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

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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: DICK BRAME

FISHING INDUSTRY PERSPECTIVE ON IMPACTS OF ACL IMPLEMENTATION AND CONSEQUENT CHANGES IN FISHING REGULATIONS: CAPT. BILL KELLY

A SCIENTIFIC PERSPECTIVE ON CHALLENGES AND SUCCESSES WITH ANNUAL CATCH LIMITS, AND POSSIBILITIES TO IMPROVE FISHERY SUSTAINABILITY: RICHARD D. METHOT JR.

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.

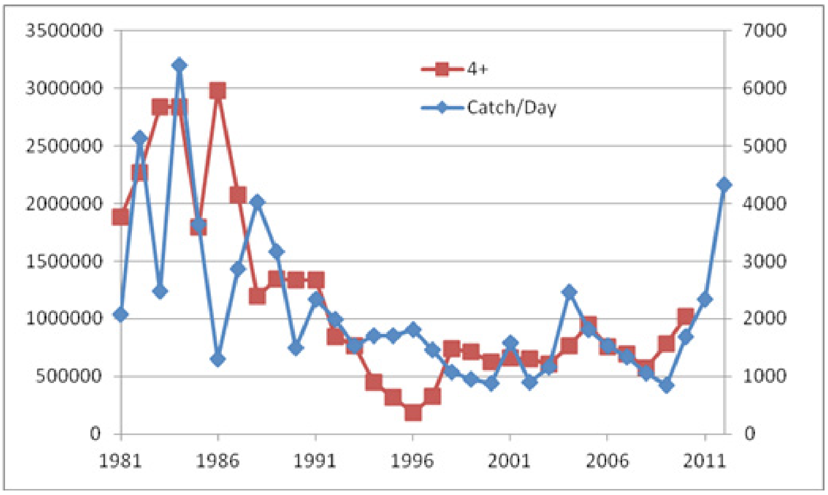

Figure 1. Black sea bass recreational catch/day and catch of 4+ fish over time. John Carmichael, SAFMC

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.

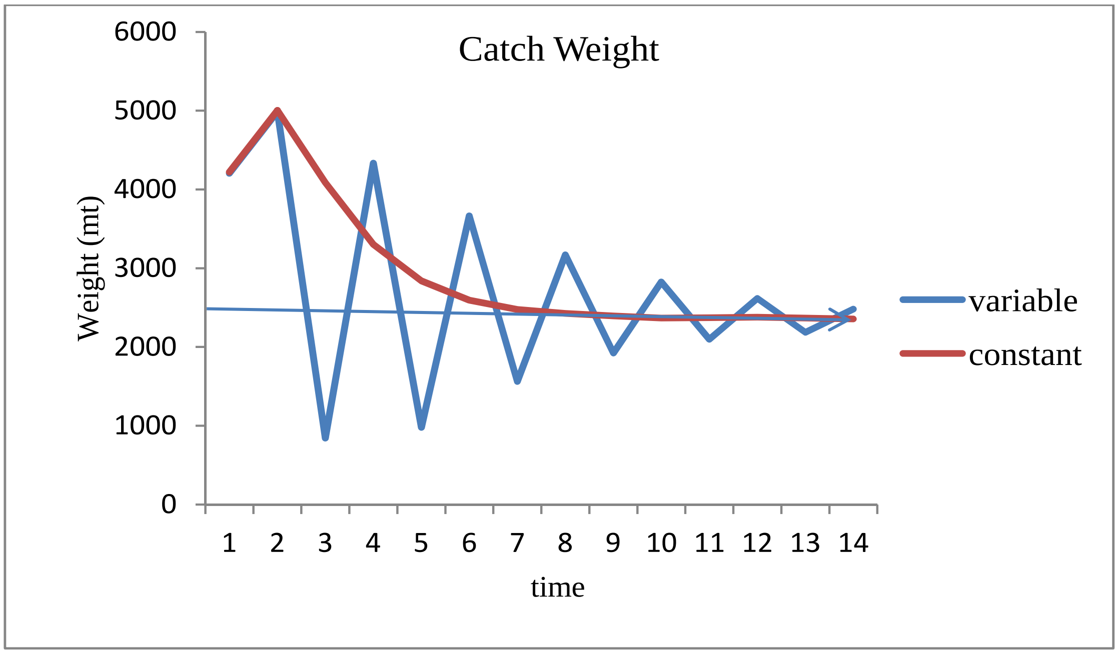

Figure 2. Hypothetical graph of exploitation over time of a stock that starts above MSY and is reduced back to equilibrium harvest. Dr. Gary Shepherd, NOAA Fisheries.

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.

