fishery Management Councils and other organizations staffed display booths.

Poster Abstracts

Quantity or Quality—Crew Jobs and Community Benefits as a Function of Fleet Size

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The Gordon-Schaefer bio-economic model is widely used to illustrate the relationship between fish population dynamics, fishing revenue, fishing costs, and net benefits to society. For the purpose of measuring net benefits to society from a fishery, all inputs are valued at their opportunity cost, which is what they would be worth in their next best use. The standard approach produces the familiar straight line for total fishery costs because opportunity costs don't vary as fishing effort increases. In order to truly understand the dynamics of a fishery, however, including the quality of crew jobs, it becomes necessary to take into account the share system, under which fishing vessel crews are paid a share of the revenue from the catch. Under most share systems, the crew pays part or all of the variable costs of fishing. When the share system is considered, the effective cost and earnings structure facing fishing businesses departs from the classic model. Annual catch limits also change the shape of the yield curve compared to an unregulated fishery. The modification of the usual fishery production function illustrated here does a better job of explaining the trade-off between the number of crew jobs and the quality of those jobs as a function of fleet size when catch limits cap revenues. By looking at costs and earnings in more detail, the loss of economic benefits to communities that occurs with excessive fishing capacity also becomes clear.

Alaska Community Profiles: Delivering Critical Information to Alaskan Coastal Communities

ROB AMES, PACIFIC STATES MARINE FISHERIES COMMISSION; AND CAMILLE KOHLER, RESOURCE DATA, INC. RAMES@PSMFC.ORG

Developing effective fisheries policies and regulations that consider the importance of fishery resources to fishing communities is challenging because comprehensive and consolidated sources of community-based data have not been available for most regions. To fill this need, Alaska Fisheries Information Network (AKFIN), in collaboration with the Alaska Fisheries Science Center, acquired and processed Alaska commercial, recreational, and subsistence fisheries data along with census demographics data into a comprehensive collection of over 600 pre-calculated annual statistics for each of the 350 selected Alaska communities from 2000 to 2011. These metrics are available to authorized users through an online Oracle Business Intelligence reporting tool, which has allowed social scientists from the Alaska Fisheries Science Center to publish an expanded and updated technical memorandum entitled Community Profiles for North Pacific Fisheries—Alaska. These published community profiles, along with AKFIN's comprehensive collection of community metrics, will assist state and Federal agencies to shape government policy and to evaluate the social and economic impact of existing regulations on these Alaska communities.

The Marine Stewardship Council as a Tool to Recognize and Improve Global Fisheries Management

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The Marine Stewardship Council (MSC) is an independent third party global certification and ecolabel program that has developed a scientifically robust standard and associated methodology, based on international norms for ecolabel programs. The standard assesses whether fisheries are ecologically sustainable and well managed and is applied equally to all fisheries that voluntarily enter into assessment. It is a market-based program designed to recognize and reward sustainable fishing practices through purchasing decisions. MSC works collaboratively with the fishing industry, seafood businesses, governments, scientific and conservation communities to achieve our mission. Fisheries are assessed by a team of independent scientific experts in a transparent, stakeholder inclusive process, and the work is peer reviewed by independent scientists. If successful, a fishery can make the claim that it is MSC certified. The MSC adopts a rational, consultative process based on the best science available to ensure it consistently reflects global best practice. The program assesses health of the stock, impact on the marine ecosystem and fisheries management and fishing practices, and can be a useful performance evaluation tool to leverage improvements in fisheries.

Several highly migratory species fishery assessments and certifications reside within the MSC portfolio, intersecting with many regional fisheries management organizations across the global landscape, and many fisheries use MSC as a tool to gauge performance. The rigor within the indicators of the MSC standard is designed to capture principles of a) sustainable stock status using reference points, harvest control rules, and rebuilding timelines; b) minimal environmental impact on bycatch, benthos and the ecosystem, and c) an effective overarching management system including eliminating illegal, unreported and unregulated fishing. Over 50 percent of U.S. fisheries are certified as sustainable under the MSC program and products from those fisheries are eligible to use the MSC label in the marketplace. That success in the U.S. helps incentivize fisheries elsewhere to achieve sustainable fishery management practices and exploitation levels already evident in the U.S. The MSC can help level the playing field as an important instrument to promote and achieve consistency, through assessments and certification, in the ecological and management outcomes across the global fishery management landscape.

Community Fisheries Network: Building Capacity for Commercial Fishing Communities

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The Community Fisheries Network is a group of 15 community-based fishing organizations and supporting organizations from around the United States that have joined together to address common challenges faced by small-scale fisheries. While the fisheries differ from community to community, members find common ground by sharing information about their work on and off the water, the management challenges they face, and how they can best adapt to change. The goal of the Network is to increase the long-term sustainability of commercial fishing communities by building business-planning acumen, strengthening social networks, and creating economic resilience through expanding markets.

The Network is committed to pursuing "triple-bottom line" community fisheries sustainability strategies, ensuring fisheries are ecologically, economically, and socially sustainable for the long-term. Members agree to operate under these principles, and seek to improve practices to meet the standards. Specific goals include improving or sustaining ecosystem and species health, ensuring equitable access to fishery resources, and improving the economic performance of local fisheries businesses and associated community infrastructure.

As the Network develops a national brand and markets for its fish, the underlying triple bottom line standards and metrics tell a story about how the fish, fishermen, and their community are intertwined. Keeping this story with the fish as it moves through the seafood product chain is a key goal for members.

Successful community based fishing businesses can help coastal communities preserve their working waterfronts. By investing in infrastructure, businesses, communities, deckhands and crew, and by engaging in creative marketing, small scale fisheries across the country can help ensure there is enough revenue crossing the wharves they rely on to ensure the long term sustainability of their communities. The National Marine Fisheries Service can aid in this process by providing much needed guidance on the development of Community and Regional Fishing Associations and associated sustainability plans in catch share programs to ensure equitable access. In both catch share and non-catch share fisheries, ideas like the Community Fisheries Network present fishermen and fisheries managers with non-regulatory solutions that help improve the health of the ocean ecosystem and sustain fishermen and their communities.

Defining Ecosystem-Based Fisheries Management: Comparisons Between the Mid-Atlantic and New England Fishery Management Councils

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Debates about the definition and scope of concepts included with the notion of "ecosystem-based fisheries management" abound. We compared how different stakeholder groups in the New England and Mid-Atlantic regions define ecosystem-based fisheries management (EBFM). We considered how each selected stakeholder group defines EBFM, the content of those definitions, differences in definition between groups, and the extent to which Council decision makers are able to characterize the views of selected stakeholder groups. We used the Coorientation Model to characterize communication processes and understanding between regional fishery management council members, staff, and scientists, commercial and recreational fishermen, and environmental nongovernmental organization leaders in the New England and Mid-Atlantic regions. The Coorientation Model is an approach that can measure the dynamics of the communication exchange and the levels of agreement in values between Council leaders and stakeholders. Approximately 5,500 questionnaires were mailed to selected stakeholders. Two versions of the survey were sent. The first version targets Council members, Council staff, and Scientific and Statistical Committee members and inquired about what survey recipients thought and also asked how the survey recipients thought the other stakeholder groups would respond. The second version targets commercial fishers, recreational anglers, and environmental nongovernmental organization leaders and inquires about what the recipients themselves thought. The question referring to the definition of EBFM asks, "Please indicate to what extent YOU agree or disagree that the definition of 'ecosystem-based fisheries management (EBFM)' should include the following concepts?" Commonly selected definition components include: "Considering the interactions between the physical, biological, and human factors that affect the health of fisheries," and "Protecting and/or enhancing habitat." Data analysis includes comparisons of stakeholder responses about the definition of EBFM, grouped and displayed visually using charts, graphs, and figures. The findings from this research will provide information to regional fishery management councils regarding what aspects of EBFM stakeholders find most important and how well priorities about EBFM are communicated among stakeholders.

The Community Development Quota Program: Developing Sustainable Communities in Western Alaska

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The Western Alaska Community Development Quota (CDQ) Program is widely viewed as one of the most successful rural development programs ever undertaken in Alaska. The CDQ program does not depend on direct government funding for its programs and activities; rather, the six nonprofit organizations that make up the program are sustained by their ability to harvest a small percentage of the fishery resources of the Bering Sea.

Established by the North Pacific Fisheries Management Council in 1992, this innovative Federal community and economic development program provides its sixty-five eligible communities with roughly ten percent of many of the Bering Sea and Aleutian Islands' harvestable fish stocks.

The goal of the CDQ Program is to encourage fisheries-related economic development in rural Western Alaska communities, helping to build the infrastructure required to support long-term participation in the fishing industry.

For over twenty years, residents of Western Alaska, through six nonprofit CDQ entities or community coalitions, have implemented the CDQ Program in an effort to overcome the geographic isolation, heavy reliance on subsistence activities, high cost of living, high unemployment, and limited economic opportunities that make this area one of the most economically-challenged in the United States. In working to fulfill their mission, the CDQ organizations have created jobs, infrastructure and opportunity in some of the nation's most geographically isolated and economically depressed communities.

The CDQ entities work both independently and through partnerships to generate revenues from the Bering Sea and Aleutian Islands commercial fisheries, which make it possible to invest in community, human, and economic capital. By balancing these investments, eligible communities are provided the right mix of resources and assets to achieve future economic sustainability, giving residents more control over their economic future.

This poster presentation will highlight some of the successes realized through the CDQ Program, illustrate the tremendous impact of CDQ investments, programs, and jobs on the 27,700 residents who inhabit the 65 western Alaska Coastal communities included in the program, and address some of the ways the CDQ entities are responding to the ongoing and future challenges faced by Western Alaska.

The Partnership for Mid-Atlantic Fisheries Science

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The Partnership for Mid-Atlantic Fisheries Science (PMAFS) is a multi-state, multi-institutional partnership formed in 2008 that combines the commercial and recreational fishing industries with the expertise of leading academic institutions in the Mid-Atlantic region. PMAFS is the first and only organization of its kind in the Mid-Atlantic and was formed primarily to address the most urgent scientific issues limiting successful management of fisheries in the Mid-Atlantic region. Much of the science undertaken by PMAFS is directly applicable to solving the most important impediments limiting the stock assessment programs of finfish stocks. PMAFS is currently focusing their efforts on summer flounder (*Paralichthys dentatus*) and black sea bass (*Centropristas striata*). A Board of Trustees was formed that consists of commercial and recreational fishing industry leaders from New York and New Jersey. The Board oversees the partnership. A Science Director was selected from an academic institution. A Science Advisory Committee was appointed by the Board and consists of academic and National Marine Fisheries Service scientists and representatives from important fisheries management groups including the Mid-Atlantic Fishery Management Council and Atlantic States Marine Fisheries Commission. The Science Advisory Committee met and set priorities for the 2009 and 2010 research programs. The fishing industries obtained Federal appropriations totaling one million dollars in each of two years to fund the Advisory Committee priorities. Seven research projects were funded in the first year addressing summer flounder management and stock assessment issues. In Year 2, seven projects were funded that address both summer flounder and black sea bass management and stock assessment issues.

Assessing Catch Share Results

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The 2010 State of World Fisheries and Aquaculture report estimates more than 80 percent of global fisheries are fully or over exploited. Decades of overfishing and poor fishery mismanagement have had negative impacts on fishermen and our oceans including job loss, stock depletion, habitat damage and even on-the-job death. Also, jeopardized is the food security of billions of people worldwide. However, there are a growing number of examples where effective management has prevented these issues by aligning fishermen's economic interests with ensuring biologically robust fish stocks (e.g. catch shares). A recent study of 15 North American catch share fisheries reveals that when carefully designed and implemented, these programs result in environmental, economic and social improvements. Impacts include higher revenues, a reduction in discarded fish, improved safety for fishermen on the job and greater economic and employment stability. This presentation, A Turning Tide for America's Fisheries, will discuss the results of this analysis and examine how well-designed and implemented fishery management programs can address environmental, social and economic concerns using examples of fisheries that have transitioned from traditional management to catch shares.

Community Fisheries Action Roundtable: Industry Participation for Social Learning

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Research demonstrates that public participation in environmental decision making can increase understanding of diverse worldviews and knowledge bases, public faith in governance institutions, and compliance with resulting rules. Concerns linger around costs, polarization and decreased legitimacy in cases of poorly executed processes, and the ability of newly empowered groups to gain political leverage over others. If participants in public processes can bracket their personal experience to better assess other viewpoints, establishing mutual respect and understanding through civic debate, they are more likely to maximize public benefits from their involvement and minimize corresponding risks. This is "multiple-loop" social learning, social change undertaken through collective discussion and interaction. A capacity-building workshop program aims to foster such learning within the Maine fishing industry. In social contexts removed from the norms of daily life and the frustrations of past fishery management confrontations, harvesters acquire knowledge and skills that facilitate more strategic and productive engagement in formal and informal decision processes. Key learning moments include suspension of longstanding assumptions and recognition of tradeoffs. Evidence indicates corresponding changes in industry attitudes and actions. Case material draws on participant observation and interview data, analyzed using grounded theory as a standard qualitative social science method.

Managing for Sustainability: Full Catch Accountability in New England and Beyond

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The Magnuson-Stevens Act (MSA) mandates that the National Marine Fisheries Service (NMFS) implement measures to establish Annual Catch Limits (ACLs) with corresponding Accountability Measures (AMs) as the primary means to control catch and end overfishing across U.S. fisheries. Additionally, all fisheries must employ a Standardized Bycatch Reporting Methodology (SBRM) and minimize bycatch. To date, very few Fisheries Management Plans successfully implement robust catch monitoring and reporting. Without representative information about catch, fisheries managers are unable to control mortality and prevent overfishing while achieving Optimum Yield.

Oceana advocates improving the quality of catch monitoring and reporting for the dual purposes of stock assessment and catch management. Robust monitoring must track all catch (including bycatch) from all sectors, including from different fleets and different regions that affect the same stock. Effective catch monitoring programs will produce accurate data for use in developing stock assessments, setting ACLs, administering AMs, and improving long-term fishery productivity. These modern monitoring programs can create sustainable and more abundant fisheries.

Oceana has conducted advocacy, including litigation, to compel NMFS to improve catch monitoring. Because of these efforts, the Northeast Region SBRM is being redeveloped to establish a rational approach to setting coverage levels which will improve assessments and the management of both target and non-target catch. In the New England groundfish catch share fishery, a Court ruling established that effective monitoring is essential to the administration of this fishery. NMFS must demonstrate that the catch monitoring program would provide reliable data for in-season management of the fishery.

Accurate estimates of bycatch are essential for understanding the full scope of fishing mortality. Oceana recommends an approach that enables NMFS to reliably count everything that is captured, cap the amount of allowable catch, and control fishing to ensure catch does not exceed these caps. Once established in New England, we suggest that such an approach can and should be developed and implemented in other U.S. fisheries to improve catch management in other regions.

Utilizing State Management to Comply with MSA Requirements

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The Magnuson-Stevens Reauthorization Act of 2006 expanded the requirements for fishery management plans (FMPs) to include provisions intended to prevent overfishing through the use of annual catch limits (ACLs). This poster focuses on recent revisions to two FMPs under the jurisdiction of the North Pacific Fishery Management Council: the FMP for Bering Sea/Aleutian Islands King and Tanner Crab and the FMP for the Salmon Fisheries in the Exclusive Economic Zone off the Coast of Alaska. The crab and salmon FMPs are unique in that management of these two fisheries in Federal waters is delegated to or shared with the state of Alaska.

The crab FMP establishes a state/Federal cooperative management regime that defers many aspects of crab fisheries management to the state. For crab stocks, the ACL is set equal to the acceptable biological catch (ABC) and the ABC control rule is a function of the scientific uncertainty in the estimate of the overfishing level and any other specified scientific uncertainty. The state sets harvest limits in the directed crab fisheries and takes into account any scientific uncertainty not already accounted for in the ABC. The existing state process for setting harvest limits was recognized by the North Pacific Council as a more clearly defined, flexible, and precautionary method of incorporating additional uncertainty in order to meet National Standard 1 (NS1) Guidelines.

The geographic scope of the salmon FMP was recently amended using an alternative approach to satisfy NS1 requirements. Salmon fisheries are managed by the state throughout Alaska using an escapement and abundance based system with real-time monitoring and inseason management actions to control catch and prevent overfishing. The revisions to the FMP serve to facilitate continued state management of salmon fisheries by avoiding the creation of a dual Federal and State management structure and reaffirming that commercial and sport salmon fishery management is delegated to the state in accordance with the Pacific Salmon Treaty and other Federal law. With this action, the Council acknowledged that salmon warrant an alternative approach, per the NS1 Guidelines, to best control catch, prevent overfishing, and achieve optimum yield.

Evaluating Methods for Setting Annual Catch Limits for Data-Limited Stocks

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The requirements for science-based catch limits for most federally-managed fish species in the U.S., combined with the large number of data-limited stocks, has spurred an emerging field of methods for setting annual catch limits for data-limited stocks. The purpose of this research is to simulate and evaluate the performance of different data-limited methods and management approaches, including 15 that have been adopted or recommended for use in U.S. fishery management plans, 10 alternative approaches and six reference methods. Management strategy evaluation is a cost-effective approach to testing these methods. MSE also provides an opportunity to better understand the trade-offs among management objectives for any given management approach and to quantify the value of various types of information and data to the accuracy of model outputs.

In total, 31 methods are applied to six “case study” stocks exemplifying a range of life-histories, exploitation scenarios, and relevant management approaches. Each method is simulated 10,000 times for each stock over a 30 year time period. Performance of the different methods is evaluated in terms of preventing overfishing, rebuilding overfished populations, relative yield, depletion over time, and sensitivity to a credible range of error in user inputs.