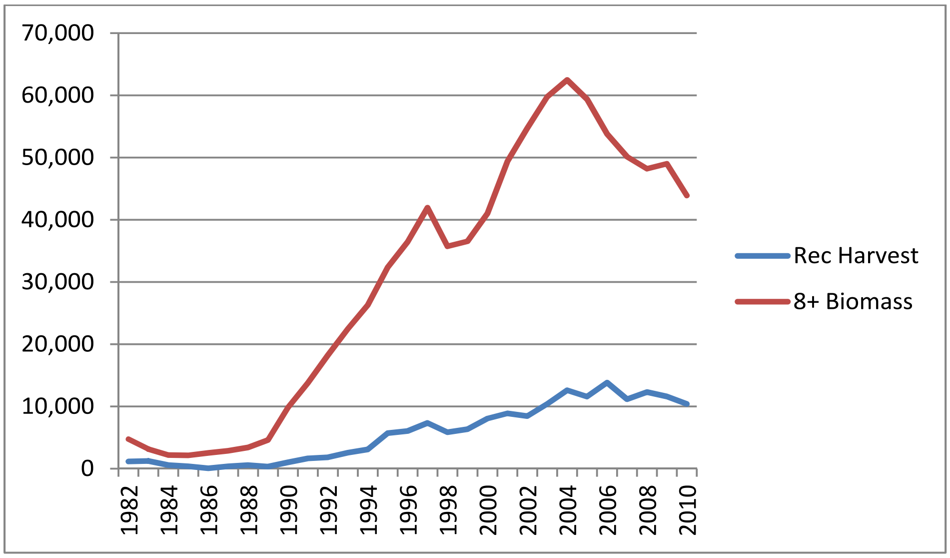

Figure 3. Striped bass recreational harvest and abundance in metric tons. Kate Taylor, ASMFC

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.

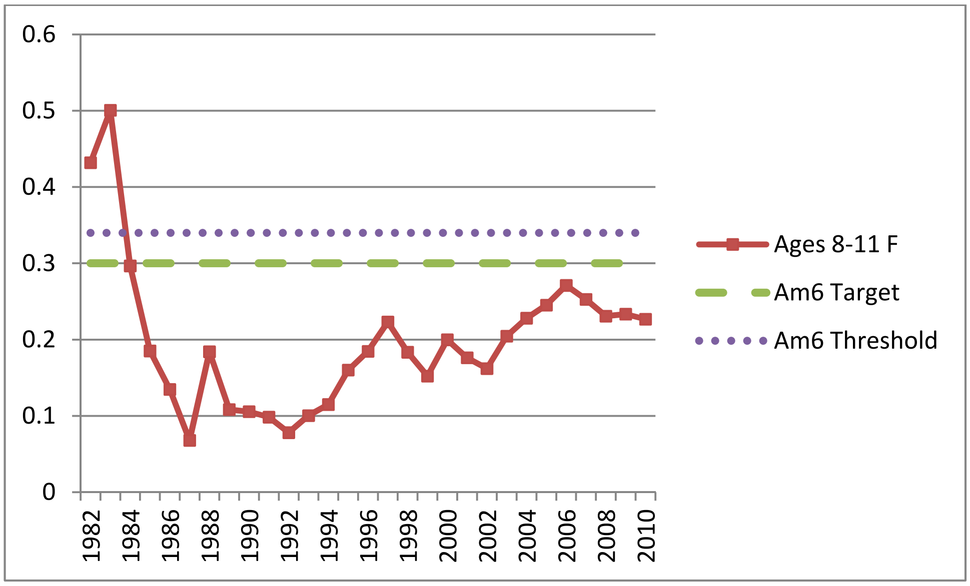

Figure 4. Fishing mortality on fully recruited striped bass in relation to the FMP fishing mortality threshold and target. Kate Taylor, ASMFC.

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 trans-boundary 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.

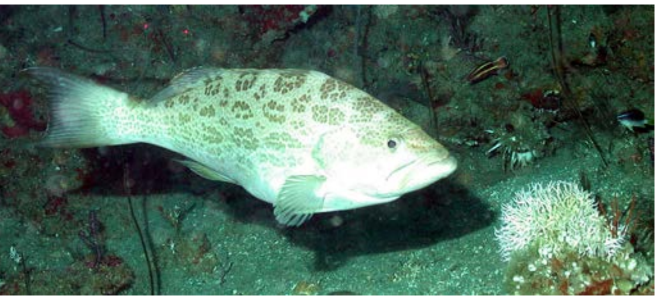
The Councils should not be required to set ACLs on all species, and to that end should consider establishing minimum requirements for setting ACLs based on stock assessments. Councils should also consider setting ABC or ACL at OY since the MSA requires calculating and managing OY. Also worth considering 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.