Preliminary results indicate that many data-limited methods currently in use in U.S. fisheries management that rely mainly on historical catch do not perform well in preventing overfishing and avoiding or recovering from an overfished condition. These methods perform particularly poorly when starting from depleted conditions (e.g. less than 50 percent biomass at maximum sustainable yield). In contrast, methods that rely more on current abundance than on historical catch perform markedly better in preventing overfishing and avoiding or recovering from an overfished condition. The performance of different methods also does not change markedly under different life-history scenarios.

Sea Grant and Alternative Marketing of Seafood—Helping to Build Fishing Community Resiliency in Challenging Times

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Fishing community resiliency depends on their ability to adapt to dynamic and unpredictable ecosystems, management, and markets. One way fishermen can adapt is to develop alternative or value-added markets for their products that captures the value of their catch before it leaves fishing communities. Alternative marketing has also helped fishermen organize, enabling them to participate in cooperative research and management and produce fine scale economic data that has not been readily available before. These efforts have gained traction in fishing communities as they also achieve a range of other social and environmental goals. As a result, interest in these forms of marketing from fishermen, fishery scientists, managers and fishing communities has been widespread. Despite its potential, there are a variety of technical barriers, risks, and overarching questions about the long-term viability of alternative marketing. In particular, these business models require that fishing communities develop skills and expertise in new areas such as processing, distribution, handling, pricing, and marketing of seafood. In many cases, permits, licenses, insurance, new relationships, and careful business planning are required. For fishermen and others in fishing communities, this is often a brand new skill-set and business setting, and developing businesses without these capacities runs the risk of losing money and missing business opportunities; an outcome that many fishing communities simply cannot afford. Sea Grant is playing a critical role in helping fishing communities meet some these challenges by providing training, access to new technologies and facilitating new partnerships. Inspired by Sea Grant's ongoing commitment to a safe and sustainable seafood supply, burgeoning demand from coastal communities, and alignment with broader NOAA objectives, direct and alternative marketing is an important and timely topic for fishermen and fishing businesses as well as an opportunity for partnership. Crosscutting a multitude of stakeholders and disciplines, alternative marketing is of economic and social significance to constituents; it represents a unique opportunity for Sea Grant and NOAA to engage with stakeholders; and it has the potential to inform and be informed by management and policy decisions.

Measuring Social and Economic Indicators in Northeast U.S. Fisheries and Fishing Communities

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Over the past several years the Social Sciences Branch of the National Marine Fisheries Service, Northeast Fisheries Science Center has been developing indicators to track the social and economic performance of fisheries. Indicator development has focused on the following topics: fishery performance, vessel costs, and community vulnerability. The Fishery Performance Indicators cover five theme areas: financial viability, distributional outcomes, stewardship, governance, and well-being. These theme areas were developed in a year-long process involving literature searches, stakeholder meetings, and an academic workshop. Vessel Cost Indicators cover variable and fixed costs related to fishing, including: trip costs; the costs of repair, maintenance, upgrade, and improvements; business costs; and crew payments. We also use cost information to calculate net revenue and profitability indicators. Community Vulnerability Indicators are grouped in three categories: social vulnerability, gentrification pressure, and fishing dependence. The Social Sciences Branch has implemented new regional-level data collection efforts to support indicator development, including an annual cost survey, a vessel owner survey, and a crew survey. We have already published initial reports on the fishery performance indicators based on secondary data. Reports for fishery performance and annual cost indicators based on new survey data will be prepared after data are audited and analyzed. A publication is also being developed on community vulnerability indicators.

Marine Resource Education Program for Fishermen in the Southeast Fisheries Region

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The Gulf of Mexico, South Atlantic and Caribbean Fishery Management Councils look to their many advisory panels for advice and recommendations, but broad constituent participation is also an extremely important part of the fishery management process. All too often, commercial and recreational fisheries constituents feel intimidated or remain unclear on best ways they can contribute, and feel the science underlying the management process is difficult to absorb and understand. In response, fishermen have sought additional ways of obtaining foundational knowledge necessary to navigate fishery data and understand how this data is used in management.

The Gulf of Maine Research Institute is collaborating with partners from the three regions to develop and implement a multi-day Fishery Science & Management Education Program for commercial and recreational fishermen, modeled after the highly successful New England Marine Resource Education Program. This education enables fishermen and others to participate productively in the fisheries management process, and leads to improved cooperation and trust between fishermen, scientists and managers. Fundamentally, a co-learning approach is used in this program, where program developers, program participants and program presenters all learn from one another through their interactions and collaborations.

The strength of the Marine Resource Education Program model is that it is "for industry by industry". Extension of the model to the Southeast fisheries region has mirrored this, and draws upon local fishing industry representatives to serve as leaders in regional implementation, and building long-term capacity within the region. The curriculum has been developed by a Steering Committee—consisting of 18 industry members who represent a balanced mix of fishing effort types, gear types and regions—and is tailored to the region's fisheries, fishing communities, and management practices. Program presenters have been drawn from local and regional Federal agencies and provide a unique opportunity for scientists and managers to communicate with fishermen in a neutral setting, build trust, and overcome barriers to cooperation.

The Steering Committee will meet annually to guide evolution of content for future workshops, and also recommend new workshop locations throughout the three regions, to ensure a broad reach and best possible accessibility.

Empirical Move-on Rules to Inform Fishing Strategies: A New England Case Study

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Increasingly, fisheries are being managed under catch quotas that are often further allocated to specific permit holders or sectors. At the same time, serious consideration is being given to the effects of discards on the health of target and non-target species. Some quota systems have incorporated discard reduction as an objective by counting discards (including unmarketable fish) against the overall quota. The potential effect of the introduction of a quota system that includes accountability for discards on the fishing strategies employed by fishermen is enormous. This is particularly true for multispecies fisheries where healthy and depleted stocks co-exist; resulting in a trip's catch being applied to very large and very small stock quotas simultaneously. Under such a scenario, fishermen have a strong incentive to minimize (i) catch of low-quota or 'choke' stocks, (ii) regulatory discards due to minimum size limits and (iii) catch partially consumed by predators. 'Move-on' rules (i.e. event-triggered, targeted, temporary closure of part of a fishery when a catch or bycatch threshold is reached) have been employed in a variety of fisheries. However, their efficacy has been limited by a lack of empirical analyses underpinning the rules. Here, we examine the utility of spatiotemporal autocorrelation analyses to inform 'move-on' rules to assist a sector of the New England Multispecies Fishery to reduce discards and maximize profits. We find the use of empirical move-on rules could reduce catch of juvenile and choke stocks between 27 and 33 percent, and depredation events between 41 and 54 percent.

FishSmart: Using Technology to Create Access

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FishSmart is a NOAA-funded, angler-led program to improve the survival of fishes released by anglers. This collaborative effort is focused on developing fishing techniques, tackle, and management approaches to reduce catches of fish that need to be returned to the water and improve the survival of fish that are released.

FishSmart has spurred and highlighted innovation, research, and management consideration of devices and practices to counter barotrauma, a condition deep water fish suffer from when brought to the surface quickly. Barotrauma involves the rapid expansion of gasses in a fish's body which can cause significant tissue damage and impaired swimming ability, resulting in mortality or increased rates of predation. In part, due to this phenomenon, high post-release mortality rate estimates are applied in the stock assessment process.

High post-release mortality rates can contribute to reduced access for fishermen when stock status is assessed. The FishSmart program is innovating to counteract barotrauma, while simultaneously encouraging research on the survival of descended fish and broadly promoting the importance of proper handling and release of fish to maximize survival. The initiative has led to reconsideration of how release mortality is handled in some fisheries and a recently initiated examination of NOAA Fisheries scientific approach to release mortality. Through this program there is the possibility to produce real conservation gains and improved science, which could result in improved survival and ultimately greater fishery access.

An Ecosystem Approach to Fisheries Management: A Voluntary Environmental Management System Approach to Fisheries Practices in a Large Marine Ecosystem Framework

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This study/poster addresses international aspects of fisheries sustainability as part of the Large Marine Ecosystem modular approach. Consideration is given to consensus-based voluntary environmental management systems (VEMS) as an adaptive management aspect of fishing practices being integral strategic parts of marine ecosystems. A VEMS is a unique means or tool for managing the impacts of a fisheries enterprise's activities on the marine environment.

For sustainability planning and implementing environmental protection measures, the VEMS provides a structured approach. A VEMS integrates environmental management quality at various scales into an organization's everyday operations as well as its long-term planning. A VEMS is an important "ecosystem consideration" component of the Large Marine Ecosystem approach as it is intended to lead toward improved valuation assessments and movement to sustainability of vulnerable resources. The fisheries practice VEMS is meant to promote dialogue on VEMS being a scientifically based tool ("best scientific information available standard") for ecosystem-oriented management of living marine resources.

Avoiding No-Win Management Scenarios Through Development of Bycatch Reduction Devices in Alaska

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Bycatch management of Alaska groundfish fisheries must balance large scale commercial fisheries with interests of subsistence users and small-scale commercial and recreational users of the bycatch species. The North Pacific Fishery Management Council (NPFMC) is diligently addressing salmon and halibut bycatch in groundfish fisheries, but solutions often involve difficult and non-productive tradeoffs. This is because traditional bycatch management tools typically reduce efficiency and create potential for leaving large amounts of groundfish un-harvested. Use of closed areas has proven problematic because the degree of spatial overlap between groundfish and bycatch species is highly variable. Once in place, closure regulations take years to modify and in some cases have actually resulted in closures of areas where bycatch rates would be much lower than the areas left open to fishing. Implementation of hard bycatch caps administered through cooperatives has created strong incentives for bycatch minimization and hotspot avoidance. Nevertheless, when spatial and temporal overlap between bycatch and target species is strong, attainment of the bycatch cap before groundfish total allowable catches can be inevitable. In an attempt to create potentially better outcomes or at least a different set of tools in the toolbox, the Alaska groundfish industry and National Marine Fisheries Service's Resource Assessment and Conservation Engineering Division have successfully partnered to develop and systematically test bycatch reduction devices. Resulting excluders are now widely used, with demonstrated bycatch escape rates of 25 percent to 42 percent for Chinook salmon by pollock trawlers and up to 60 percent to 80 percent escapement of halibut for flatfish and cod trawlers. Loss rates of target species are less than one percent with use of salmon "excluders" in pollock fishing and loss rates of target catch range from 10 percent to 20 percent in cod and flatfish fisheries. These devices are proving to be critical tools to help industry manage its bycatch under the NPFMC's hard caps, incentive plan agreements, and rolling hotspot bycatch management programs.

How the Sustainability of Reduction Fisheries is Being Assessed and Addressed and Suggestions for Moving Forward

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Much attention has been given to forage fish science and management in recent years. In particular, it has been noted that forage fish fisheries, which are primarily destined for reduction to fishmeal and fish oil, may require different management measures than those traditionally used to manage wild-capture fisheries. This is a result of their vital role in the food web, as well as their unique life-history characteristics. In this review we have identified the main management requirements for forage fish fisheries and questions that can be used to address a reduction fishery's sustainability, including: accounting for predator needs through reduced catch limits as well as spatial management, incorporating stock fluctuations due to climate variability (e.g., El Niño/La Niña, decadal oscillations, etc.), evaluating the economic value of the fish as wild prey versus their value as feed, use of real-time management, and implementation of precautionary harvest strategies. Precautionary harvest strategies are particularly important given the lack of adequate stock assessments for many of these species, due to their short-lived nature and a dearth of resources for monitoring and assessing the stocks. Furthermore, we have looked at how various non-governmental organizations working in the sustainable seafood sphere address reduction fisheries in their assessments of wild-capture fisheries, and also to what degree reduction fisheries management is addressed in assessments of aquaculture species. In general, we found that non-governmental organizations do account for the role of forage fish in the ecosystem, but the majority does not ask detailed questions regarding how forage fish are managed. We conclude with a list of questions that we believe should be the basis for any evaluation of reduction fishery sustainability.

Fishery Access Strategies to Support Ecosystem-Based Management

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Fishermen, fishery managers, academics, and non-governmental organizations agree that single-species systems of fishery management are not working. Illegal leasing of fishing rights, decades–long waiting lists, and "boxed-in fishermen" are just a few of the many problems identified at a licensing policy workshop held by Penobscot East Resource Center and Maine Sea Grant in 2012. In addition, today's licensing systems present a significant obstacle to the transition away from single species management and toward an ecosystem-based fishery management approach that protects biodiversity and resilience.

In 2012, Penobscot East and Maine Sea Grant gathered ideas and insights on this problem from Maine fishermen and fishery leaders and thinkers from New England, Atlantic and western Canada, California and Alaska. Together these experts began to frame a new approach to licensing coastal fisheries; one that could help relieve some of the problems facing today's fisheries while at the same time facilitating the transition toward ecosystem-based fishery management.

The underlying concept for this licensing system is to create a system that enables adaptive access to multiple fisheries based on a denomination that could be called stewardship credits—credits that would be accumulated by individual, owner-operator fishermen learning, doing, and sharing the practices of sound stewardship, on the water and in their communities. Credits would qualify individual fishermen to obtain endorsements on a state-issued, multi-purpose commercial fishing license. The state license would qualify a fisherman to obtain one or more endorsements issued by a state, regional, or local fisheries management body (depending on which scale of governance was most suited to a given fishery). An endorsement from the appropriate governing body, would permit a fisherman to commercially harvest a managed or emerging, living, ocean resource.

Framing the Message about Seafood: Outcomes of a Conference About Communicating Seafood Safety

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The Framing the Message About Seafood conference represented the first time that a very diverse group of stakeholders convened to discuss the information that has been presented to the public on seafood health benefits and risks in a format designed to specifically explore and identify alternative approaches to reduce confusion and misinformation. It was remarkable that a consensus was reached on an alternative approach that could be readily translated to an existing Web-based resource.

The Seafood Health Facts Website is designed to be a comprehensive resource on seafood products for healthcare providers and practitioners and their patients. It is also intended to be a resource for consumers to obtain objective information on seafood products. The information on this site is organized by topic and includes resources for seafood nutrition and the benefits of seafood consumption, seafood safety and the risks associated with certain types of seafood, a comparison of the risks and benefits of seafood consumption, and the seafood supply in the U.S. It is also organized to provide different types of resources appropriate for different groups of people. The educational materials and other resources for each of the seafood and health related topics are organized into three different sections based on their usefulness for: the general public; healthcare professionals; and scientific publications for all groups. Customize Your Seafood Consumption Information: Based on the consensus that was reached during Framing the Message About Seafood conference a new web tool was developed for the Seafood Health Facts Website. This tool is designed to help consumers determine whether they are eating the right amount of seafood based on current dietary recommendations, and what (if any) specific food safety advice may pertain to them based on where they get their seafood and other issues such as sustainable fisheries.

Guidance on Electronic Technologies and Fishery-Dependent Data Collection

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Monitoring is an important component of fisheries management and with annual catch limits and accountability measures in place, the demands for fishery dependent data for the agency's science and management use will continue to rise. The implementation of fisheries management regulations that require near real time monitoring of catch by species at the vessel level have challenged the traditional methods of self-reporting, on-board observers and dockside monitoring. There has been growing concern that the current trend in catch monitoring in the United States is neither economically sustainable nor meeting the needs for quality, timeliness and coverage across fisheries, regions, or regulations. Recognizing these issues, NOAA Fisheries in partnerships with Regional Councils and the fishing industry is developing policy and technical guidance that will support and encourage the adoption of electronic technology solutions for fishery-dependent data collection programs, where feasible. Electronic technologies include the use of vessel monitoring systems, electronic logbooks and the use of video cameras for electronic monitoring. The goal is to achieve a more cost-effective and sustainable approach to fishery-dependent data collection, and take advantage of the range of current/emerging electronic technologies. This poster provides information about the process for evaluating electronic technologies and technical guidance on its implementation.

Sustainable Seafood in the U.S.—What Challenges Remain?

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In the United States seafood market, consumers are increasingly looking for sustainable seafood options, as evidenced in part by the proliferation of various environmental organizations' sustainable seafood purchasing guides. Retailers and restaurants are responding and taking steps to meet the demand by adopting some of these guides as a basis for their seafood purchases. Eco-labels, such as the Marine Stewardship Council, are another basis upon which consumers and retailers are making their seafood decisions. While eco-labels provide consumers with a clear and quick indication that the product meets specific criteria, and producers using the label can gain a market advantage, third party verification programs can be costly and time-consuming. With various eco-labels and seafood recommendation guides, consumers can feel confused and frustrated.

The Magnuson-Stevens Act (MSA) contains strong provisions that incorporate the three key factors of sustainability – ecological, economic, and social—into fisheries management. As a result, U.S. fisheries are managed under some of the most rigorous regulations in the world, particularly when combined with other U.S. laws. In contrast, many of the consumer guides for sustainable seafood are based solely on ecological factors, disregarding the economic and social.

When consumers learn that the MSA addresses the three aspects of sustainability, they often feel reassured and seek to buy U.S. harvested seafood. Unfortunately, at markets and restaurants, they can have a hard time finding out where seafood products were harvested. Labels with country- and/or fishery-of-origin are difficult to find. In order to have these, systems are needed that trace seafood through the supply chain and verify product claims.

These market challenges are increasingly affecting fulfillment of MSA goals—U.S. fisheries that provide benefits to the nation through food, jobs, and revenue. Innovative models, such as Trace & Trust, Gulf Seafood Trace, and FishTrax, are emerging around the country to connect seafood consumers with U.S. suppliers. In what ways can NOAA work more with other agencies, non-governmental organizations, and industry to help support efforts that will better identify U.S. seafood options for consumers?

Challenges to Leveling the Playing Field: A Case Study of Mitigating False Killer Whale Impacts in the Hawaii-Based Tuna Longline Fishery

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The Magnuson-Stevens Act (MSA) requires compliance with other applicable laws, including the Endangered Species Act and Marine Mammal Protection Act (MMPA). Fisheries are frequently impacted by requirements to comply with domestic environmental policies, presenting a disadvantage in leveling the playing field in the international arena. The Hawaii-based tuna longline fishery has faced new challenges in recent years with false killer whale interactions.

False killer whales are distributed worldwide in tropical to temperate waters. Depredation by false killer whales and other cetaceans on longline fisheries is common around the world and is a significant problem to fishers due to the economic loss experienced as a result of these events. Occasionally, false killer whales become hooked or entangled if they are not successful in avoiding the gear. Research to develop technological solutions has thus far been unsuccessful in developing effective long-term solutions.

The occasional interactions with false killer whales have become a challenging issue to the Hawaii-based tuna longline fishery in recent years, as National Marine Fisheries Service (NMFS) estimates that the annual number of interactions exceeds the potential biological removal, a level thought to be sustainable to the long-term health of the false killer whale population in the area. Under requirements of the MMPA, NMFS initiated the False Killer Whale Take Reduction Plan process in 2010 to develop strategies to reduce the interactions.

At issue are the timeline for developing a plan and the lofty implementation goals set forth under the MMPA. According to the process, the Take Reduction Team must develop a draft plan within six months of convening, with a short-term goal of reducing take below potential biological removal within six months of the plan's implementation. As a result of these constraints to the process, the resulting Take Reduction Plan includes measures to reduce serious injuries that count against the fishery by requiring gear modification and to reduce interactions within the target management area under the Take Reduction Plan by closing large portions of the U.S. Exclusive Economic Zone around Hawaii. However, the Take Reduction Plan process failed to develop measures to reduce depredation events, a solution that would simultaneously reduce impacts on false killer whales and provide economic benefits to U.S. fishers to help them survive in an increasingly competitive and unlevel playing field against international fisheries.

Bottom Communities in the Mid-Atlantic Bight

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The coastal ocean off the Delmarva (Delaware, Maryland, Virginia) peninsula has supported a variety of fisheries for over 300 years. This area of the Mid-Atlantic Bight ranges from sand swept beaches along the shore to the canyons along the continental slope, which are the Pleistocene remnants of the great eastern rivers. Ocean depth is up to 200 m, and the bottom is primarily a mix of sand ridges and muddy hollows, with infrequent hard bottom formed from low relief rock outcrops, or compact sediments of biological origin. The area is in the midst of major population centers that heavily use the coastal waters for recreation, transportation, food production and, of late, power generation. Anthropogenic impacts have resulted in decreases in bottom relief from decades of bottom trawling along with enhancement of relief from centuries of shipwrecks, and more recently, attempts at artificial reef construction. We present a summary overview of the biological communities that are associated with the various bottom types found here with special emphasis on natural hard bottom. These natural and some artificial structures support valuable recreational and commercial fishery resources that far outweigh their areal makeup of the bottom. The overview is meant to encourage managers and researchers to strongly consider these habitats in future planning agendas.

Climate Change, Thermal Habitat Dynamics, Habitat Coverage Bias and Food Web Dynamics with Special Reference to Keystone Forage Species in the Mid-Atlantic Bight

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Two important considerations for ecosystem-based fishery management are habitat and predator-prey relationships. The Mid-Atlantic Bight experiences some of the largest seasonal fluctuations in water temperature and other features defining marine habitats. As a result, many mobile ectotherms in the region are migratory, behavioral thermoregulators. Many track their thermal niche envelopes across the ecosystem using productive shallow coastal habitats to the northwest as summer feeding/nursery grounds and overwintering in deeper offshore habitats near the shelf break. Atlantic butterfish (*Peprilus triacanthus*) and longfin inshore squid (*Doryteuthis pealeii*) are short lived, pelagic species central to the Mid-Atlantic Bight food web that exhibit migratory thermoregulation. Recent changes in climate are causing spatial and temporal expression of thermal niches in the ocean to change.

Changes in spatial and temporal expression of thermal niches in the Northwest Atlantic have the potential to confound population estimates based on surveys conducted during fall and spring transition periods that don't sample the entire ecosystem, creating habitat coverage bias that may be systematic under a climate change scenario. Large scale forces changing quantity and quality of thermal habitat could also affect the fundamental processes regulating populations. We are developing approaches to parameterize thermal niche models based on fundamental principles of metabolism and thermal ecology. We are projecting these models and thus habitats in space and time at the scale of the whole ecosystem using hydrodynamic models. We are using these projections as tools to account for habitat coverage bias in traditional surveys, design cooperative industry based surveys for behavioral thermoregulating species, and understand mechanistic relationships between habitat and population dynamics including modulation of density dependent mechanisms of population regulation by habitat dynamics.

We are developing our analyses and models using an "open source" collaborative approach. Our working group, Open Ocean, has been formed to collectively move from inception of ideas through delivery of evaluated products. It includes partners with expertise in physical oceanography, ecosystem science, and assessment science from government, academia, and the fishing industry. We believe that our collaborative approach of sharing responsibility of developing best available science with expert ecosystem users is required for effective management of marine ecosystems.

Successful Rebuilding of Bristol Bay Red King Crabs and Current Management Under an Annual Catch Limit Control Rule that Incorporates Uncertainty

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The Bering Sea and Aleutian Islands crab fisheries management plan (FMP) provides for a state/Federal cooperative regime that defers most crab fishery management to the state of Alaska with Federal oversight. After peak landings in 1980, the red king crab fishery in Bristol Bay was closed in 1983 because of stock collapse. In the ensuing decade, small harvests and additional fishery closures associated with depressed stock status prompted a reappraisal of the management strategy. A length-based population model was developed to provide improved stock assessments for setting annual total allowable catches (TACs). A management strategy evaluation revealed that a harvest strategy, which included a stair-stepped harvest rate of 10 to 15 percent of mature males and a threshold for effective spawning biomass below which no fishing is permitted, provides for relatively high long-term yield, greater stability in yield, fewer fishery closures, and higher effective spawning biomass. This strategy for setting TACs was adopted by the State of Alaska in 1996; at the same time the North Pacific Fishery Management Council amended the groundfish FMP to include crab bycatch caps and area closures protecting sensitive crab habitats. The stock responded well to these conservation measures and has been rebuilt since 2003. Over 1996-2008, abundance of legal-sized males increased by 58 percent, mature males doubled, and mature female abundance and effective spawning biomass tripled. The stock remains healthy today, although it is now experiencing a declining trend owing to lack of recent above average year classes. A sharp reduction in fishing capacity, after implementation of an individual fishing quota program in 2005, substantially improved fishery profitability. Other recent FMP changes include revised overfishing definitions using a five-tier system based on the level of available information for any given stock and establishment of annual catch limits (ACLs) implemented in 2008 and 2011, respectively. ACLs are set equal to the annual biological catch based on a control rule that accounts for a level of risk of overfishing (P*) corresponding to scientific uncertainty in the overfishinglimit. The Council selected P* = 0.49 (i.e., 49 percent chance of overfishing), recognizing that additional buffering to account for outside-of-model scientific uncertainty is accomplished by the State of Alaska during the annual TAC-setting process.

Implementing Sector Management in New England's Groundfish Fishery

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In 2010, New England's groundfish fishery began operating under sector management, an output-based management system under which communities formed harvesting cooperatives—called sectors—that receive an annual allocation of groundfish stocks. The poster presents the key design elements of the sector system.

Establishing and maintaining durable sectors is essential to sustaining New England's groundfish communities. To that end, Gulf of Maine Research Institute (GMRI) provided technical assistance to 14 of the 16 active sectors, helping them draft and submit by-laws, rosters, operational rules, harvesting plans, and environmental assessments.

Sector management required a new level of monitoring, including dockside and at-sea monitoring, to verify stock area, discards and landings. GMRI convened a group of industry, nonprofit, and NOAA leaders to design the dockside monitoring program and strategize on how to implement cost-effective and accurate at-sea monitoring.

With sector management now well established, GMRI is focusing on organizational and business development for the sectors, reducing the costs of sector management, and improving data collection and monitoring. We also engage in cooperative research to test and develop industry-developed gear modifications to increase species and size selectivity.

History of the Magnuson-Stevens Act and National Standard 1 Guidelines

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Marine fisheries management in the United States is primarily governed by the Magnuson-Stevens Fishery Conservation and Management Act (MSA). The overarching principles of the MSA is that fisheries should not jeopardize the capacity of a fish stock to produce maximum sustainable yield (MSY), and that overfished stocks (i.e., biomass is too low) should be rebuilt to the level that will support MSY. To address these challenges, the eight Regional Fishery Management Councils and NOAA Fisheries use National Standard 1 (NS1) of the MSA and its associated guidelines as their primary resource. The MSA and the NS1 guidelines have been revised a number of times to address ongoing challenges in fisheries management, including ending and preventing overfishing and rebuilding depleted fish stocks. Here we briefly recap the basis and history of the MSA and the National Standard 1 guidelines with regard to provisions to prevent overfishing, achieve optimum yield, and rebuild overfished stocks and highlight some of our major accomplishments.

Northeast Regional Ocean Council Commercial Fishery Mapping Project

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The Northeast Regional Ocean Council, a New England planning organization, mapped commercial fishing activity for use in future ocean planning. The Commercial Fishing Mapping Project used vessel trip report (VTR) and vessel management system (VMS) data, filtered to protect confidentiality, to produce maps of commercial fishing activity in New England. Preliminary maps were used for stakeholder engagement to verify mapping information, add information missing from VTR and VMS based maps, and to ask questions about past fishing patterns.

VMS based maps show great promise in accurately portraying spatial use patterns for selected commercial fisheries (Atlantic herring, Northeast groundfish, scallop, monkfish, and surf clam/ocean quahog). VTR data exists for many more fisheries but are limited to broad patterns of fishing activity, e.g. inshore and offshore. Future work includes separation of transit/steaming time from fishing for VMS maps and development of mapping approaches for fisheries that are not well represented by VTR or VMS data, most notably the American lobster fishery.

The maps provide accurate information about commercial fishing activity to use in future decisions about ocean uses. Future ocean use planning will minimize conflicts when based on accurate, publicly available information about current uses.

United Nations Food and Agricultural Organization Framework Assessment of U.S. Management Systems

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NOAA has often stated that "fisheries managed under the Magnuson-Stevens Fishery Conservation and Management Act are sustainable" but has not provided a program to formally document its sustainability and distinguish U.S. managed seafood products in the marketplace.

Ocean Trust with the support and cooperation of the Gulf States Marine Fisheries Commission and NOAA Domestic Fisheries Division are exploring a framework evaluation process and pilot assessment of Federal and state management conformance to the United Nations Food and Agriculture Organization's (FAO) Ecolabelling Guidelines for Marine Capture Fisheries.

The initiative builds upon recent "Science & Sustainability Forums" conducted with participation from leading fishing nations and scientists which concluded that fisheries sustainability is best defined by management systems, not snapshots of the stock status or fishing levels at any given point in time or of one fishery in isolation, but rather by the capacity of the system to respond to changes in stock levels or impacts via management measures in all fisheries under its jurisdiction.

The pilot assessment framework process we present is based on the 2010 FAO Draft Evaluation Framework to Assess the Conformity of Public and Private Ecolabelling Schemes with the FAO Guidelines for the Ecolabelling of Fish and Fishery Products from Marine Capture Fisheries, which provides benchmarking indicators to validate U.S. management systems conformity with the FAO Guidelines for ecolabelling and subsequent potential designation of the sustainability of U.S. managed fisheries.

Our approach is to evaluate the management and stock assessment process, identify gaps between Federal/state systems and FAO criteria, and develop recommendations for consideration by NOAA, Regional Councils and state managers. The pilot conformance assessment describes Applicable Statute(s) as well as regulations and guidelines that apply to Federal and state fisheries, followed by a discussion section on major stocks that illustrates how fisheries are managed. We then assess conformance with FAO criteria for sustainable fisheries, identify gaps, and provide recommendations to address those areas of non- or low-conformance.

We view this exercise as a very significant initial step for improving fishery management systems and providing a process to systematically document the sustainability of U.S. managed fisheries.

Communicating Seafood Sustainability from the Gulf Coast: a Two-Pronged Approach

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Pressure on seafood buyers to demonstrate that the seafood they are sourcing is "sustainable", has created an influx of sustainability models and programs. This has created an increased amount of pressure on government fishery management agencies to provide communications and assurances to the supply chain with limited budgets and staff. Louisiana Department of Wildlife and Fisheries is working on two approaches to help fill this communication void by providing a transparent source of data on our fisheries and to provide a third-party level of confidence to the buyers of our seafood.

1. One of the key projects the Gulf Coast states are embracing is a "Gulf Watch" website. This would be similar to the NOAA FishWatch website, but would emphasize those species managed at the state level—species not currently covered by the federally managed species on FishWatch. This site will be a transparent resource of information for buyers and consumers to make educated decisions about our fisheries.
2. The second key project is to combine efforts with the Audubon Nature Institute to develop a program

that can verify if a fishery is in conformance to the United Nations Food and Agriculture Organization's (FAO) Code of Conduct for Responsible Fisheries. This project will also utilize the concept of fishery development plans for those fisheries with challenges to conformance or for those fisheries where the market only requires a fishery development plan—not full certification.

The Audubon Nature Institute is a conservation organization with a strong reputation on the Gulf Coast, and will lend third-party credibility to this program. This program will be made available to any Gulf Coast fishery and will highlight the strengths of the major Gulf Coast fisheries and indicate areas that need improvement to conform to the FAO Code of Conduct for Responsible Fisheries—a balanced/accurate view of Gulf Coast fisheries.

Integrating Habitat Conservation into Sustainable Fishery Management: Recommendations from the NOAA Habitat Blueprint Symposium at the 142nd Meeting of the American Fisheries Society

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In 1996, Congress added the "essential fish habitat" (EFH) provisions to the Magnuson-Stevens Act (MSA) in recognition of the decline of fish habitat that threatened our nations' sustainable fisheries. Since 1996, NOAA and the regional fishery management councils have identified EFH for more than 1,000 species, designated over 100 habitat areas of particular concern, and protected over 700 million acres of EFH from the impacts of fishing. Despite these accomplishments, habitats essential for healthy fisheries are still at risk, many fish stocks are not meeting biomass targets, and fishery scientists and managers struggle to effectively demonstrate a link between specific habitat improvements and fishery productivity.

The NOAA Habitat Blueprint is a new strategy to address the growing challenge of coastal and marine habitat loss and degradation, increase the effectiveness of NOAA's habitat programs to achieve sustainable and abundant fish populations, recover threatened and endangered species, and protect coastal and marine areas and habitats at risk. To advance this effort, NOAA hosted a symposium on the NOAA Habitat Blueprint at the 142nd Annual Meeting of the American Fisheries Society on August 22nd, 2012 in St. Paul, Minnesota. Panelists included representatives of NOAA, the Councils, and other non-government organizations who discussed the impediments to applying existing habitat conservation authorities in MSA to achieve fishery goals, options for developing habitat conservation objectives for fishery managers, and recommendations for implementing such objectives.

The panelists concluded that many opportunities exist for fishery managers to act now to strengthen habitat conservation to achieve sustainable fisheries:

1. NOAA should work with the Councils to develop strong, actionable objectives for some habitat-dependent fish stocks.
2. NOAA can work immediately with the Councils on ecosystem-based fishery management plans.
3. Stronger procedures for Council engagement in key EFH consultations will help NOAA achieve its objectives for sustainable fisheries.
4. A potential reauthorization of the Magnuson-Stevens Act would offer opportunities for NOAA and the Councils to improve their habitat authorities and adapt to the growing number of challenges faced by our nation's fisheries.

Fisheries Management Policies and Their Effects on Safety in the Commercial Fishing Industry

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Background: Studies from many countries have suggested that fisheries management may affect fishing safety. However, there has been relatively little systematic analysis of how fisheries management affects safety or the extent to which changes in management can make fishing safer or less safe. This poster outlines some of these effects.

Methods: To better understand the relationship between fisheries management and fishing safety, the Food and Agriculture Organization of the United Nations and the U.S. National Institute for Occupational Safety and Health are cooperating in an international effort to document the relationship between fisheries management and fishing safety to provide practical guidelines for fisheries managers and safety professionals. International case studies were collected and reviewed for evidence to four hypotheses of how fisheries management policies could affect safety.

Results: Each case study provided evidence supporting at least one of the hypotheses. The review of the case studies resulted in establishing the following:

1. a conceptual framework, terminology and hypotheses about the relationship between fisheries management and fishing safety;
2. a review of the evidence provided by the international case studies with respect to these hypotheses;
3. a review of other evidence in the published literature supporting these hypotheses;
4. preliminary recommendations for fisheries managers and safety professionals about how they can help make commercial fishing safer; and
5. suggestions for important areas for future research.

Conclusions: Fishery management is a complex challenge. Managers must attempt to balance multiple objectives, under significant uncertainty, with limited resources. We recommend that safety professionals and fisheries managers take practical steps and acknowledge the relationships we have outlined and then take steps which may help to save lives and reduce injuries to fishermen.

Designing and Implementing Annual Catch Limits for North Pacific Groundfish and Crab Stocks

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The Alaska Fisheries Science Center provides the main stock assessment support to the North Pacific Fishery Management Council for Bering Sea/Aleutians and Gulf of Alaska groundfish and for some Bering Sea/Aleutian Islands crab stocks. Stock assessment scientists have been instrumental in the development of the groundfish and crab tier systems, which define harvest control rules that vary according to the type of information available. A number of changes have occurred in these tier systems in order to meet the annual catch limit requirements of the Magnuson-Stevens Act. In addition, vulnerability assessments have been used to guide the assignment of species/complexes to the ecosystem component management category. Different methods have been evolving for dealing with uncertainty and data poor complexes; some of these approaches will also be highlighted.