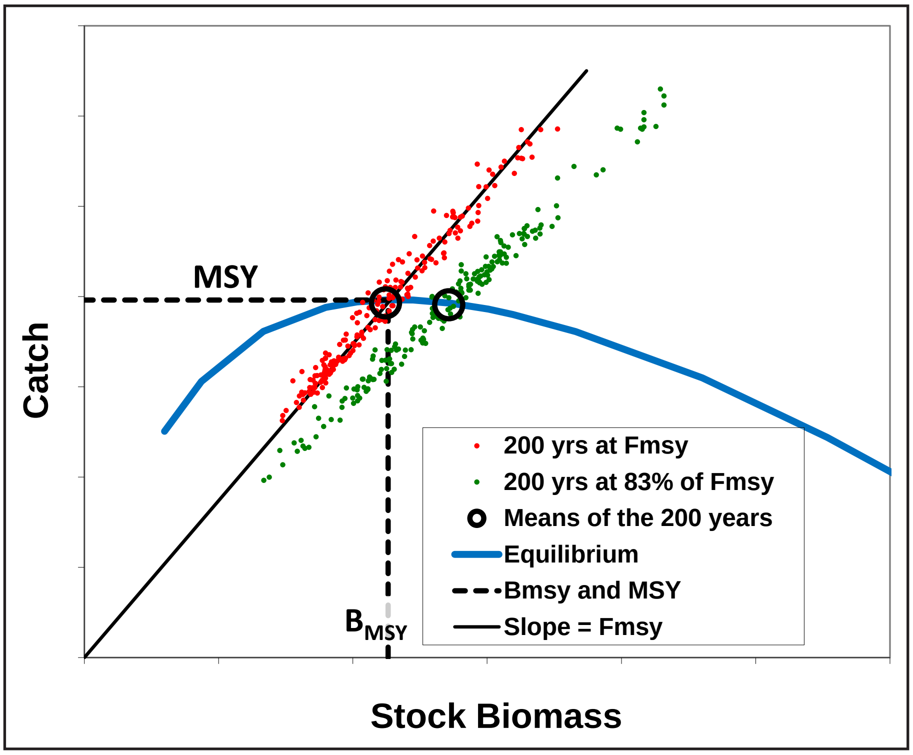

Figure 1. The scientific basis for sustainable fisheries shows that fishing at a moderate rate, F_{msy} (shown as the slope of the diagonal line) can produce a maximum long-term average catch, MSY, while maintaining the stock near an intermediate biomass level, B_{msy}. This MSY is a theoretical maximum 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

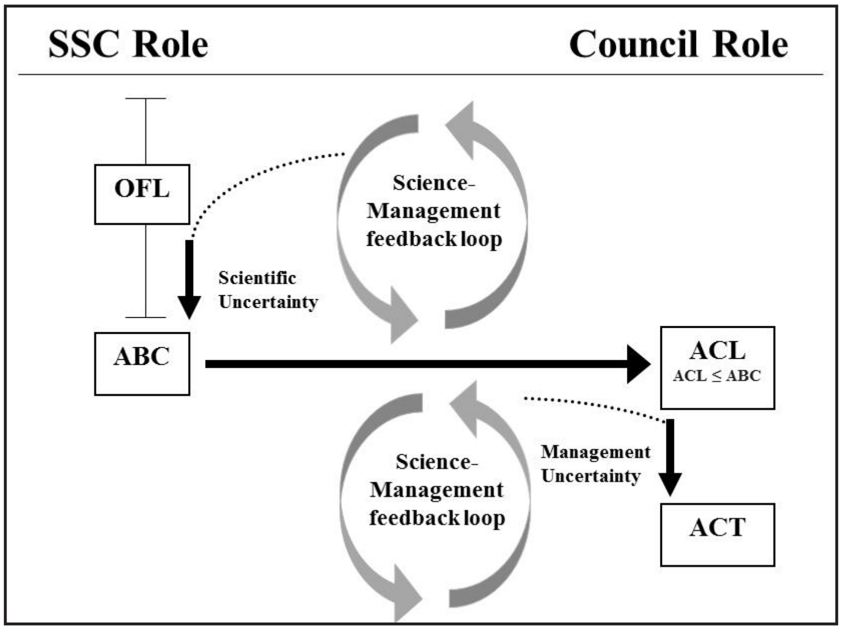

Figure 2. A schematic describing the related roles of the Councils and their Scientific and Statistical Committee (SSC) in translating scientific information into recommendations for catch limits.

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.

	Recreational Catch in 2009 (1000s of lbs)							
Commercial catch (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

Speakers

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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)

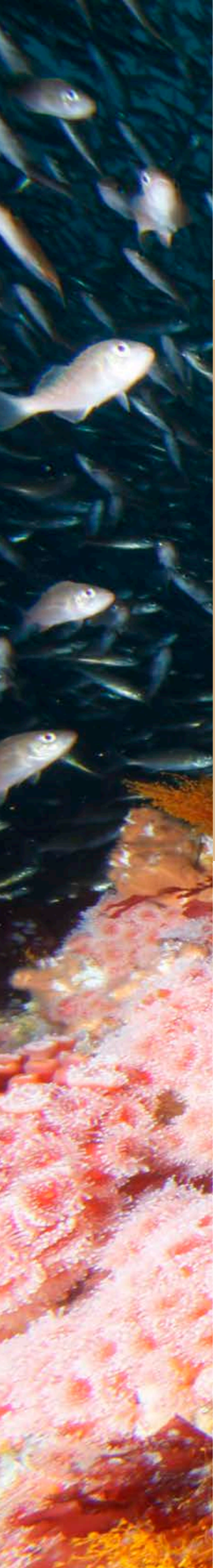
One presenter recommended that a default buffer of 75 percent of the maximum fishing mortality threshold (MFMT) be used, which provides for a "pretty good yield" that while less than MSY, would greatly mitigate risk and increase management and fishery stability. Scientific uncertainty, time lags, and 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.