Private Bycatch Contracts Reduce Chinook Salmon Bycatch in the Pollock Fishery

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Amendment 91 to the Bering Sea and Aleutian Islands Groundfish Fishery Management Plan limits Chinook salmon bycatch in the Bering Sea pollock fishery. The regulations implement an innovative approach to controlling Chinook bycatch in that a limit on the number of Chinook that may be caught incidentally each year is combined with an incentive agreement and performance-standard requirement designed to minimize Chinook bycatch to the extent practicable in all years.

Pollock Conservation Cooperative member companies operate vessels designed to catch and process Bering Sea pollock. The regulations motivated the Pollock Conservation Cooperative member companies to create Chinook bycatch quotas at the individual vessel level through private contracts. Primary incentive-agreement components include: (1) data gathering, monitoring, reporting, and information sharing; (2)

identification of bycatch avoidance areas; and (3) fishing-area prohibitions for vessels with poor Chinook bycatch performance. Additional components include: (1) an A-season closed area of approximately 755 square nautical miles on the northern flank of the Bering Canyon; and (2) a set of conditional, B-season closed areas of approximately 1,295 square miles along the outer Bering Sea shelf.

The year 2011 was the first for the program. An examination of trawl locations in space and time and the bycatch performance of the Pollock Conservation Cooperative vessels shows that the vessels changed their fishing locations to avoid Chinook bycatch. A salient feature of this change was for vessels to locate fishing away from the outer margins of the shelf initially. Depending on the locations of pollock schools, any movement of fishing to deeper water was accomplished via a deliberate, slow, and cautious progression; evidence of local Chinook concentrations in deep water generally caused vessels to move back to shallow grounds. In addition, very little fishing was located near the bycatch avoidance areas. An evaluation of vessel bycatch performance indicated a very uniform distribution of performance during the 2011 A-season. In contrast to prior years, there were no poor-performance outliers in the distribution (no right-hand tail), and the distribution coefficient of variation, which is a normalized measure of dispersion, was reduced by roughly half under the Amendment 91 program as compared to the 2008-2010 A-seasons.

Education Tax Credits: New Money for Marine Mammal Research in Alaska

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The member companies of the Pollock Conservation Cooperative own and operate catcher-processor vessels that catch pollock in the Bering Sea off Alaska. The Pollock Conservation Cooperative member companies pay a Fishery Resource Landings Tax based on the value of the pollock catch. The Alaska Education Tax Credit Program provides a tax credit to businesses that make contributions to Alaska universities and accredited nonprofit colleges for research and educational purposes. Since 2000 Pollock Conservation Cooperative member company contributions of about $2 million to the University of Alaska have supported more than 25 marine mammal research projects while contributions to Alaska Pacific University have funded the development of a Marine Biology Program with a focus on marine mammal research. Project cooperators include the Alaska SeaLife Center, the Aleut Community of St. Paul Island Tribal Government, the National Marine Mammal Laboratory, Oregon State University, the Prince William Sound Science Center, the University of British Columbia Marine Mammal Research Unit, and the University of Washington School of Fisheries and Aquatic Sciences.

Projects have investigated Steller sea lions, northern fur seals, harbor seals, and Biggs' killer whales over an area from California through the Pribilof, Aleutian, and Commander Islands. Research has focused on marine mammal predators, foraging ecology, prey diets and nutrition, the effects of persistent organic pollutants, and the potential for competition with groundfish fisheries for prey. An unexplained megafaunal collapse that began during the 1970s and extended throughout much of the northern North Pacific Ocean and southern Bering Sea motivated many of the projects. Important accomplishments include the development of an implantable life-history tag used to investigate marine mammal predation, and the deployment of data loggers on pollock fishing vessels to evaluate the potential for fishing-induced declines in pollock abundance. New projects for 2013 include the estimation of sea lion vital rates in the Commander Islands based on mark and re-sight data collected during 2000-2012, and satellite-tagging of killer whales in the western Aleutian Islands to determine foraging locations and diving behavior near sea lion rookeries.

Educating Teachers and Youth about Sustainable Seafood: A Place-Based Model for Understanding Connections Between Your Community and Ocean Resources

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NOAA Fisheries will present a new model for educating the public about key concepts of ocean literacy by providing a professional development opportunity for K-5 teachers centered around the fundamental concepts needed to understand the ecological, social, and economic elements involved in fisheries sustainability. NOAA Fisheries staff forged partnerships with educators from the Maryland State Department of Education, Montgomery County Public Schools, and a local conservation organization to align the Ocean Literacy Principles and Concepts with local curriculum and state environmental literacy standards, helping teachers and students make connections "from the schoolyard to the ocean" through place-based, hands-on lessons. Teachers are brought through the fundamentals of ocean science leading up to an understanding of ocean resource sustainability and how it is managed through NOAA Fisheries. Workshop facilitators use striped bass as a model to connect concepts and provide continuity among workshop modules from the physical and chemical properties of the ocean, adaptations for life in the ocean, ocean ecosystems, gathering and using data, human impacts and mitigations (such as for marine debris/derelict fishing gear), and ocean stewardship, including making seafood choices. Pre and post assessment data and positive partner feedback prove this new model to be a very effective way to promote ocean literacy and seafood sustainability through public schools.

Maine Coast Fishermen's Association: Building a Fishery for our Future

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The Maine Coast Fishermen's Association (MCFA) is a fishermen led non-profit organization that identifies and fosters ways to restore the fisheries of the Gulf of Maine and sustain Maine's iconic fishing communities for future generations.

The fishermen who formed MCFA came together in response to years of mismanagement and the reduction of fish stocks within the Gulf of Maine. They saw their way of life at risk of disappearing forever. Together, MCFA provides a voice for fishermen fishing in the Gulf of Maine at the regulatory bodies that govern New England fisheries, and facilitates building strong fishing businesses in the face of changing regulations and a changing environment.

For more than 300 years Maine's fishing industry and their communities have been the foundation of our cultural identity. Preserving our shared marine heritage requires vibrant communities with a foundation based on strong fishing businesses and healthy fish stocks. Our member fishermen are predominantly groundfish fishermen, but Maine's small-boat fleet cannot rely on groundfish alone. Many fishermen also fish for shrimp, scallops, urchins, tuna, elvers, whiting and lobster and their individual business plans are as diverse as the harbors they come from.

Through the guidance from the fishermen, MCFA has developed and continues to support the Maine Coast Community Sector. It has also supported the development of Port Clyde Fresh Catch, an industry-led local processing facility and the first in the region community-supported-fishery that directly supports fishermen. Projects also include a National Fish and Wildlife funded risk pool, which is currently being developed in response to the massive allocation cuts in New England, and on-going business planning to ensure successful businesses in an ever changing economy.

As stewards of the marine ecosystem, MCFA fishermen promote and advocate for a healthy Gulf of Maine resource while balancing the needs of our fishing communities. MCFA works to achieve these goals through advocacy, education, outreach, and collaborative research projects.

Cooperative Marine Fisheries Statistics Program

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The Atlantic Coastal Cooperative Statistics Program doesn't just store fishery-dependent data through the Data Warehouse, but is also a robust data collection program. In the past ten years, through the Standard Atlantic Fisheries Information System, almost 500,000 records have been collected from fishermen, harvesters, dealers, and anglers. These real-time records, not only provide the ability to monitor fisheries, but are also integrated into the Data Warehouse for more comprehensive stock assessments and, ultimately—

fishery management decisions.

Two Atlantic Coastal Cooperative Statistics Program program partners that have illustrated success using the Standard Atlantic Fisheries Information System have been the Maine Department of Marine Resource Management and the Massachusetts Division of Marine Fisheries.

Beginning in January 2008, the Maine Department of Marine Resource Management began collecting mandatory trip level dealer reporting. For the first time detailed data were collected on all of Maine's commercial fisheries. The objective of this project has been to continue with the implementation of the comprehensive dealer reporting regulation in Maine for all 680 dealers that buy directly from harvesters. In the past five years the project has shown to be vital for monitoring changes in fisheries, providing knowledge of fleet characteristics, and ensuring accurate communications to NOAA Fisheries and Atlantic States Marine Fisheries Commission about Maine landings. This data collection is one of the best ways to monitor the health of Maine's fisheries.

Beginning in 2010, the Massachusetts Division of Marine Fisheries embarked on a new project to achieve a goal common of all program partners—to collect comprehensive, standardized trip-level catch and effort data from all commercial permit holders. This project to collect standardized comprehensive fishery-dependent data from both dealers and harvesters creates improvements in data quality, quantity, and timeliness. Although this project only covers the activities of Massachusetts commercial harvesters, it does include the harvest of species which are managed regionally, such as lobster, striped bass, scup and sea bass. Thus regional management bodies such as the Atlantic States Marine Fisheries Commission benefit from having comprehensive fishery-dependent data from Massachusetts.

Fisheries Monitoring Roadmap

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Fishery management goals that require accurate accounting of annual catch levels are increasing the need for robust fishery-dependent data. Limited financial resources to support fisheries monitoring underscore the importance of cost efficiency and transparency in the use of government funds and industry fees. Fisheries managers and industry stakeholders interested in optimizing the economics of their monitoring programs are encouraged to evaluate tools currently used to meet monitoring objectives, explore how those tools can be best utilized optimized, and determine the appropriateness of new or additional monitoring approaches, including electronic monitoring and electronic reporting tools.

Modifying a fishery monitoring program to include new sources of data or data collection tools can require regulatory revisions, changes in personnel, and the development of new infrastructure. Understanding the scope of change required and communicating those needs to relevant stakeholders, is critical to planning and successfully implementing a monitoring program. The Fishery Monitoring Roadmap is an attempt to assist managers and stakeholders in these processes. Composed of five complementary sections, the "Roadmap" includes: (1) a step-by-step process for evaluating, designing and implementing a fishery monitoring program; (2) a matrix to help identify data needs and an assessment of the ability of monitoring tools to meet those needs; (3) an outline of practical considerations and trade-offs of various monitoring tools; (4) a list of relevant references and resources; and (5) case studies to demonstrate how similar fisheries are implementing different monitoring tools.

As fishery managers and stakeholders look to new and emerging technologies to meet fishery monitoring and data needs, it is important to recognize that incorporating electronic monitoring or electronic reporting into a fishery monitoring program is a multi-step process that must be tailored to the specific needs of the fishery, fleet and often vessel. The Fishery Monitoring Roadmap helps stakeholders understand differences between monitoring tools, and match tools with clearly identified management and monitoring goals, ultimately allowing for the optimization of fishery monitoring programs.

Rebuilding Pacific Coast Groundfish Stocks: Management Successes and Challenges

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Community resilience is often characterized as a system's vulnerability to a specific environmental change, event or hazard, and its adaptive capacity to cope and/or adapt. Social vulnerability is comprised of the demographic and socioeconomic characteristics of populations that may affect responses to change, events, or hazards. In an effort to identify fishing communities that may be vulnerable to environmental or fishery regulation changes, NOAA Fisheries is developing social vulnerability indicators for coastal fishing communities in five regions within the U.S. including the northeast, southeast, Pacific coast, Alaska and Hawaii. Place-level data from the U.S. Decennial Census, American Community Survey, NOAA Fisheries and state fish and wildlife agencies, as well as a variety of additional sources, are included in a factor analysis to create indicators of social vulnerability, gentrification vulnerability, and fishing engagement and reliance. This poster will highlight the approach as applied to fishing communities located along the west coast of the U.S. including a description of regional-specific data, observed changes in socio-economic vulnerability in Pacific coast communities between 2000 and 2010, and future research and data needs. Results from the analysis are anticipated to be incorporated into the California Current Integrated Ecosystem Assessment as well as used to inform social impact assessments in fishery management.

Assessing the Impacts of Climate Change in a Coupled Socio-Ecological System: The Case of Atlantic Surfclams

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The Atlantic surfclam (*Spisula solidissima*) fishery lands 22,000 metric tons annually, which in 2008 netted $39 million, making it one of the most valuable single species commercial fisheries in the U.S. Since 1997, populations from southern inshore regions of the clam's range have experienced significant mortality events co-incident with warm bottom water temperatures (reaching 21-24°C in September). Resulting changes in population distribution have major implications for the clam fishery. The processes underlying and consequences of this shift are being investigated using a multi-disciplinary approach that integrates physical oceanography, biology, socio-economics and anthropology.

Larval connectivity among fished clam populations along the Mid-Atlantic Bight is being studied using a physical fluid dynamics model (Regional Ocean Modeling System, or ROMS) by oceanographers at Rutgers University. This larval connectivity is of integral importance to how these populations will respond over time to changing climate and future fishery pressures.

Biological impacts of changing bottom water temperature are being addressed through individual-based metapopulation models. This is a collaborative effort between scientists at Old Dominion University, the Haskin Shellfish Research Lab, the Gulf Coast Research Laboratory, and Virginia Institute of Marine Science. These models will provide insight into the mechanisms behind ongoing changes in clam distribution and allow for prediction of possible future changes in distribution and biological parameters for the fishery.

Economic experiments are being used to examine how changes in the distribution of the fished stock may alter decisions around where to fish. This component of the project is being run through University of Massachusetts Amherst and will identify ways the changing environmental conditions influence individual and collective behavior in the fishery.

The social and cognitive processes involved in making management decisions are being studied by anthropologists in the Department of Human Ecology at Rutgers University. This group is examining the nature of managerial responses to changes in the fishery, economics, surfclam biology and oceanography—a key coupling mechanism between natural and human elements of the system.

This diverse and comprehensive approach will ultimately provide guidance for a proactive approach to management for Atlantic surfclams in the face of climate-driven shifts in distribution.

Collecting Data for Social and Economic Indicators in the Northeast U.S. Fisheries and Fishing Communities: Methods and Approaches

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National Marine Fisheries Service's (NMFS) Northeast Science Center's Social Science Branch in Woods Hole, Massachusetts is currently implementing a set of three surveys of fishing crew and owners in the Northeast Region (New England and Mid-Atlantic). These surveys provide for the ongoing collection of social and economic data related to fisheries and their communities (a separate poster provides details on the development and nature of those measures).The three surveys cover the collection of socioeconomic data from fishing crew, socioeconomic data from vessel owners, and annual fishing business and operational costs from vessel owners. Although data to support some performance indicators are already routinely collected by NMFS, these surveys fill in the gaps and allow the Social Science Branch to collect trend data needed for more thorough analysis of changes in the fisheries, including impacts from changes in management regimes. This poster will provide details on (1) how the Social Science Branch translated the performance indicators into data elements on a survey, (2) the methods and approach being used to collect data in the field, and (3) the current status of the data collection efforts.

Assessing the Vulnerability of Fish Stocks to Climate Change

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Climate change is already impacting fishery resources and the communities that depend on them. Environmental changes have been implicated in shifting distributions and altered abundances of fish stocks in many marine ecosystems. These impacts are expected to intensify in the future, increasing the need to understand which fishery resources are the most vulnerable to environmental change. We have developed a tool for conducting a rapid vulnerability assessment for a large number of stocks to create an index of relative vulnerability. The index can help fishery managers identify high vulnerability stocks and more effectively target limited research and assessment resources on stocks of highest concern. The vulnerability assessment integrates climate forecasts, species distributions, and species life history characteristics to estimate relative vulnerability across stocks. The methodology was created for use on data rich and data poor stocks; integrating quantitative information when available, and extrapolations from related species combined with expert opinion when quantitative data is lacking. The methodology includes an index of data quality which provides a gap analysis of future research needs. Pilot tests have found the methodology to be robust across temperate and tropical ecosystems.

Marine Outreach and Education U.S. Virgin Islands Style (MOES-VI)

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NOAA's Coral Reef Conservation Program (CRCP) identifies fishing impacts, land-based sources of pollution, and climate change as the top three stressors of coral reefs within the 7 states, territories, and commonwealths of the U.S., including U.S. Virgin Islands (USVI). Federal and local resource managers recognize the need for building community awareness and capacity to participate in natural resource management to mitigate these threats. To address these needs, a series of projects have been developed under the brand of Marine Outreach and Education USVI Style (MOES-VI). The MOES-VI initiative consists of several projects, including: (1) The Marine Environmental Community Awareness Project assessing local community awareness gaps of marine environment topics and management, led by the local fishing associations (2) The Commercial Fishers' Training Module and Fishing/Boating License Project aimed at building commercial fisher knowledge of fisheries management rules and regulations, a collaboration between CRCP and USVI Division of Fish and Wildlife and Division of Environmental Enforcement; and (3) The development of a USVI Communications, Outreach and Education Strategic Plan (2015-2020) which entails (A) engaging the fishing community through implementing focus group meetings and interviews to determine the communication, outreach and education needs specific to coral reef and fisheries management and conservation; and (B) strategizing to the identified needs with aim to build upon and complement efforts in the other MOES-VI projects. Together, these MOES-VI projects will serve as a foundation for building community ownership of sustainable fisheries management and conservation, while strengthening community relationships. These projects are in different states of implementation and collaborators include the NOAA-CRCP, NMFS-Southeast Regional Office, Caribbean Fishery Management Council, USVI Department of Planning and Natural Resources, University of the Virgin Islands Center for Marine and Environmental Sciences, Puerto Rico Sea Grant, The Nature Conservancy, St. Croix Commercial Fishermen's Association, St. Thomas Fishermen's Association and VI Network of Environmental Educators.