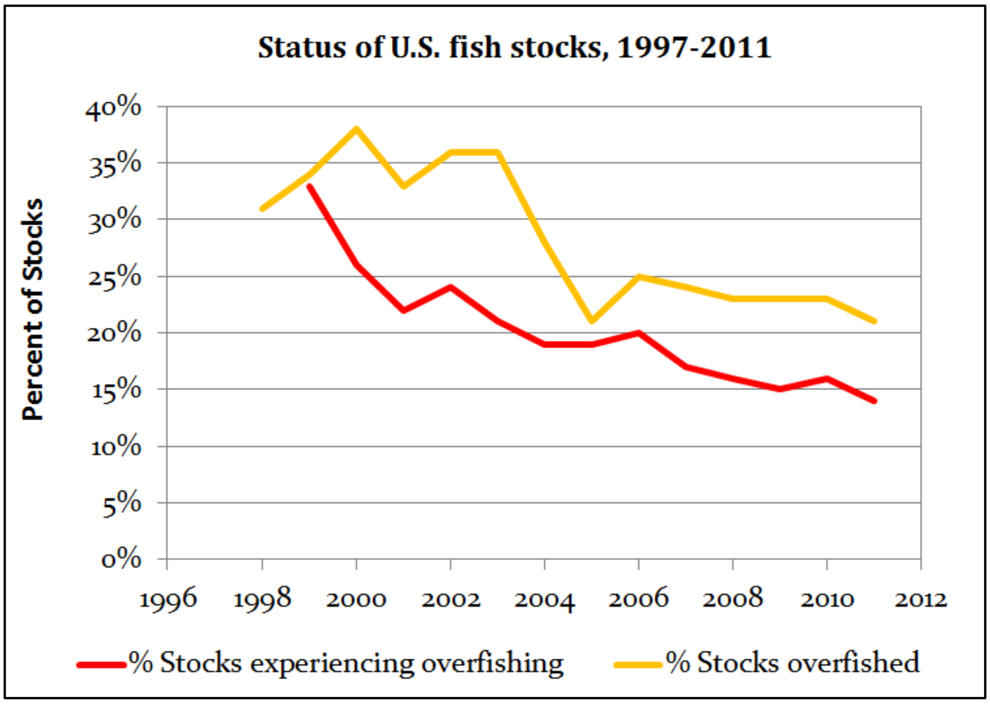

Figure 1. Status of U.S. fish stocks, 1997-2011. Source: 2011 Report to Congress. Status of U.S. Fisheries. National Marine Fisheries Service. May 2012.

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.

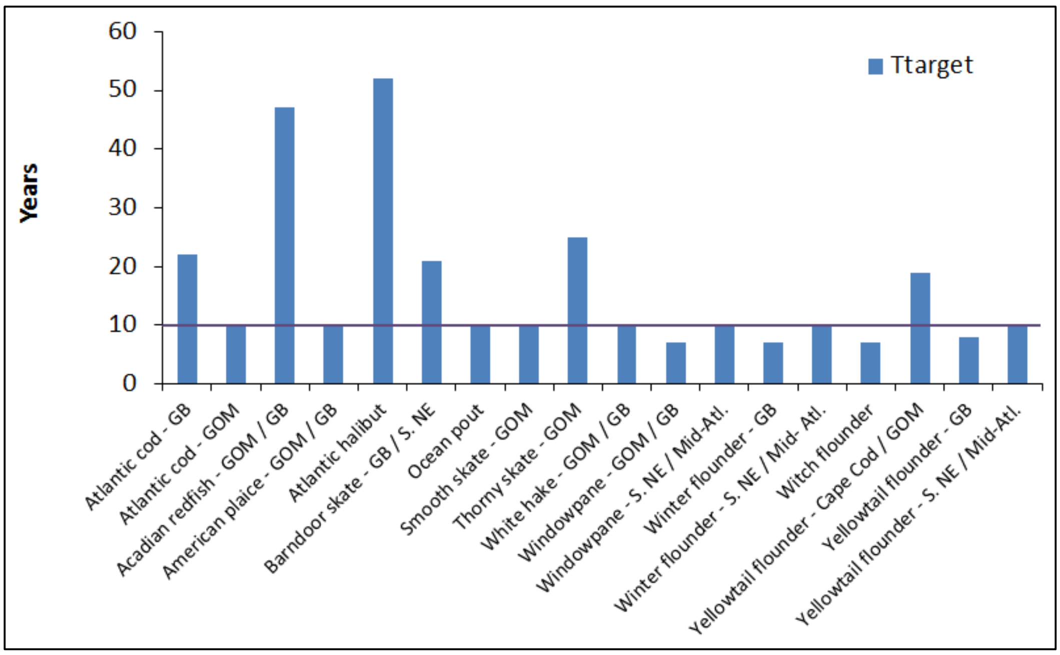

Figure 2. Target (T_{target}) rebuilding times for stocks subject to a rebuilding plan in New England where values of T_{max} (maximum) and T_{min} (minimum) rebuilding times were not available. The horizontal line marks the ten-year rebuilding deadline.

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.

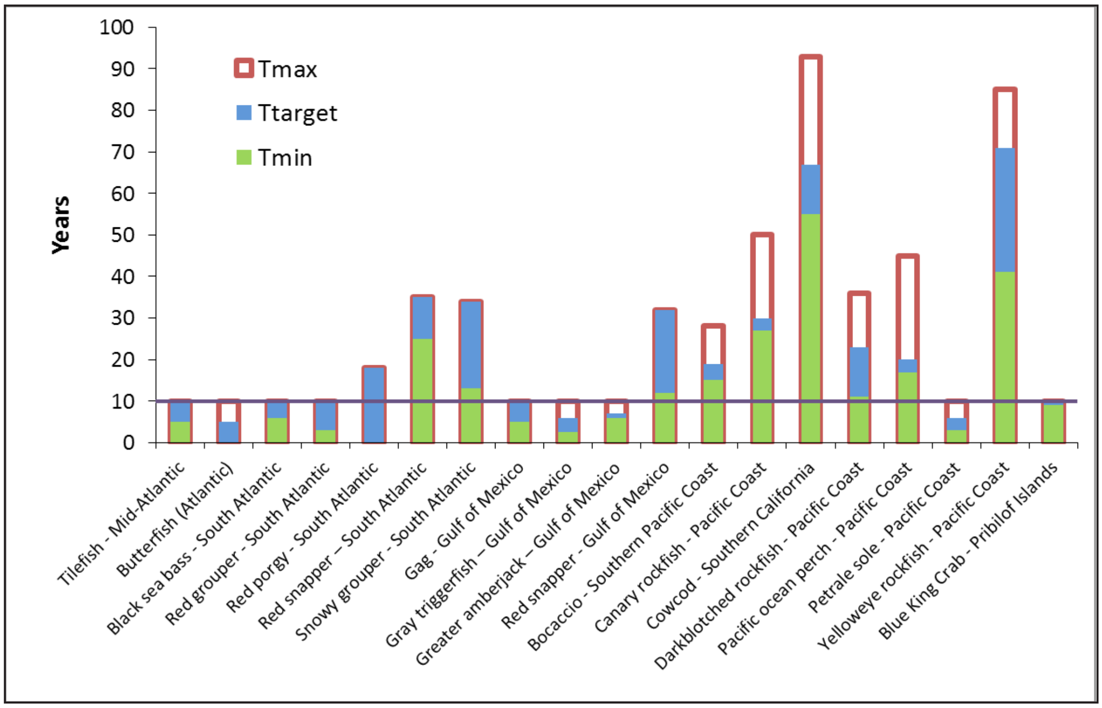

Figure 3. Minimum (T_{min}), maximum (T_{max}) and target (T_{target}) rebuilding times for stocks subject to a rebuilding plan, where values of T_{min} and T_{max} were available. The horizontal line marks the ten-year rebuilding deadline.

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}.

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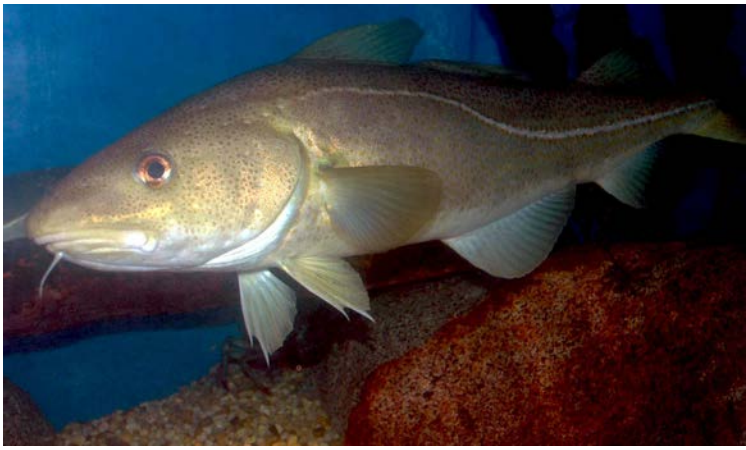
Disclaimer: This paper is based off of my experience as the Executive Director of the Northeast Seafood Coalition since 2003. Any opinions contained in this paper are mine and should not be interpreted as being a formal position of the Northeast Seafood Coalition.

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 overestimated 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).

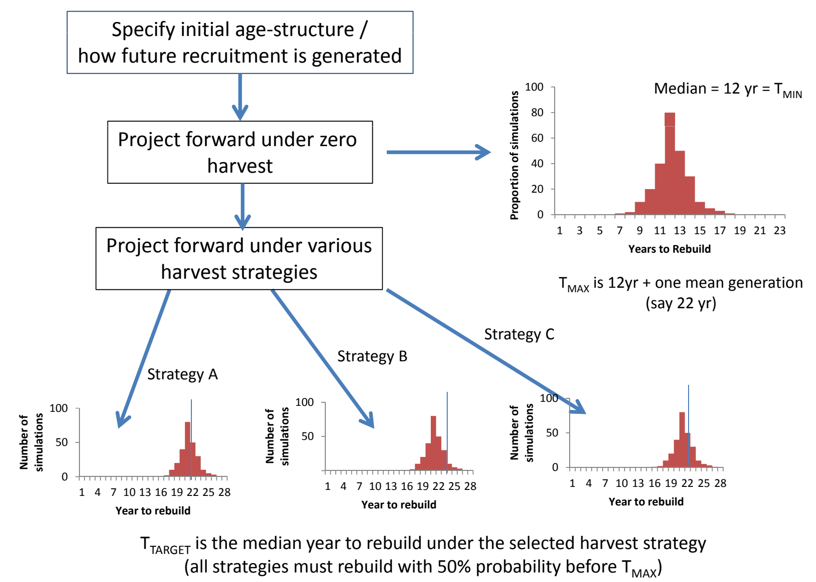

Figure 1. Graphical summary of how rebuilding analyses are conducted

- 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)