Factors Affecting Management Uncertainty in U.S. Fisheries

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Marine fisheries management is often based on a system of target and limit reference points, which contain significant amounts of scientific and management uncertainty that fishery managers must address. In the United States, these target and limit reference points are based on the annual catch limit (ACL) framework (i.e., overfishing level ≥ acceptable biological catch (ABC) ≥ ACL ≥ annual catch target (ACT)). Within this framework, scientific uncertainty is accounted for in the setting of the ABC, while management uncertainty is accounted for in the setting of the ACT. Scientific uncertainty has been widely addressed since 2009, when the ACL framework was described in the National Standard 1 Guidelines. However, few researchers have examined management uncertainty, except in a theoretical context. Our research goes beyond the theoretical by taking a closer look at 17 U.S. fisheries, describing variations in management uncertainty among management regimes, and identifying potential factors that account for these differences. We found that a manager's ability to keep a fishery at or under the ACL can vary substantially among fisheries depending on the fishery sector (i.e., commercial, recreational, etc.), the management regime, the frequency of landing reports, and the degree to which target change from year to year. Lastly, our research shows that unless management uncertainty is accounted for, overages of the ACL can commonly occur and even result in overfishing.

Innovations for Community-Based Fisheries in Kodiak, Alaska

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Commercial fisheries are an essential economic, social and cultural component of Alaska's coastal communities. However, fresh approaches are needed to ensure viable opportunities for local fishermen given the complex challenges that fishing communities face. We highlight two innovative, triple-bottom line initiatives that foster small-scale fisheries, community sustainability and long-term conservation in Alaska.

The first project is in partnership with the Alaska Jig Association and the Community Fisheries Network and aims to capitalize on a new entry-level opportunity for Kodiak's low-impact jig fleet. In recent years, fishery managers created a set aside that allows the fleet to stair-step up to 6 percent of the total allowable catch for Pacific cod in the Gulf of Alaska. Jigging has low capital requirements and offers the opportunity to diversify fishermen's portfolios and generate income to facilitate entry into other fisheries. However, with cod prices extremely low, this forward-thinking regulatory measure needs to be solidified with market-side improvements to generate greater economic and social benefits. Our project leverages the fishery's assets including its local fleet of owner-operators, low ecosystem impact, and potential to produce high quality seafood products. We report on our approach to transform the jig fishery into a higher-value enterprise by working with the fleet to create a community fishing organization, develop best handling practices, and generate appreciation in the market for the strong conservation performance and social benefits of the fishery.

The second project is Alaska Marine Conservation Council's Catch of the Season, an annual Community Supported Fishery program that features Kodiak Tanner crab. This social enterprise delivered over 10,000 lbs. of crab within Alaska in 2013 to about 250 households, seven restaurants, and Princess Tour's lodges.

Local, conservation-minded fishermen catch the crab for the program and get a price bonus for participating, and proceeds benefit Alaska Marine Conservation Council's work to sustain healthy working waterfronts. The program is building valuable connections between our fishing communities and consumers, restaurants chefs, and businesses. Through a product they can connect to, awareness is being generated about the benefits of local seafood and the important role of community-based fishermen in sustaining our coastal economies and providing stewardship of our marine ecosystems.

Measuring Success of Regional Fisheries Management Goals and Objectives: A Retrospective Analysis of Stated Goals and Objectives

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Most Regional Fishery Management Councils have not yet crafted a clear vision—or a set of objectives—for measuring management success in their regions. To inform these processes as they emerge and to illustrate what have been the main stated goals of each Council, we conducted a retrospective analysis of the principal regulatory documents of each Council since 1977 when the Magnuson-Stevens Act was implemented. For each of the eight management councils, we identified all of their fishery management plans [FMPs] (and associated amendments), and coded and analyzed selected FMPs stated goals and objectives, with a particular focus on the social and economic goals. Key fisheries in each region were selected based on the number of participants and ex-vessel revenue. This list was then modified through a series of informal interviews with Council staffs, NOAA science and policy personnel, and others having specific knowledge about the FMPs in each region. Using Atlas Ti qualitative data analysis software, we created hierarchical trees of each fishery to enable analysis and comparison. Our initial results indicate that a similar core set of goals exist throughout the U.S. However, in many cases, fisheries goals and objectives conflict both within, and among, fisheries in the region. Our conceptual maps offer a springboard for ongoing discussions about regional visioning efforts.

Help Spread the Word: U.S. Seafood is Sustainable

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In today's dynamic and at times complicated seafood culture, U.S. fishers are challenged with being competitive in the marketplace and U.S. seafood consumers are confused about how to buy seafood. Once on land, fishers, who have responsibly harvested U.S. seafood, are challenged with marketing their seafood products to help consumers understand that their product meets their demands for healthy, safe and sustainable seafood. Developing innovative marketing strategies that educate the consumer is imperative to the economic success of U.S. fishers and the communities that support them. NOAA Fisheries is finding ways to help fishers and their communities figure out ways to connect their products with consumer demands and help demystify seafood choices. Staff at NOAA Fisheries are developing outreach and educational materials that help spread the word that U.S. seafood is safe, sustainable and healthy. Materials, written in plain language, promote the relevance and importance of the work that NOAA Fisheries conducts to help communities throughout the Nation spread consistent messages such as U.S. Seafood is Sustainable. Activities through Fishwatch.gov, seafood festivals, educational curricula, professional development and getting involved with locavore or foodie movements are a few ways that NOAA Fisheries is providing tools to encourage economic stability in our communities while preserving an important part of our cultural heritage.

The Alaska Deep-Sea Coral and Sponge Initiative: A Research Program to Support Management of Coral and Sponge Habitats

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Deep-sea coral and sponge habitats are widespread throughout most of Alaska's marine waters. In some places, such as the western Aleutian Islands, these may be the most diverse and abundant deep-sea coral and sponge communities in the world. In 2012 the Alaska Fisheries Science Center initiated a three-year field research program in the Alaska region funded by the Deep Sea Coral Research and Technology Program to better understand the location, distribution, ecosystem role, and status of deep-sea coral and sponge habitats. A series of projects were designed to fill information gaps relevant to ongoing management needs in Alaska. Two projects to be highlighted in the poster presentation include an effort to model coral and sponge distribution in the Aleutian Islands and corresponding fieldwork to groundtruth the model, as well as a study that examines the relative benefits in terms of fish growth, recruitment and density of coral and sponge habitats relative to other habitats in the Gulf of Alaska. To date, the modeling study has resulted in maps for the Aleutian Islands predicting the probability of coral and sponge occurrence, the relative density of coral and sponge and a prediction of coral diversity. Preliminary results of the second study have indicated differences in density in commercially important rockfish in different habitats. The results of both these studies will provide data to support management decisions regarding coral and sponge habitat in all Alaskan regions.

Managing "Data-Limited" Stocks Under Catch Limits in the Western Pacific Region: Approach and Challenges

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The Reauthorization of the Magnuson-Stevens Act in 2006 had significantly changed the way Regional Fishery Management Councils deal with managing the U.S. fisheries through implementation of annual catch limits (ACLs). Stock and output control-based approaches like ACLs pose problems for fisheries that are multi-gear, multi-species and spatially diverse by nature. The National Standard 1 Guidelines of the National Marine Fisheries Service is reliant on the existence of maximum sustainable yield for stock managed under ACLs. This provides very little guidance for reef fishes that has very few stock assessments in which the overfishing limit, a critical component of the ACL process, is based upon. Biological reference points that determine stock status are lacking for most of the species. Managing stocks that are data deficient proved to be a big challenge. This presentation outlines the approach that the Western Pacific Regional Fishery Management Council took in specifying ACLs for reef fishes in the U.S. Pacific island state and territories. Gaps and challenges were identified and recommendations are provided to enhance management of reef fish stocks under a catch limit system.

The Introduction of the Integrated Ecosystem Assessment Approach to Gulf of Mexico Management

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Integrated ecosystem assessments (IEAs) are an emerging management tool designed to provide decision support needed for moving toward an ecosystem approach to management. The Regional Fishery Management Councils are ideal clients for the introduction of IEA products, especially management strategy evaluations, given their statutory responsibility to make trade-off decisions regarding the Nation's fishery resources that take into account the protection of marine ecosystems. Current fisheries management is set up to process information derived from single species stock assessments that often do not take into account species interactions or environmental factors. Such an approach makes the IEA process particularly useful to improve management. IEAs are intended to be complimentary to traditional single species approaches. One way to introduce managers and stakeholders to IEAs is to present IEA products to the Councils and their Scientific and Statistical Committees alongside traditional stock assessment results. With this in mind, the Gulf of Mexico IEA Program is joining the thirty-third Southeast Data Assessment and Review (SEDAR 33) process in the assessment of Gulf of Mexico gag grouper by introducing several ecosystem models, including Ecopath with Ecosim and OSMOSE, that will be run in parallel with models employing single species approaches. Our broad objectives are to (1) introduce the Gulf of Mexico IEA Program to the Scientific and Statistical Committees (Standing and Ecosystem) of the Gulf of Mexico Fishery Management Council; (2) provide support to the single species assessment of gag via the SEDAR process; and (3) provide ecosystem considerations to the specified management options that the single species assessment is not capable of producing and to establish the Gulf of Mexico IEA as a regular part of the SEDAR process. Results from both the IEA and SEDAR will be presented to the Scientific and Statistical Committees for generating scientific fishery advice to the Gulf Council. The gag IEA will serve as a pilot or proof of concept study to demonstrate the capabilities of the IEA to the Gulf Council and stakeholders in the Gulf of Mexico region and to get them to think about management strategy evaluations they would like to see to help them evaluate trade-offs between alternative management strategies and to inform adaptive management.

Bringing the Fish Back: An Evaluation of U.S. Fisheries Rebuilding Under the Magnuson-Stevens Act

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Congress amended the Magnuson-Stevens Fishery Conservation and Management Act in 1996 to require that overfished ocean fish stocks be rebuilt in as short a time period as possible, not to exceed 10 years, with limited exceptions. As part of evaluating the success of these requirements, Natural Resources Defense Council examined population trends of all U.S. ocean fish stocks that were subject to the requirements and for which sufficient information was available to assess rebuilding progress. Out of these 44 fish stocks, almost 65 percent can currently be considered rebuilding successes: 21 have been designated rebuilt (and have not been determined to again be approaching an overfished condition) or have exceeded their rebuilding targets, and 7 have made significant rebuilding progress, defined as achieving at least 50 percent of the rebuilding target and at least a 25 percent increase in abundance since implementation of the rebuilding plan. This success rate demonstrates that the Federal law has been generally successful in rebuilding fish stocks. Our analysis also showed areas of concern, including (a) gaps in the application of the rebuilding requirements, such as with respect to stocks that are not federally managed, of "unknown" population status, or internationally managed; (b) certain regions, such as New England, the South Atlantic, and the Gulf of Mexico, with significant proportions of stocks showing a lack of rebuilding progress; and (c) continued overfishing during rebuilding plans. We also found that rebuilding fish stocks confers substantial benefits. For example, estimated average annual 2008–2010 dockside revenues from commercial landings of the 28 U.S. fish stocks that have been rebuilt or are demonstrating significant rebuilding progress totaled almost $585 million, which is 92 percent higher (54 percent when adjusted for inflation) than dockside revenues for these stocks at the start of rebuilding. Many of the rebuilt and rebuilding stocks also have significant economic benefits associated with recreational catch.

NOAA Fisheries' Marine Recreational Improvement Program

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The Marine Recreational Information Program, or MRIP, is the new way that NOAA Fisheries is collecting and reporting recreational fishing catch and effort data. Working with scientists, managers, fishermen and others, MRIP is making significant improvements to virtually everything we've done in the past. MRIP plays a critical role in sustainably managing our ocean resources by providing estimates of fishing activity are both accurate and trusted. In this poster we will go over how recreational catch estimates fit in the overall stock assessment and fisheries management process, the types of surveys used in estimating our nation's recreational catch, the various changes being implemented in the new MRIP program, and our plans for future improvements. NOAA Fisheries is working to ensure the long term sustainability of our nation's fisheries and MRIP is a key element in meeting that goal.

Best Practices for Forage Fish Management

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The current management regime for commercial forage fish fisheries generally fails to balance harvests against the beneficial ecological role of forage species. Forage fish (e.g., herring, anchovies, squid, sardines, etc.) are clear examples of species valuable both as direct landings and as prey for larger fish species and marine wildlife. Fishing pressure on forage fish can have a disproportionate ecological effect relative to fishing other species. These interactions are further complicated by natural fluctuations in forage fish abundance, caused by complex and often unpredictable relationships with oceanic conditions.

Optimum yield, as defined in the Magnuson-Stevens Act (MSA), requires fishery managers take into account the protection of marine ecosystems, and is based on maximum sustainable yield as reduced by relevant economic, social, or ecological factors. Here we discuss these factors in the context of forage species, and propose both short and long-term strategies for integrating ecological considerations and socioeconomic trade-offs into harvest control rules, focusing on Pacific sardine as a case study. We highlight the practical limitations of the current management context, and propose ideas for advancing an Ecologically Sustainable Yield approach that accounts for predator requirements and food web dynamics.

In addition to an Ecologically Sustainable Yield approach for the management of existing forage fish fisheries, best practices include protecting forage species before new fisheries develop. While there are many forage species not currently subject to commercial exploitation, the increasing global prices of fish meal and fish oil are likely to make new fisheries profitable in the future. Given the ecological importance of forage species, a precautionary approach can prevent unintended consequences to other fisheries, communities and ecosystems. We provide an overview of available pathways to proactively prevent new fisheries from developing on currently unmanaged forage species under current statute and guidelines, with examples from the Pacific and North Pacific regions. Yet changes to the MSA could facilitate comprehensive solutions that prevent new fisheries from developing on forage species unless and until scientific criteria are met.

The International Scientific Committee for Tuna and Tuna-Like Species in the North Pacific Ocean

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The goal of the International Scientific Committee for Tuna and Tuna-Like Species in the North Pacific Ocean (ISC) is to advance fishery science of North Pacific tuna and tuna-like fishes through cooperation and collaboration among interested parties. It is an inter-governmental organization with members from coastal states and fishing entities of the region and coastal states and fishing entities with vessels fishing for highly migratory species in the region. Unlike regional fisheries management organizations, ISC is supported completely by in kind contributions from participants' organizations, not through specific government funding. Most ISC work has focused on stock assessments of North Pacific stocks, including Pacific bluefin tuna, swordfish, striped marlin, albacore tuna, and recently some sharks. Stock assessments are collaborative and depend on member commitments to provide not only the required data but also qualified scientists to conduct the assessments. Present challenges the ISC faces in providing the best available science information to fishery managers include the identification and adoption of biological reference points by the Western and Central Pacific Fisheries Commission.

First Stewards: Coastal Peoples Address Climate Change

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Climate change is occurring rapidly, creating an urgent need for the world to make use of indigenous ways of adapting and maintaining the resiliency that has served ancient coastal cultures for thousands of years. That was the message delivered by the indigenous coastal people of the United States and the U.S. Pacific Islands when they gathered July 17-20, 2012, in Washington, D.C., where their unified voices called for action on climate change.

The First Stewards Symposium: Coastal Peoples Address Climate Change was convened to create a mechanism for the indigenous people to engage with governments, non-governmental agencies and others to help mitigate and adapt to climate change. The very fabric of indigenous societies is threatened by over-development of coastlines; alteration of freshwater streams and lakes; destruction of life-giving watersheds and reefs; and the decline of marine and terrestrial species. These have been exacerbated by climate change, creating astonishing changes in coastal natural systems that indigenous cultures are witnessing.

A resolution drafted by the newly incorporated First Stewards and sent to President Obama requests formal recognition of the coastal indigenous people and their expertise in understanding and adapting to changes in their natural systems. The resolution asks for the Federal government to "consult with our tribal governments and indigenous communities for guidance in all policies that affect our way of life and to support our management efforts, which will strengthen America's resiliency and ability to adapt to climate change."

Because native communities continue to subsist off of the lands and live by the natural seasonality of fish, sea mammals, birds, animals, and plants, they depend upon the integrity and continued existence of healthy ecosystems and are vulnerable to climate change. Relying upon their traditional ecological knowledge and ancestral wisdom of adaptability and resilience are keys to their survival and identity. These methodologies include returning to and promoting traditional practices to ensure food stocks and natural resources continue to be available. Non- indigenous communities and climate change initiatives can benefit from the knowledge and methodologies of indigenous communities, which can serve as a tool to help the nation adapt to climate change.

How Leading by Example Can Exacerbate International Conservation Problems: A Bio-Economic Analysis

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Unilateral domestic regulations to protect endangered species from commercial fisheries impacts may exacerbate the conservation problems they were intended to mitigate. The transfer effect describes how a domestic regulation to conserve transboundary target or protected populations can lead to a transfer of effort from U.S. harvesters to foreign harvesters. Because of the transfer effect, also described as a "trade leakage" or "spillover effect," we cannot predict a priori whether unilateral domestic regulations will increase or decrease the global level of overfishing or protected species interactions on a transboundary stock. Regulation of U.S. Pacific swordfish fisheries (*Xiphias gladius*) intended to limit interactions with endangered leatherback turtles (*Dermochelys coriacea*) provides an example.

Endangered leatherback sea turtles are sometimes caught as bycatch in commercial Pacific swordfish fisheries, including rare event bycatch in the Hawaii and California swordfish fisheries. The population ranges of leatherback sea turtles and swordfish extend outside the 200 mile Exclusive Economic Zone limits of the U.S. and other Pacific Rim nations across the Pacific basin, with a high degree of overlap creating opportunity for leatherback-swordfish fishery interactions. The U.S. has regulated the swordfish fisheries in Hawaii and California to address Endangered Species Act requirements to protect the endangered leatherback turtles; however, commensurate regulations have not been imposed on non-U.S. commercial Pacific swordfish fisheries. The Theory of the Second Best suggests that it is impossible to predict a priori whether the effect of unilateral domestic regulation will be to increase or to decrease the global level of protected species interactions.