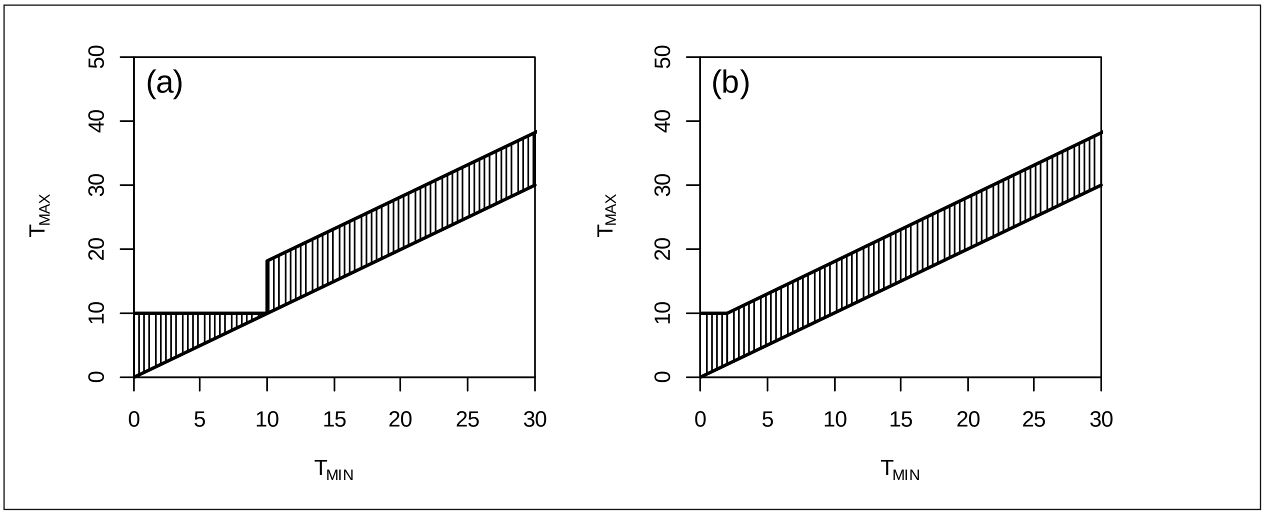

Figure 2. Relationship between T_{MIN}, and T_{MAX} for a stock with a generation time of 20 years given the current guidelines (a), and this relationship without the 10-year rule (b). T_{TARGET} has to be selected from within the shaded region. The vertical line at T_{MIN} = 10 years in (a) indicates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

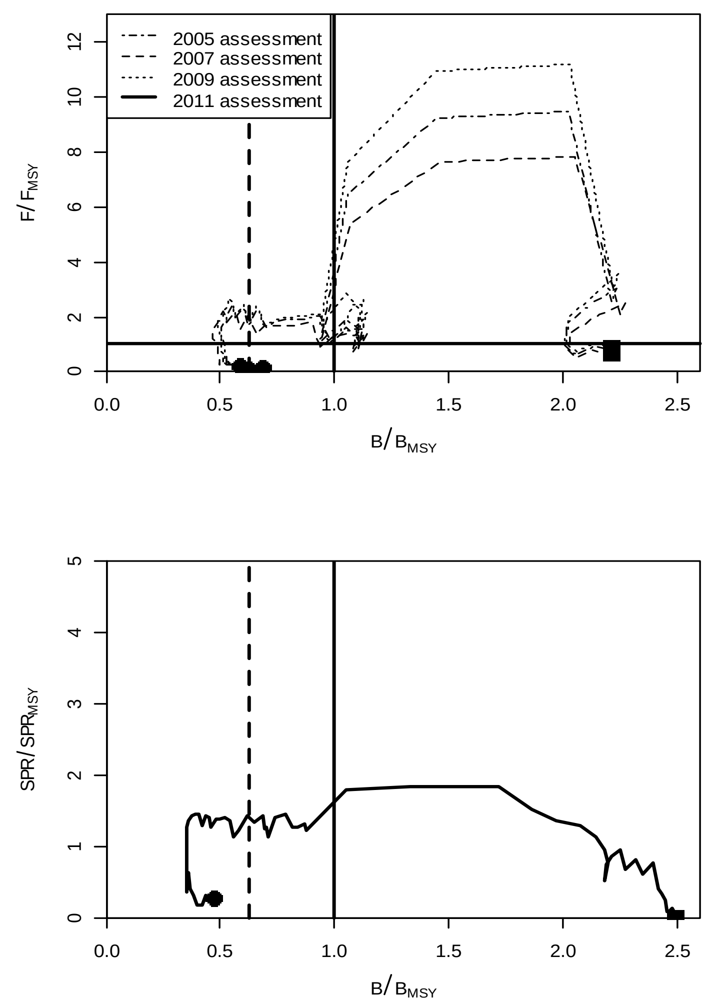

Figure 3. Phase plots for Pacific Ocean perch. The solid square indicates the first year included in the assessment, and the solid circle the last year included in the assessment.

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.