A two-sector bioeconomic model of swordfish catch and endangered sea turtle interactions in the U.S. domestic and foreign Pacific swordfish fisheries describes effects of unilateral domestic regulation to reduce endangered sea turtle interactions as potential implications of the Theory of the Second Best. The model assumes sea turtle interactions are an intrinsic production externality in both U.S. domestic and foreign sector fisheries. The analysis demonstrates that unilateral domestic regulation of the swordfish fishery intended to reduce interactions with endangered sea turtles may reduce U.S. swordfish fisheries' competitive advantage in production while increasing the global level of sea turtle interactions in Pacific swordfish fisheries.

Has the New England Commercial Fishing Industry Gone to the Dogs?

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Commercial fishing directly or indirectly supports over 200,000 jobs in New England, generating over $10 billion in revenue. Despite this importance, the industry is in perilous times. A disaster was declared for the 2013 fishing year as many important groundfish populations have failed to respond to restrictive management measures over the last five years. Concern over the poor condition of these stocks and that the biomass declines could worsen, additional reductions in fishing pressure have been implemented. Atlantic cod quota's (*Gadus morhua*), historically one of the most commercially important fish in New England, have been hit especially hard by these new reductions, with some regions experiencing additional cuts of over 70 percent when compared to the quota's of the 2012 fishing season. In contrast, spiny dogfish, *Squalus acanthias*, populations have exhibited fourfold increases in biomass over this same time frame. This small coastal shark is thought to be benthic in nature, make coordinated long distant, coast wide, seasonal migrations in large packs, and have a diet consisting of a mix of vertebrate and invertebrate prey items. However, we present data from several integrated studies to support hypotheses that are divergent to many of these common paradigms. We suggest that: 1) this shark has a more active vertical movement pattern that prevents representative sampling during trawl surveys used for stock assessment purposes; 2) this shark's horizontal movement patterns are more regional; 3) stomach content and stable isotope data suggests dogfish are more piscivorous than once thought; and 4) cod and dogfish sit at the same trophic level and thus are in direct competition for resources within this ecosystem. These collective results indicate that a larger dogfish population (currently estimated at 1,000,000 metric tons) has the potential to negatively impact this ecosystem, and in part, may help explain why cod (and possibly other groundfish) stocks have failed to rebound despite drastic reductions in fishing pressure.

Using Indicators to Discover the Effects of Catch Shares on Fishing Communities

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The Measuring the Effects of Catch Shares (http://catchshareindicators.org/) project posted its first round of results for catch share programs in the U.S. Northeast and on the West Coast in Spring 2013. The methodology arose from workshops where fishermen and fishing community stakeholders posed numerous questions about these programs. Analysis of information from the private sector, university scientists, government agencies and multiple jurisdictions is organized to answer key questions about effects of these two catch share programs on fishermen, fish stocks, fishing businesses, and fishing communities. The issues addressed through these key questions, though focused on the NE and WC programs, have broad applicability to measure changes in other catch share fisheries. The project does not advocate for or against catch shares, but provides objective, neutral data. The five-year project uses a collaborative approach to gather and rigorously analyze the best available data on economic, social, ecological, and administrative conditions and trends, comparing years before and during the catch share programs. Indicators for these key questions directly relate to the conference theme of fishing community sustainability. Select examples include:

- have fleetwide catches stayed within quotas?
- have discarding practices changed?
- has quality of fishery data changed with changes in observer coverage?
- have economic and social effects on local communities changed?
- are fishing vessels participating in a different mix of fisheries?
- has the efficiency of fishery management changed?

Poster viewers will be able to query the project web site to see the first of numerous periodic reports on the indicators.

Assessing the Impacts of Community Protection Measures in Catch Share Programs

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The efficiency gains realized under rights-based management programs in fisheries may have negative socioeconomic impacts on some communities. Less efficient operators will likely sell or lease their shares (legally-revocable privileges) to more efficient operators, increasing efficiency across the fishery. However, the exodus of these operators could mean a loss of associated employment for crews, dockside workers, processors, etc., with a potential multiplier effect across the community. According to economic theory, there is an opportunity cost associated with having less efficient operators remain in the fishery when their labor could be reallocated to other sectors of the economy. However, in isolated coastal communities with few alternative employment opportunities the benefits of this reallocation would likely not be realized.

Regulators often seek to balance efficiency gains and the potentially negative impacts on communities of rights-based management by modifying or restricting the ways in which fishermen can utilize their allocations. For example, quota shares may be allocated based on vessel class or geographic location, with limited transferability between the categories. There are, however, tradeoffs associated with these modifications, in terms of the losses in potential economic efficiency gains expected from fuller rights. Therefore, the two sides of these modifications have to be evaluated: the costs (as decreases in potential efficiency gains) and the benefits (for the relevant operators and associated communities).

Evaluating the effects of these modifications necessitates first describing the counterfactuals, which may be: 1) the status quo without the program, 2) a rights-based program with full property rights characteristics, or 3) a "standard" rights-based program (one which only includes the limits on rights designated under national legislation). For example, it may be that the rights-based program would not have been implemented without the modification.

This study delineates several common modifications to rights-based management programs. It provides the theoretical background on how they can affect the rights of the quota holders and the capacity of the market to achieve economic efficiency. A framework for evaluating the potential costs and benefits of these modifications for participants and communities is presented. Finally, some preliminary results of an application of this methodology are presented.

Catalyzing Industry to Drive Fishery Improvements

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In 2011, Darden Restaurants made a commitment, through the Clinton Global Initiative, to rebuild troubled fisheries by supporting three fishery improvement projects (FIPs) in three years and catalyzing industry support of improvement efforts. This ambitious commitment is supported by a cooperative alliance of seafood buyers, producers, suppliers, fishery managers, scientists, community members, and conservation NGOs working together to improve fisheries. An evolving tool for sustainability, improvement projects rely on multi-stakeholder support and utilize the market power of the private sector to incentivize positive change in wild fisheries and aquaculture operations. But what is the value of supply chain engagement and what role can industry play in these multi-stakeholder efforts? Moreover, what impact is being made and how can companies be assured that their FIP commitment is making a difference? Darden will share its approach to FIPs and aquaculture improvement projects focusing on its collaborative relationship with the New England Aquarium and other NGOs; the criteria developed to inform FIP engagement opportunities; the challenges and successes experienced in their first FIP commitment in the Gulf of Mexico snapper/grouper fishery; and the business case for industry support of fishery and aquaculture improvement projects.

Managing the Threat of Invasive Catfish on Ecologically and Commercially Important Species in the Chesapeake Bay

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Both blue and flathead catfish are invasive and potentially causing an unbalanced ecosystem in the Chesapeake Bay. Their increasing populations, rapid range expansion, and capacity to consume significant amounts of ecologically and economically native fish species such as menhaden, blue crab and shad raise significant concerns and ecosystem management challenges for fishery managers. These invasive catfish were introduced by humans and they are thriving in a system with high nutrient loading an available prey sources. The NOAA Chesapeake Bay Office funds research on invasive catfish to help further understand their basic biology and potential negative effects on native species and human health. Research findings will help inform management and mitigation strategies. Current research focuses on several topics:

- Estimating the abundance of blue catfish in the James River using a tagging study and mark-recapture analysis. This abundance estimate can verify other estimates, and can be used in ecological models to describe the role and ecological effects of blue catfish in the James River.
- Determining the rate of movement of adult blue catfish between freshwater and estuaries
- Conducting various studies to determine which fish species comprise blue catfish diets, and how diet varies according to certain parameters including specific tributary, season, and size. These results can provide a better understanding of the role of blue catfish in the food web depending on specific location and habitat conditions.
- Estimating predation mortality by blue catfish on anadromous fish species such as American shad and blueback herring. These results can explain the effects of blue catfish on economically important resources in the Bay.
- Evaluating the contaminant levels in blue catfish to determine if encouraging human consumption of blue catfish is a safe management option. This will help determine if promoting human consumption and expanding commercial markets for blue catfish are possible management strategies.
- Developing and analyzing blue catfish growth data to describe their growth patterns. This will allow analysis of blue catfish growth specifically in Bay tributaries, and how patterns may differ among tributaries.

Exploring the Social Side of Fishery Management: Increasing Stakeholder Engagement Through the Use of Social Media Tools and Mobile Technology

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With the reauthorization of the Magnuson-Stevens Act and the requirements for implementing annual catch limits and other National Standards, fisheries management in the South Atlantic region has developed into a complex set of issues. The fishing stakeholders involved include commercial, for-hire and recreational fishermen, environmental NGOs, and fishery managers and scientists. With such a diverse group of fishing stakeholders, the strategies used for outreach need to be designed to meet the varied needs of those stakeholders.

Traditionally, outreach strategies have focused on printed publications (regulations brochures, pamphlets, and fact sheets), website postings, and formal public hearings throughout the region. However, with the advent of social media and new mobile technology there are new opportunities to expand outreach strategies in more non-traditional platforms.

The South Atlantic Fishery Management Council has initiated a social media outreach strategy using Facebook, focusing on informing and engaging fishing stakeholders in dialogue about fishery management issues, fishery management plan and amendment development, and opportunities for public input. In addition, the Council, in cooperation with NOAA Fisheries, has developed a mobile application (SA Fish Regs) designed to provide easily accessible and up-to-date fishing regulations and other information to both commercial and recreational fishermen. The paper will highlight success stories of engaging a broad range of fishing stakeholders in the Federal management process through the use of social media and increasing understanding of Federal fishing regulations in the region through the use of the SA Fish Regs mobile app.

A Review of Essential Fish Habitat for Pacific Coast Groundfish

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In this poster, we provide an overview of the current review of essential fish habitat (EFH) for 91 species of Pacific coast groundfish. We highlight some of the key products developed for this review and are now available to the public. Initial EFH designations were based on best available data developed from 2002 to 2005; NOAA's National Marine Fisheries Service (NMFS) implemented these designations in May 2006. Beginning in 2010, the Pacific Fisheries Management Council (PFMC), Northwest and Southwest Fisheries Science Centers, and the NMFS Regions initiated the next five-year review for EFH provisions of the groundfish fishery management plan. In Phase I of this process, we compiled and summarized new and relevant information available for the review. Sources of information included published scientific literature and unpublished scientific reports, solicitation of data from interested parties, and the review of previously unavailable or inaccessible data sets. Coast-wide maps were updated for (1) bathymetry and interpreted groundfish habitat types, (2) the distribution and extent of commercial fishing effort (as potential impact to EFH), (3) the distribution and relative abundance of biogenic habitat (i.e., sponges and corals), and (4) spatial management boundaries (as potential mitigation of impacts). This complete body of information, in the form of a written report and supporting Internet data catalog, was presented to the PFMC, its advisory bodies and the public at the Council's September 2012 meeting (Phase I Report: http://tinyurl.com/ltqq6ma; online data catalog: http://tinyurl.com/kwe452v). NMFS is currently conducting an analysis of the information in the Phase I Report, and will deliver a synthesis to the Council in April 2013. During Phase II, the Council will solicit proposals to modify EFH and Habitat Areas of Particular Concern. If the Council decides to amend EFH, Phase III of the process will begin and may require an amendment to the groundfish fisheries management plan. This five-year review represents a major update of the groundfish habitat assessment for the California Current and will have research and management applications well beyond satisfying the regulatory guidelines associated with EFH.

Marine Protected Areas: Improving Tools to Sustain Marine Ecosystems

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Connecting and strengthening the nation's marine protected area programs can improve their ability to deliver ecological services in light of changing climate and increasing ocean uses. The U.S. has over 1,700 marine protected areas (MPAs), established for diverse purposes ranging from the protection of biological diversity to the protection of commercially and recreationally valuable fish stocks, to the conservation of historic treasures. Approximately 24 percent of U.S. MPAs have sustainable production as their primary purpose, encompassing over 50 percent of MPA area in the U.S. Exclusive Economic Zone. These fishery MPAs span a wide range of levels of protection, from gear restrictions to reduce bycatch to no take areas to protect sensitive habitats or spawning areas. This poster will summarize the current status of U.S. MPAs, sustainable production MPAs, and highlight recent work to enhance MPA effectiveness by managing MPAs within systems and networks, and within the broader context of ocean uses.

Overfishing, pollution, and coastal development have all placed significant stress on the nation's natural and cultural marine resources. Climate change impacts in the ocean are expected to add to these stressors, affecting the ecological services such as food production, recreation and tourism that humans depend on. Recent collaborative work with Canada and Mexico has focused on developing scientific guidelines for designing MPA networks in light of expected climate change impacts. These guidelines include: 1) protecting species and habitats with crucial ecosystem roles; 2) protecting potential carbon sinks; 3) protecting ecological linkages and connectivity pathways for a wide range of species; and 4) protecting the full range of biodiversity present in the target biogeographic area. Application of these guidelines can help MPA and marine resource managers more effectively use place-based management to address future climate impacts.

Responding to climate change is just one example of how operating as a network can enhance MPA effectiveness. The National Marine Protected Areas Center has established a national system of MPAs to link and strengthen the nation's MPA programs, including Fishery Management Councils. Current focal areas include MPA capacity building, strengthening international linkages, and developing information and tools to manage MPAs within the context of diverse, often competing, ocean uses.

The Marine Resource Education Program: Northeast Fishermen Training as Effective Contributors to Management

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The Marine Resource Education Program (MREP) arose from ongoing conversations among fishermen active in the New England management process. Initiated in 2001 as a pilot based at the University of New Hampshire, an impressive mix of partners from commercial and recreational fisheries, management, science and education came together to craft a curriculum and means of delivery. In 2005 the program was moved to a more permanent administrative base at the Gulf of Maine Research Institute.

By fishermen for fishermen, with over 450 graduates to date, MREP is receiving growing recognition for raising the knowledge-base within the regional community and is serving as a template for similar efforts outside New England. 2012 has seen the successful launch of a Mid-Atlantic MREP as a sister program to New England covering the entire Northeast region; and development of capacity for a Southeast Fisheries MREP under local leadership.

The curriculum has been well tested and continues to evolve to serve the needs of fishermen and relevant stakeholder groups. The core program covers two topic areas: a three-day Fishery Science 100, followed by a three-day Fishery Management 100.

Fishery Science 100 is designed to provide participants with grounding in the science fundamental to management. Participants are provided with basic working knowledge of population biology and the assessment process, including survey sampling techniques, statistical tools, models and their uses. Information presented demonstrates how fishing effort relates to stock assessments and how fishermen's knowledge can be incorporated.

Fishery Management 100 provides an overview of entities which manage commercial fisheries with an emphasis placed on the structure of the Fishery Management Councils and the requirements under the Magnuson-Stevens Act and National Standards. The curriculum covers the components of a management plan, describing the progression of plan development and identifying critical opportunities for participation and input. A role-play exercise simulates a specification-setting negotiation.=

An advanced MREP 200: Introduction to Stock Assessments, is a two-day exploration of the data-labs at the Northeast Fishery Science Center, Woods Hole, featuring hands-on presentations in facilities by key NMFS scientists. The workshop culminates in review of stock assessment models, relating the component parts.

Integrating a Recreational Fishery into a Catch Share Program: An Alaska Case Study

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Alaska's commercial halibut fishery has been managed under a catch share program since 1995, known as the Individual Fishing Quota Program. This program permitted and divided the total allowable catch of halibut among commercial fishermen. Prior to allocating commercial catch limits each year, removals of sport harvest, subsistence, bycatch, and wastage are deducted. As sport catch grew in the late 1990s, fisheries managers felt that if sport catch was not controlled, this would bring uncompensated reductions in commercial harvest and jeopardize the economic viability of the commercial halibut fleet.

As the charter fleet was misinterpreted as a quasi-commercial fishing enterprise, guided angler harvest was separated out from the sport harvest and regulated separately. In 2003, in an effort to manage this user group of guided recreational anglers, a guideline harvest level program was implemented. If guided angler harvest did not fall within these recommended levels, more restrictive harvest measures would be recommended for the following year.

In Area 2C (Southeast Alaska) guided harvests exceeded the guideline harvest level from the first year of implementation. This was due in part to an insufficient initial allocation and the lack of understanding regarding the dynamics that determine recreational angler harvest. Without this understanding it was difficult to impossible to set regulations to achieve results with any accuracy.

With the recent decline in halibut stocks and changes in management policies, guided recreational fishing opportunities have declined in Area 2C and are threatened in Area 3A (Southcentral Alaska). A means to transfer allocation between the commercial longline and charter recreational sectors would provide increased fishing opportunities for guided anglers and stability in their regulations.

The results of the CATCH project findings will be the subject of the poster display.