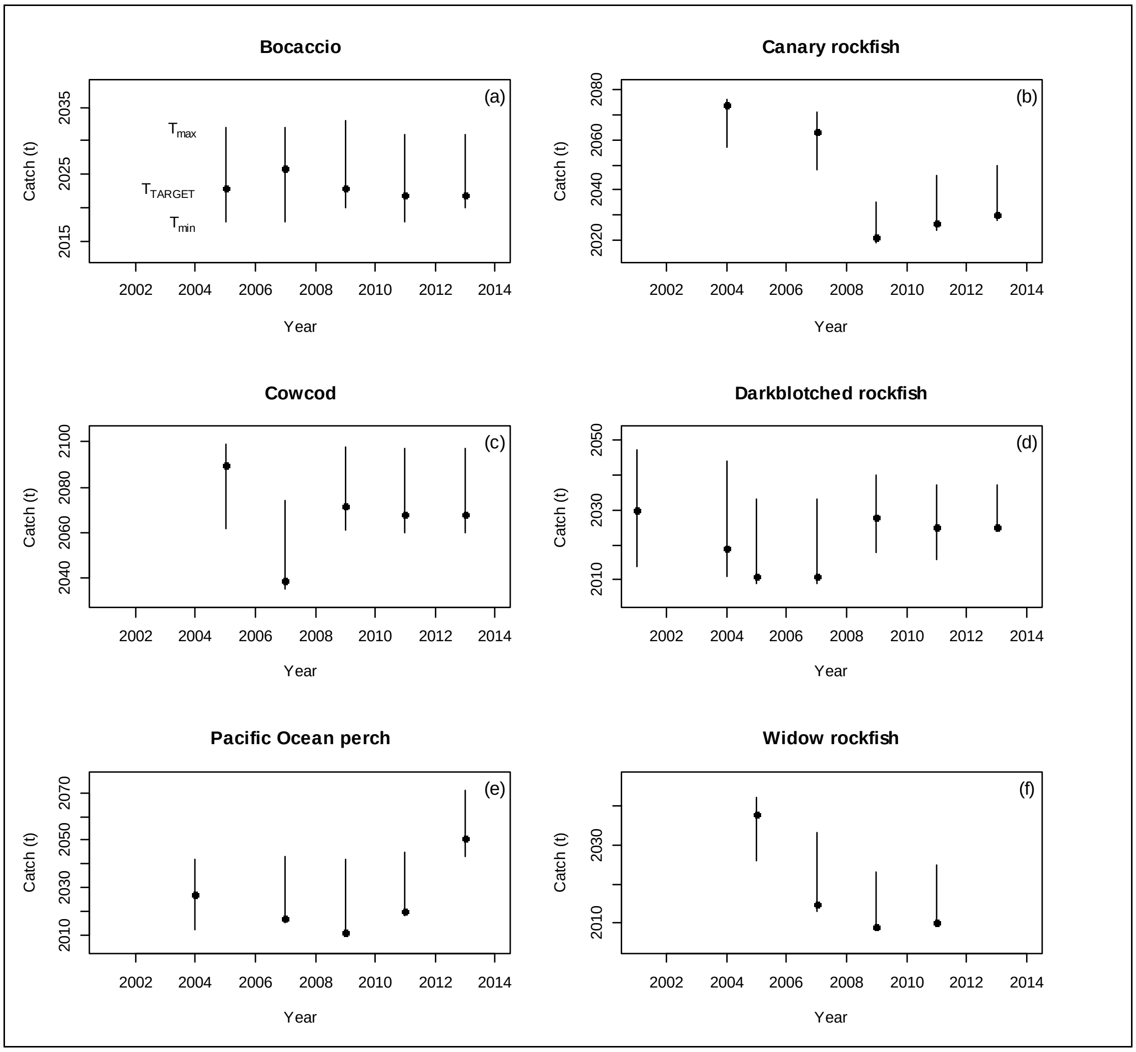

Figure 4. Values for T_{MIN}, T_{ARGET} and T_{MAX} for six selected groundfish stocks managed by the Pacific Fishery Management Council. Results are shown for each time the rebuilding analysis was updated or progress towards rebuilding was reviewed. The years on the x-axis relate to the first year for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

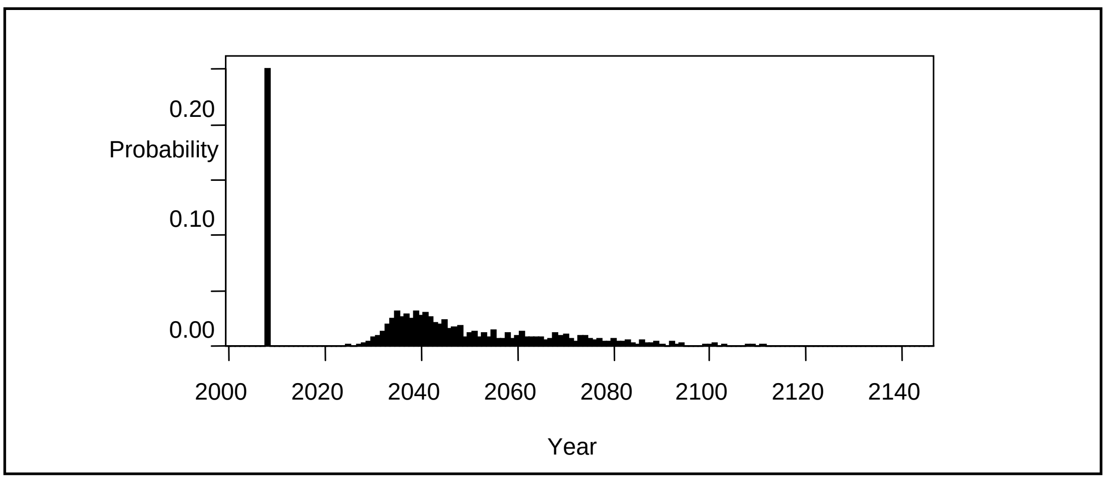

Figure 5. Distribution of time-to-rebuild to the proxy for B_{MSY} in the absence of exploitation for Pacific Ocean perch (reproduced from Hamel 2011).