Acronyms and Photo Credits

Acronyms

ABC	acceptable biological catch
ACE	annual catch entitlement
ACT	annual catch target
ACL	annual catch limit
AIS	automatic identification system
AM	accountability measure(s)
ANPR	advance notice of proposed rulemaking
AP	advisory panel
APA	Administrative Procedures Act
ARPA	automatic radar plotting aid
ASMFC	Atlantic States Marine Fisheries Commission
B	biomass
B_{OY}	biomass at optimum yield level
B_{MSY}	biomass at maximum sustainable yield
C	level of catch
CDFW	California Department of Fish and Wildlife
CFA	community fishing association
CFF	California Fisheries Fund
CMSP	coastal and marine spatial planning
CSF	community supported fishery
DAS	days at sea
DMR	(Maine) Department of Marine Resources
EBFM	ecosystem-based fisheries management
EBM	ecosystem-based management
EC	ecosystem component
ECS	ecosystem component species
EEZ	exclusive economic zone
EFH	essential fish habitat
EIS	environmental impact statement
EMS	electronic monitoring systems
EPO	eastern Pacific Ocean
ESA	Endangered Species Act
F	rate of fishing
FACA	Federal Advisory Committee Act
FAO	United Nations Food and Agriculture Organization

FFP	(NOAA's) Fisheries Finance Program
FIP	fishery improvement project
FMC	fishery management council
FMP	fishery management plan
FR	Federal Register
GARM	Groundfish Assessment Review Meeting
GDP	gross domestic product
GIS	geographic information systems
GMFMC	Gulf of Mexico Fishery Management Council
GPS	global positioning system
HAIP	(NOAA) Habitat Assessment Improvement Plan
HAPC	habitat area of particular concern
HLA	Hawaii Longline Association
HMS	highly migratory species
IATTC	Inter-American Tropical Tuna Commission
IEA	Integrated Ecosystem Assessment
IFQ	individual fishing quota
IMO	International Maritime Organization
IOOS	Integrated Ocean Observing System
ITQ	individual transferable quota
IUU	illegal, unreported and unregulated (fisheries)
LFFTF	Lenfest Forage Fish Task Force
LISA	Local Indicators of Spatial Association analysis
MAFAC	Marine Fisheries Advisory Committee
MAFMC	Mid-Atlantic Fishery Management Council
MCA	Marine Conservation Alliance
MFC	Marine Fisheries Commission
MFCMA	Magnuson-Stevens Fishery Conservation and Management Act
MFMT	maximum fishing mortality threshold
MMPA	Marine Mammal Protection Act
MP	management procedure
MPA	marine protected area
MRIP	Marine Recreational Information Program
MSA	Magnuson-Stevens Act (see MFCMA)
MSB	mackerel, squid, and butterfish
MSC	Marine Stewardship Council
MSE	management strategy evaluation
MSMC	Multispecies Monitoring Committee (New England Fishery Management Council)
MSRA	Magnuson-Stevens Reauthorization Act (see MFCMA)
MSST	minimum stock size threshold
MSVPA-X	Multispecies Virtual Population Analysis
MSY	maximum sustainable yield
NBSRA	Northern Bering Sea Research Area
NEFMC	New England Fishery Management Council

NEPA	National Environmental Policy Act
NGO	nongovernmental organization
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPFMC	North Pacific Fishery Management Council
NRDC	Natural Resources Defense Council
NS	National Standard
NSC	Northeast Seafood Coalition
NSG	National Standard Guideline
OFL	overfishing limit
OY	optimum yield
PDT	plan development team
PFMC	Pacific Fishery Management Council
POP	Pacific ocean perch
RFMC	Regional Fishery Management Council
RFMO	regional fisheries management organization
ROV	remotely operated vehicle
SAFMC	South Atlantic Fishery Management Council
SASI	Swept Area Seabed Impact model
SAW/SARC	Northeast Regional Stock Assessment Review Workshop
SFA	Sustainable Fisheries Act (see MFCMA)
SSB	Social Sciences Branch (of the NMFS Northeast Fisheries Science Center)
SSB	spawning stock biomass
SSC	Scientific and Statistical Committee
T_{TAC}	target total allowable catch
TAC	total allowable catch
TCRP	Theodore Roosevelt Conservation Partnership
T_{MIN}	The rebuilding timeframe in the absence of all fishing
T_{MAX}	The maximum amount of time allowable for rebuilding under the protocol set forth in the National Standard Guidelines
T_{TARGET}	The target date chosen for rebuilding
TMGC	Transboundary Management Guidance Committee
TRAC	Transboundary Resource Assessment Committee
UVI	unique vessel identifier
VPA	virtual population analysis
VMS	vessel monitoring system
WCPFC	Western and Central Pacific Fisheries Commission
WPFMC	Western Pacific Fishery Management Council
WWF	World Wildlife Fund

Photo Credits

Front section

Page 8	Donald McIsaac. Photo: Ed Ebisui.
Page 10	Mike Burner. Photo: Jennifer Gilden.
Page 11	The plenary session. Photo: Kimberly Ambert.
Page 13	Chairman Doc Hastings. Official portrait.
Page 14	Chairman Doc Hastings addresses the conference. Photo: Kimberly Ambert.
Page 15	Chairman Doc Hastings addresses the conference. Photo: Kimberly Ambert.
Page 16	Chairman Doc Hastings, Pacific Fishery Management Council Executive Director Don McIsaac, and NOAA Assistant Administrator Eric Schwaab.
Page 17	Senator Mark Begich. Official portrait.
Page 18	Diners at the conference's Wednesday night banquet: Dan Wolford, Phil Anderson, Bill Hogarth, Don Hansen.
Page 19-20	Senator Mark Begich addresses the conference. Photo: Kimberly Ambert.
Page 21	NOAA Assistant Administrator Eric Schwaab. Photo: Kimberly Ambert.
Page 22	Larry Simms (top).
Page 22	Larry Simpson (bottom).
Page 23	Eric Schwaab. Photo: Ed Ebisui.
Page 24	Doc Hastings and Eric Schwaab. Photo: Ed Ebisui.
Page 25	Eric Schwaab and Don McIsaac. Photo: Ed Ebisui.
Page 26	Barton Seaver. Photo: Kimberly Ambert.
Page 27	Chesapeake Bay crab, posed for an April 19, 2012 press conference announcing that the number of blue crabs in Chesapeake Bay had tripled over the last five years to the highest total in nearly two decades. The rebound was caused by restrictions on catching female crabs imposed by Virginia and Maryland in 2008, according to Maryland fisheries scientists. Photo: Jay Baker at Annapolis, Maryland. "MarylandGovPics" on Flickr Creative Commons. License: CC BY 2.0. http://tinyurl.com/kykz5hr
Page 28	Barton Seaver, Don McIsaac and Keith Colburn. Photo: Ed Ebisui.
Page 29	Barton Seaver's book *For Cod and Country*.
Page 31	Keith Colburn. Photo: Kimberly Ambert.
Page 32	A dangerous coating of ice on the NOAA Ship *Miller Freeman*. Such icing can affect a ship's stability and cause capsizing. Alaska, Bering Sea. Photo: NOAA NMAO Pacific Marine Center.
Page 33	*F/V Wizard*. Source: Capt. Keith Colburn (Facebook page).
Page 34	David Cupka. Photo: Kimberly Ambert.
Page 35	Rip Cunningham. Photo: Kimberly Ambert.

Page 36 Dorothy Lowman. Photo: Kimberly Ambert.

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Section title background photo: Rockfish recruits on the top of Cordell Bank National Marine Sanctuary, taken on the first visit ever by NOAA divers (2010). Photo: Greg McFall, NOAA (http://tinyurl.com/mlxsz2p)

Page 40 Fishermen with red snapper. Photo: M. Brown.

Page 41 Black and yellow rockfish (*Sebastes chrysomelas*). California, Channel Islands National Marine Sanctuary. Photo: Claire Fackler, CINMS, NOAA.

Page 42 Black sea bass. Photo: Ed Killer.

Page 43 Cabezon motionless on rock. Photo: Lt. John Crofts, NOAA Corps, Point Lobos State Reserve, California.

Page 44 Guam longline transshipment. Source: Western Pacific Fishery Management Council.

Page 46 Key Colony sport boats. Photo: Kim Iverson.

Page 49 North Pacific Fishery Management Council staff Gail Bendixen with halibut. Photo: Chris Oliver.

Page 51 Tortugas Ecological Reserve, Key West. Photo: National Ocean Service. (http://tinyurl.com/p3ztsb2)

Page 52 Shrimpers. Photo: Kim Iverson.

Page 54 F/V *Josie*. Photo: Jennifer Gilden.

Page 55 F/V *Unimak*. Photo: Alaska Fisheries Science Center.

Page 56 Scamp, *Myteroperca phenax*. Atlantic Ocean, Southeast U.S. shelf/slope area. 2004. Photo: Andrew David, NOAA/NMFS/SEFSC Panama City; Lance Horn, UNCW/NURC—Phantom II ROV operator (Southeast).

Page 59 Trawler. Photo: Karla Bush.

Page 62 Plymouth Harbor, Massachusetts, south shore. New England Region. Source: New England Fishery Management Council.

Page 64 Trawling operations on the NOAA Ship Delaware II. Atlantic Ocean, Gulf of Maine shelf/slope area, New England region. Photo: Personnel of NOAA Ship Delaware II.

Page 65 New England Fishery Management Council constituent meeting.

Page 66 Weathervane scallops. Source: Alaska Scallop Association.

Page 68 Pike Place Fish Market, Seattle. Photo: "Slideless in Seattle," Flickr Creative Commons. License: CC BY-NC 2.0. http://tinyurl.com/k8psbow.

Page 69 Lingcod on NOAA trawl survey. Photo: Jennifer Gilden.

Page 70 Cowcod, 2011 Southern California Hook & Line Survey (NOAA/PSMFC), Channel Islands, California, September 2011. Bo Whiteside, Pacific States Marine Fisheries Commission (on the right holding fish). Photo: NOAA West Coast Region.

Page 74 Fishing in Hawaii. Photo: Roy Morioka.

Page 75 Winter flounder. Photo: NOAA.

Page 76 Speakers Gway Kirchner (Oregon Department of Fish and Wildlife) and Ed Richardson (At-Sea Processors Association). Photo: Kimberly Ambert.

Page 77 *Voyager* charter boat. Photo: Andy Meizero.

Page 78 Scallops. Photo: A. Applegate.

Page 80 Newport, Oregon bayfront. Photo: Jennifer Gilden.

Page 82 Glassy smooth days make launch work look easy. Photo: Personnel of NOAA Ship *Thomas Jefferson*.

Page 87 Lifting a boat at the unique port of Port Orford, Oregon. Photo: Ray Gilden.

Page 88 Dogfish at the dock. Photo: New England Fishery Management Council.

Page 89 Stonington, Maine, Lobster Coop. Photo: Chris Ford, Flickr Creative Commons. License: CC BY-NC 2.0. http://tinyurl.com/kegfyqo

Page 92 "They that go down to the sea in ships 1623 -1923." The Fishermen's Memorial at Gloucester commemorating the thousands of fishermen who have lost their lives from this port. Gloucester, Massachusetts. Photo: Nance S. Trueworthy (NOAA).

Page 93 Atlantic cod. Photo: NOAA.

Page 94 Atlantic cod. Photo: NOAA (fishwatch.gov).

Page 95 New England groundfish gear. Photo: New England Fishery Management Council.

Page 96 Purse seining. Photo: A. Lovewell, New England Fishery Management Council.

Page 97 Fish in baskets. Photo: L. Steele, New England Fishery Management Council.

Page 98 Atlantic cod. Photo: NOAA.

Page 99 Small Northeast groundfish trawler. Photo: NOAA.

Page 100 Yellowtail flounder. Photo: NOAA.

Page 101 Lord's Lobster Fish Market, New Brunswick, Canada. Photo: Ian Muttoo, Flickr Creative Commons. License: CC BY-NC-SA 2.0. http://tinyurl.com/kffzjch

Page 102 F/V *Tina Marie* in Portland (ME) Harbor. Photo: Corey Templeton, Flickr Creative Commons. License: CC BY-NC-ND 2.0. http://tinyurl.com/pfkfz5z

Page 104 NOAA Fisheries Research vessel in Morro Bay, California. Photo: Jennifer Gilden.

Page 105 Midshipman (*Porichthys notatus*) caught on West Coast trawl survey. Photo: Jennifer Gilden.

Page 108 Sorting crabs. Photo: Mark Fina.

Page 116 NOAA Northwest Fisheries Science Center survey staff. Photo: NOAA.

Page 117 Halibut research. Photo: NOAA Northwest Fisheries Science Center (http://tinyurl.com/l3eoeua)

Page 122 Windowpane flounder. Photo: NOAA.

Page 123 Anglers with wahoo. Photo: Christopher Page.

Page 124 Between sessions at the Managing Our Nation's Fisheries conference. Photo: Kim Ambert.

Page 125 Crescent City, California fishing boat in dry dock. Photo: Ray Gilden.

Page 129 San Diego fishing vessels. Photo: Jennifer Gilden.

Page 130 Observer measuring bigeye tuna. Photo: NOAA.

Page 131 Bluefin tuna. Photo: NOAA.

Page 132 The Hanalei Dolphin Fish Market, Kaua'i. Photo: Wally Gobetz, Flickr Creative Commons. License: CC BY-NC-ND 2.0. http://tinyurl.com/m3zbfey

Page 133 A green sea turtle in Humpback Whale National Marine Sanctuary, Maui, Hawaii. Photo: Claire Fackler, CINMS, NOS, NOAA.

Page 134 Bluefin tuna fishing vessel. Photo: NOAA.

Page 135 Illegally fishing vessel off the coast of Gabon. Photo: NOAA.

Page 137 The IUU fishing vessel *Taruman* held 143 tons of illegally harvested Patagonian toothfish (Chilean sea bass). Photo: Australian Customs Service.

Page 138	The shark fishery in Taiwan, Province of China is not limited to longlining fleets fishing in international waters; local boats are also landing sharks in Taiwan. Pictured here is a fisher's catch of sharks along with mahi mahi. Photo Credit: Shawn Heinrichs for the Pew Environment Group.
Page 139	Mountains surrounding Pago Pago Harbor. Tuna boats in port. American Samoa. 2009 February. Photo: Dr. Matt Kendall, NOAA/NOS/NCCOS/CCMA/BGB.
Page 140	Western and Central Pacific Fisheries Commission meeting. Photo: WCPFMC.
Page 141	The crew of the Coast Guard Cutter *Rush* escorts the suspected high seas drift net fishing vessel *Da Cheng* in the North Pacific Ocean on August 14, 2012. Photo: U.S. Coast Guard.
Page 142	Regional fisheries management organization regions. Source: Ecowatch.com.
Page 143	Capt. Diane Durham, commanding officer of Coast Guard Cutter *Rush*, shakes hands with a China Fishery Law Enforcement Command officer after providing documentation and information in the transfer of custody of the suspected high seas drift net fishing vessel *Da Cheng* to Chinese jurisdiction in the North Pacific Ocean Aug. 14, 2012. Photo: U.S. Coast Guard.
Page 146	Purse seiner. Photo: Western Pacific Fishery Management Council.
Page 147	IUU fishing vessel. Photo: NOAA.
Page 148	Fish auction. Photo: NOAA.
Page 149	United Fishing Agency dock. Photo: Western Pacific Fishery Management Council.

Session 2

Section title background photo: Channels through eelgrass beds in Izembek Lagoon, Izembek National Wildlife Refuge. Photo:Kristine Sowl, U.S. Fish and Wildlife Service.

Page 152	NOAA Ship *John N. Cobb* in Tracy Arm Fiord during a harbor seal pupping survey, southeast Alaska. Photo: Aleria Jensen, NMFS Alaska Region.
Page 153	Data loggers are one way to collect information on changes in water level, salinity, temperature, etc. in different water bodies. These data loggers are being installed in the coastal zone to document tidal, seasonal, and yearly changes in hydrology on Kigigak Island. Photo: Melissa Gabrielson, U.S. Fish and Wildlife Service, Yukon Delta National Wildlife Refuge.
Page 154	Rapporteurs Whitney Tome, Kim Gordon, and Amy Kenney (Fisheries Leadership & Sustainability Forum). Photo: Kimberly Ambert.
Page 155	Northern fulmars vying to be first in line at the discharge chute, commercial cod longline vessel. Photo: Yolanda Malavear, NMFS Certified Observer.
Page 156	MONF Session 2. Photo: Kimberly Ambert.
Page 160	The Sawyer Glacier in Alaska's Tracy Arm Fjord in Tongass National Forest, June 2011. Photo: Peter E. Lee, Flickr Creative Commons. License: CC BY-NC 2.0. http://tinyurl.com/lrl82zj
Page 161	Smokehouse alderwood and Nass River oolichan (eulachon). Photo: Sam Beebe, Ecotrust. Flickr Creative Commons License CC BY 2.0. http://tinyurl.com/lx4nanr
Page 162	Fishing for King Salmon, Naknek, Bristol Bay, Alaska. Photo: Chris Ford, Flickr Creative Commons. License: CC BY-NC 2.0. http://tinyurl.com/m7fmwc6
Page 163	Alaska king crab. Photo: Steve ("aktraildog"), Flickr Creative Commons. License: CC BY-SA 2.0. http://tinyurl.com/lnwuxzg
Page 164	1929 fishing boat headed up the Inside Passage, Alaska. Photo: Jenny Pansing, Flickr Creative Commons. License: CC BY-NC-SA 2.0. http://tinyurl.com/kmp5k6z
Page 165	Lingcod hiding motionless on a reef. California, Point Lobos State Reserve. Photo: Lt. John Crofts, NOAA Corps.

Page 166 Sea otter. Photograph courtesy of the U.S. Fish and Wildlife Service, Alaska Image Library

Page 167 Alaska Brown Bear (*Ursus arctos*), Alaska Peninsula, Katmai area. Photo: Mandy Lindeberg, NOAA/NMFS/AKFSC

Page 168 Trawl catch of pollock caught during an acoustic trawl survey. Alaska, Stephens Passage. 2004. Photo: David Csepp, NOAA/NMFS/AKFSC/Auke Bay Lab.

Page 170 Ring of Fire 2002 Expedition. The animals at the top of the chimney are deep-sea octocorals or soft corals (*Octocorallia: Alcyonacea*), and sometimes go by the common name "mushroom coral." As with other cnidarians, the mushroom coral has stinging cells or nematocysts within its flashy tentacles that are used to capture minute prey. Photo: NOAA.

Page 172 Bearded seal. Photo: "Smudge 9000," Flickr Creative Commons. License: CC BY-SA 2.0. http://tinyurl.com/jwynss9

Page 175 Zooplankton: octopus larva. Photo: Matt Wilson/Jay Clark, NOAA NMFS AFSC.

Page 177 Gulf of Alaska 2004 Expedition. Deep-sea spider crabs, like this one, have long, spider-like legs and are a brilliant red. Photo: Gulf of Alaska 2004. NOAA Office of Ocean Exploration.

Page 178 Studying groundfish. Photo: Massachusetts Marine Fisheries Institute.

Page 179 Sorting a trawl catch in the ship wet laboratory. Photo courtesy of Officers and Crew of NOAA Ship PISCES; Collection of Commander Jeremy Adams, NOAA Corps.

Page 180 South Atlantic Fishery Management Council meeting question and answer session, March 2013. Photo: SAFMC.

Page 181 Gopher rockfish perched on rock. California, Point Lobos State Reserve. 2005 November 22. Photo: Lt. John Crofts, NOAA Corps.

Page 186 Kodiak, Alaska. Photo: Karla Bush.

Page 187 Students listen to information about ocean acidification and climate change presented by NOAA. Photo: U.S. Fish and Wildlife Service, Alaska Region.

Page 188 Audience, Session 2, Focus Topic 1. Photo: Kimberly Ambert.

Page 189 Panelists Brad Warren (Sustainable Fisheries Partnership), John Annala (Gulf of Maine Research Institute), and Malin Pinsky (Princeton University). Photo: Kimberly Ambert.

Page 192 Eulachon collected from Taku Inlet, near Juneau, Alaska. Photo: NOAA.

Page 193 Researchers with herring caught during an acoustic trawl survey. Photo: David Csepp, NOAA Fisheries.

Page 194 Sandlance. Photo: Mandy Lindeberg, NOAA/Wikipedia.

Page 195 Pacific Fishery Management Council meeting. Photo: PFMC.

Page 197 Traditional fishing in Guam. Photo: Leana Peters.

Page 198 Shrimper *Lady Danelle*, Key West. Photo: Kim Iverson.

Page 199 Anchovies schooling. Photo: NOAA SWFSC.

Page 202 Sardine fishery, cannery and steamer, Greens Landing, ME (Stonington, ME). Archival Photographer Stefan Claesson. Gulf of Maine Cod Project, NOAA National Marine Sanctuaries; Courtesy of National Archives.

Page 206 F/V *Valiant* in Astoria, Oregon. Photo: Jennifer Gilden.

Page 208 Stream survey: netting in Young's Creek at Rooster Rock State Park on the Columbia River, Oregon, 2009. Pictured: Paul Olson, Sean Sol, Dan Lomax. Photo: NOAA Fisheries West Coast.

Page 209 Humpback whales in North Pass between Lincoln Island and Shelter Island in the Lynn Canal north of Juneau, Alaska. This is a group of 15 whales that were bubble net fishing on 18 August 2007. Photo: Evadb (Wikimedia Commons, Public Domain (http://tinyurl.com/k4s3x3q).

Page 210 Pacific sardines. Photo: NOAA.

Page 212 AFSC scientists sort small pelagic fishes from a surface trawl in the Chukchi Sea during Leg 1 of the cruise. Photo: Alex Andrews.

Page 216 Market squid. Photo: NOAA SWFSC.

Page 217 Gulf menhaden, St Andrew State Park, Florida, 2011. Photo: "Crabby Taxonomist." Flickr Creative Commons. License: CC BY-NC-SA 2.0. http://tinyurl.com/lot4x42

Page 218 Menhaden mothership *Carters Creek*. Photo: "Mainsul," Flickr Creative Commons. License: CC BY-NC-SA 2.0. http://tinyurl.com/mdacjp7

Page 220 The Menhaden fishing industry:Delaware Public Archives sign. Photo: Lee Cannon, Flickr Creative Commons. License: CC BY-NC 2.0. http://tinyurl.com/kg3thcj

Page 221 Anhinga dining on unidentified fish, Florida. Photo: Jennifer Gilden.

Page 222 Researchers inspect survey sample and find herring. Photo: NOAA.

Page 226 Audience during session 2. Photo: Kimberly Ambert.

Page 227 Gerrod "Roddy" Smith of the Shinnecock Nation asks a question during session 2. Photo: Kimberly Ambert.

Page 228 Lee Anderson (Vice Chair, Mid-Atlantic Fishery Management Council) asks a question during session 2. Photo: Kimberly Ambert.

Page 229 Session 2 Topic 2 speakers David Crabbe (Pacific Fishery Management Council), Geoff Shester (Oceana), Mary Beth Tooley (New England Fishery Management Council), and Julie Morris (Marine Fisheries Advisory Committee). Photo: Kimberly Ambert.

Page 230 Anchovies trying to escape lunging humpback whale, Port San Luis, California. Photo: Howard Ignatius, Flickr Creative Commons. License: CC BY-NC-ND 2.0. http://tinyurl.com/mldjwub

Page 231 Anchovy swarm in the overhead tank at the Aquarium of the Bay, San Francisco. Photo: Kenny Louie, Flickr Creative Commons. License: CC BY 2.0. http://tinyurl.com/krd8637

Page 234 Redfish Lake, Idaho, source of an imperiled run of sockeye salmon. Photo: Jennifer Gilden.

Page 235 Wetlands, St. Charles Parish, Louisiana. Photo: Ken Lund, Flickr Creative Commons. License: CC BY-NC-SA 2.0. http://tinyurl.com/m42zdaf

Page 236 The Life on the Edge 2004 mission has collected a diverse array of invertebrate life around deep-sea corals. Squat lobsters are just one of the many types of organisms that use deep-sea corals for shelter. North Carolina Continental Slope. Photo: NOAA Photo Library (http://tinyurl.com/mdl3cxd).

Page 237 A white-tip shark (*Triaenodon obesus*). Hawaiian name is *mano lalakea*. Northwest Hawaiian Islands. July, 2004. Photo: Dr. Dwayne Meadows, NOAA. (http://tinyurl.com/mv28p8k)

Page 238 Spruce Creek, Kittery Point, Maine. Photo: "InAweofGod'sCreation." Flickr Creative Commons. License: CC BY 2.0. http://tinyurl.com/lyrq9am

Page 239 Kelp-covered granite at low tide at Edgar M. Tennis Preserve, Deer Isle, Maine. Photo: Captain Albert E. Theberge, NOAA Corps (Ret).

Page 242 Zigzag coral (*Madrepora oculata*). Gulf of Mexico, Bright Bank. Photo: NURC/UNCW and NOAA/FGBNMS. (http://tinyurl.com/l24yofh)

Page 244 The lobster's large claw can crush crabs, clams and fingers. *Homarus americanus*. Atlantic Ocean, offshore Maine. Photo: OAR/National Undersea Research Program. (http://tinyurl.com/lbgx-mom)

Page 248 *Lophelia* bush with squat lobsters, crinoids, an urchin, and a startled fish. North Atlantic. Photo: Bioluminescence 2009 Expedition, NOAA/OER. (http://tinyurl.com/mcva3pd)

Page 249 Darkblotched rockfish. Photo: NOAA Northwest Region.

Page 250 Black sea bass (*Centropristis striata*) hovering over the reef. Georgia, Gray's Reef National Marine Sanctuary. Photo: Greg McFall, Gray's Reef NMS, NOS, NOAA. (http://tinyurl.com/kvoqp5h)

Page 255 Mountains in the Sea Expedition 2004. A crab strikes an agressive pose. New England Seamount Chain. Photo: Mountains in the Sea Research Team; the IFE Crew; and NOAA/OAR/OER. (http://tinyurl.com/kre44fx)

Page 256 Elwha River habitat, Washington. Photo: NOAA. (http://www.habitat.noaa.gov/habitatblueprint/about.html)

Page 257 The Russian River watershed has been selected as the first Habitat Focus Area under NOAA's Habitat Blueprint. Photo: NOAA. (http://www.habitat.noaa.gov/habitatblueprint/russianriver.html)

Page 260 Hogfish (*Lachnolaimus maximus*) on reef in Puerto Rico. Photo: NOAA CCMA Biogeography Team.

Page 261 Rock hind in a sponge in about 20 feet of water. Photo: Chris Coccaro; Bonaire 2008: Exploring Coral Reef Sustainability with New Technologies; NOAA/OAR/OER

Page 262 George Geiger (former Chair, Mid-Atlantic Fishery Management Council) asks a question in Session 2, Topic 3. Photo: Kimberly Ambert.

Page 263 Session 2 Topic 3 panelists Buck Sutter (NOAA Fisheries) and Rip Cunningham (Chair, New England Fishery Management Council). Photo: Kimberly Ambert.

Session 3

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Page 266 CNMI Satawal canoes. Photo: Jack Ogumoro.

Page 267 Display at Hawaii Fishing and Seafood Festival, 2012. Photo: Western Pacific Fishery Management Council.

Page 272 Marine education in Guam. Photo: Western Pacific Fishery Management Council.

Page 273 American Samoa fisherman. Photo: Dave Hamm.

Page 274 Lummi First Salmon ceremony. Photo: Gary Sims, NOAA West Coast Region. http://tinyurl.com/jwwoha6

Page 275 Fishing in Guam. Photo: Ryan Harvey, Flickr Creative Commons. License: CC BY-NC-SA 2.0. http://tinyurl.com/kxdb4j9

Page 276 Fishing on Santa Catalina Island, California. Photo: Zohar Manor-Abel, Flickr Creative Commons. License: CC BY-NC 2.0. http://tinyurl.com/lx9gst5

Page 277 Recreational anglers. Photo provided by Ken Franke.

Page 278 *American Angler*, Point Loma, California. Photo: Flickr user **Mary**. License: CC BY-NC-SA 2.0. http://tinyurl.com/m5g8pxw

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Page 280 Fish in a barotrauma recompression crate. Photo: Florida Sea Grant. Flickr Creative Commons. License: CC BY-NC-ND 2.0. http://tinyurl.com/kuazuu2

Page 281 Rockfish. Photo provided by Mike Nussman.

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Page 283 Fishing off the pier, Kitty Hawk, NC. Photo: Randy Pertiet, Flickr Creative Commons. License:

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Page 284 Fishing boat at the Clinton Marina, Connecticut. Photo: "slack12," Flickr Creative Commons. License: CC BY-NC-ND 2.0. http://tinyurl.com/lmmhj9u

Page 286 Nome, Alaska. Photo: Dave Witherell.

Page 287 Session 3; Kitty Simonds, Executive Director, Western Pacific Fishery Management Council. Photo: Kim Ambert.

Page 288 Traditional fishing in Hawaii. Photo: Eric Woo.

Page 289 Manny Duenas (Western Pacific Fishery Mangement Council) at MONF3. Photo: Kim Ambert.

Page 292 Westport Charter Association, Westport, Washington. Photo: Jennifer Gilden.

Page 293 Unalaska fishing boats, Alaska. Photo: Maria Shawback.

Page 294 Gloucester Fishermen's Wives Memorial, Massachusetts. Photo: Elizabeth Thomsen, Flickr Creative Commons. License: CC BY-NC-SA 2.0. http://tinyurl.com/l6abhwb

Page 295 Spiny lobster (*Panulirus interruptus*). California, Channel Islands NMS. Photo: Claire Fackler, CINMS, NOAA. http://tinyurl.com/nyh92m2

Page 296 Scallops with a watercress chimichurri and herbed spaetzle at Boucherie, New Orleans. Photo: rdpeyton, Flickr Creative Commons. License: CC BY-NC-SA 2.0. http://tinyurl.com/le6vqph

Page 297 Lighthouse at Cape Disappointment, Washington. Photo: Jennifer Gilden.

Page 298 Fishing vessels off the Columbia plume, Washington. Photo: Jennifer Gilden.

Page 299 Yelloweye rockfish and friends. Photo: Rex Murphy.

Page 301 Returning from a day of fishing, Louisiana. Photo: Mira John, Flickr Creative Commons. License: CC BY-NC-SA 2.0. http://tinyurl.com/lcu5dcf

Page 303 Smith's Pacific Shrimp, Garibaldi, Oregon. Photo: Jennifer Gilden.

Page 304 Fishing vessels, Garibaldi, Oregon. Photo: Jennifer Gilden.

Page 305 Fishing gear, Garibaldi, Oregon. Photo: Jennifer Gilden.

Page 306 Hauling in squid in Morro Bay, California. Photo: Linda Tanner, Flickr Creative Commons. License: CC BY 2.0. http://tinyurl.com/ldzod7c

Page 307 F/V *San Giovanni*, Monterey Harbor, California. Photo: Jay Galvin, Flickr Creative Commons. License: CC BY 2.0. http://tinyurl.com/k8eccse

Page 308 South Carolina fishing boat. Photo: Shayla Mae, Flickr Creative Commons. License: CC BY-NC-SA 2.0. http://tinyurl.com/l5nvxry

Page 309 Fisherman cutting his catch in port at Charlotte Amilie on St. Thomas. Photo: Chuck Kramer, Flickr Creative Commons. License: CC BY 2.0. http://tinyurl.com/lquz8cp

Page 310 University of Florida seminar, sponsored by Darden Restaurants, on Advancing Ethical Practices in Seafood Sourcing. January 2014. Photo: Darden Restaurants.

Page 312 Frozen shrimp. Photo: Gulf Seafood Institute.

Page 313 Market-size U.S. Department of Agriculture 103 catfish are ready for harvest on May 1, 2012. This new variety grows faster than other tested catfish. USDA photo by Peggy Greb.

Page 316 Speaker Larry Band (California Fisheries Fund), Session 3 Topic 2. Photo: Kimberly Ambert.

Page 317 Biloxi, Mississippi shrimp boats. Photo: Roger Smith, Flickr Creative Commons. License: CC BY-NC-ND 2.0. http://tinyurl.com/lqzrml5

Page 318 Session 3, Topic 2. Photo: Kimberly Ambert.

Page 319 Bonnie McCay (Rutgers University) asks a question. Photo: Kimberly Ambert.

Page 320 Fisherman with dolphin fish. Taken circa 1967 in or near Wanchese, North Carolina. Photo:

	Jason Garber, Flickr Creative Commons. License: CC BY-NC-SA 2.0. http://tinyurl.com/mo-5qewh
Page 321	Fishing poles lined up along the gunwale of a sport fishing party boat in Carolina Beach, NC. Photo: "Mr. T in DC," Flickr Creative Commons. License: License: CC BY-ND 2.0. http://tinyurl.com/l9q3s7e
Page 324	Boats at dock. Photo: Jennifer Gilden
Page 325	Commercial fishing vessel *Fiesta* moored in the foggy bay in the channel of Morro Bay, California. Photo: Mike Baird, Flickr Creative Commons. License: CC BY 2.0. http://tinyurl.com/l9qrzzl
Page 326	Fresh bait. Tokeland, Washington. Photo: Jennifer Gilden.
Page 327	Dogfish in sorting basket. Photo: NOAA Fisheries; Courtesy of Officers and Crew of NOAA Ship PISCES; Collection of Commander Jeremy Adams, NOAA Corps.
Page 328	Coastal restaurant. Photo: Jennifer Gilden.
Page 329	Fish and chips. Photo: David Ascher, Flickr Creative Commons. License: CC BY-NC 2.0. http://tinyurl.com/n5snsan
Page 330	Family Coastal Restaurant, Sumatra, Florida. Photo: Eleanord43, Flickr Creative Commons. License: CC BY-NC 2.0. http://tinyurl.com/n5hsp37.
Page 331	A white-tip shark (*Triaenodon obesus*). Hawaiian name is mano lalakea. Northwest Hawaiian Islands. Photo: Dr. Dwayne Meadows, NOAA/NMFS/OPR.
Page 333	New Jersey fishing pier. Photo: Dennis Sitarevich, Flickr Creative Commons. License: CC BY-ND 2.0. http://tinyurl.com/kvtaqpv
Page 334	Diawa reel (South Atlantic). Photo: Kim Iverson.
Page 335	Ginger Nappi of Martin Fish Company in Ocean City, Maryland. Photo: Mid-Atlantic Fishery Management Council.
Page 336	Montauk Harbor. Photo: Lian Chang ("diametrik"), Flickr Creative Commons. License: CC BY 2.0. http://tinyurl.com/m874v3y
Page 337	Men fishing on the Chesapeake Bay at sunset. Photo: Chesapeake Bay Program, Flickr Creative Commons. License: CC BY-NC 2.0. http://tinyurl.com/o8cp2t8
Page 338	A student looks up information about the different types of game fish caught along Virginia's coast. Photo: Janet Krenn, Virginia Sea Grant. Flickr Creative Commons. License: CC BY-ND 2.0. http://tinyurl.com/mmhhczw
Page 340	Speaker Rick Robins (Mid-Atlantic Fishery Management Council) during Session 3 Topic 3. Photo: Kimberly Ambert.
Page 341	Speakers Jim Martin (Berkley Conservation Institute) and Marty Smith (Duke University) during Session 3 Topic 3. Photo: Kimberly Ambert.
Page 342	Session Chair Mark Holliday (NOAA Fisheries) and Panelist Shirley Marquardt (Mayor, Unalaska, AK). Photo: Kimberly Ambert.
Page 343	Zeke Grader (Pacific Coast Federation of Fishermen's Associations) asks a question during Session 3 Topic 3. Photo: Kimberly Ambert.
Page 344	Speakers Shirley Marquardt (Mayor, Unalaska, AK) and Jim Martin (Berkley Conservation Institute). Photo: Kimberly Ambert.

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Page 358	Stephanie Madsen, At-Sea Processors Association. Photo: Kimberly Ambert.
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