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*).

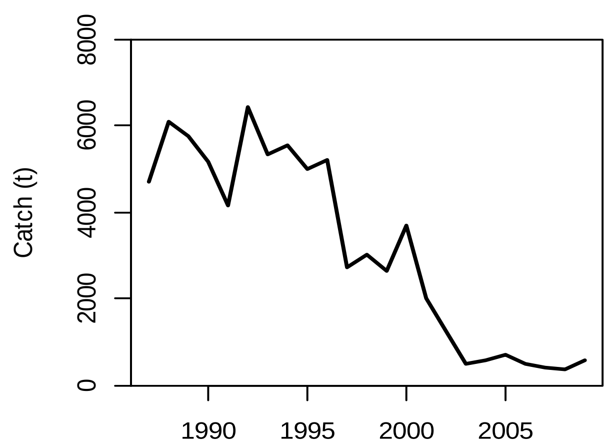

Figure 6. Time-trajectory of catch for yellowtail rockfish.

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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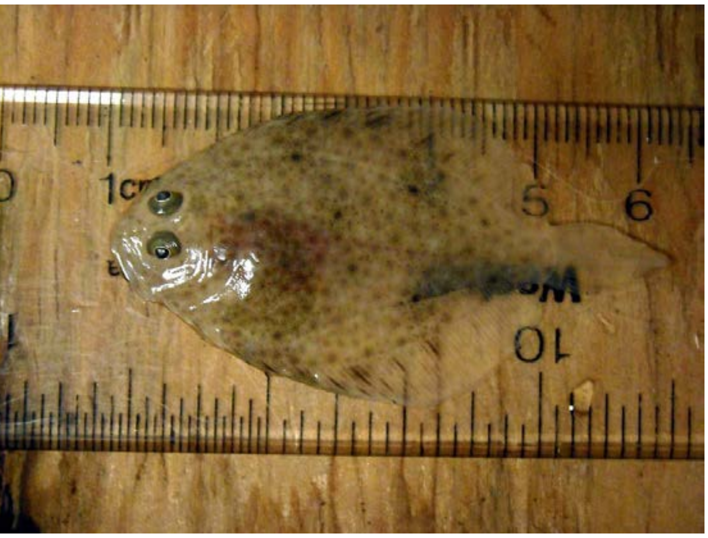
Discussion Summary: Rebuilding Program Requirements and Timelines

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

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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

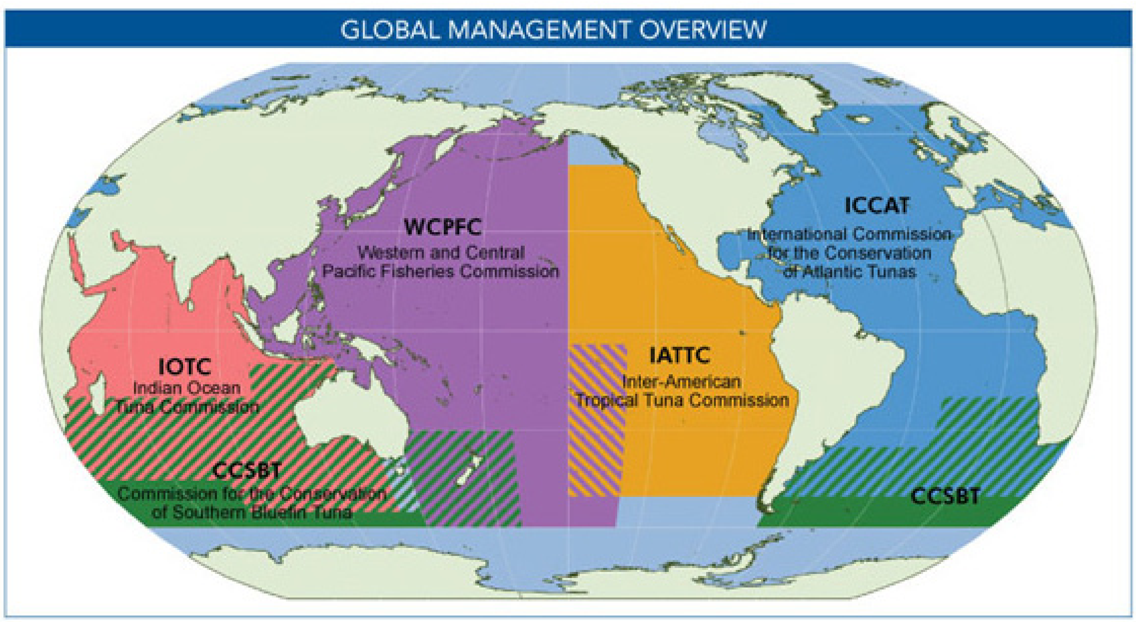
Effective, transparent and meaningful compliance monitoring schemes are critical for assessing the level of compliance by RFMO members in the implementation of management measures and ensuring that the requirements of RFMOs are effectively enforced. Understanding the levels of compliance is also key 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

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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