

1. Invitation from Fisheries Leadership and Sustainability Forum to Council Members for a workshop hosted by Stanford University in Monterey, CA from September 19-22, 2010.
2. Report from Fisheries Leadership and Sustainability Forum titled *Risk Policy and Managing for Uncertainty Across the Regional Fishery Management Councils*.

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June 1, 2010

Dear Regional Fishery Management Council Member,

You are invited to attend the fifth workshop of the Fisheries Leadership & Sustainability Forum hosted by Stanford University in Monterey, California from **September 19-22, 2010**.

The Fisheries Leadership & Sustainability Forum, a joint initiative among four of the nation's leading academic and policy institutions, promotes professional development and continuing education by bringing together fishery managers and experts from a range of disciplines. The Fisheries Forum offers council members opportunities to share experiences, build leadership skills, and enhance their understanding of fisheries law, policy, science, and economics. We sponsor semi-annual forums and provide fishery managers with ongoing support in a variety of forms throughout the year. Whether convening regional workshops or conducting research and analysis at the request of individual councils, the Fisheries Forum exists as a resource and support network for federal fishery managers nationwide.

The semi-annual forums are the cornerstone of the Fisheries Leadership & Sustainability Forum and provide council members with access to the latest research and an opportunity to discuss challenges and share success stories across regions. Each interactive forum is developed and led by faculty and staff from Stanford and Duke Universities in conjunction with leading experts in the fields of fisheries science, economics, law and policy. The forums focus on learning from experience and applying knowledge and problem solving skills to real world challenges. Previous forums focused on such timely topics as limited access privilege programs, ecosystem-based fishery management, bycatch and protected species, and managing for risk and uncertainty. These substantive themes are often coupled with skill development sessions focusing on, among other things, negotiation, consensus building and structured decision-making.

Enrollment in the forum is limited. The final deadline for the September forum is enrollment is **August 20, 2010**, however we encourage you to register early to reserve your place. To apply, please follow the links on our website at: www.FisheriesForum.org. Financial scholarships are available to cover the cost of attendance. If you have any questions about the Fisheries Leadership & Sustainability Forum or the September workshop, please contact us. We look forward to having you join us in September!

Sincerely,



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RISK POLICY & MANAGING FOR UNCERTAINTY ACROSS THE REGIONAL FISHERY MANAGEMENT COUNCILS

**Fisheries Leadership & Sustainability Forum
Duke University Marine Lab, Beaufort, North Carolina
May 10-13, 2010**

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PREFACE

The following report provides an overview of the different approaches being considered and/or adopted by each of the eight regional fishery management councils to deal with risk and account for uncertainty in their fishery management framework. The regional summaries examine the progress made by each of the councils to characterize scientific and management uncertainty and incorporate those estimates into the harvest specification process and associated management measures. The Fisheries Forum recognizes that dealing with risk and uncertainty is on an ongoing challenge and an evolving process. Each summary represents a snapshot in time and is not intended to judge or compare the relative progress and different methods being employed by individual councils. It is intended as a reference for fishery managers and a foundation for discussion among participants at the spring 2010 Fisheries Forum.

ACRONYMS

AM	Accountability Measures
ABC	Allowable Biological Catch
ACL	Annual Catch Limit
ACT	Annual Catch Target
B_{msy}	Biomass associated with MSY
CFMC	Caribbean Fishery Management Council
CPS	Coastal Pelagic Species
F_{ABC}	Fishing mortality level/rate associated with ABC
F_{msy}	Fishing mortality level/rate associated with MSY
GHL	Guideline Harvest Level
GMFMC	Gulf of Mexico Fishery Management Council
HMS	Highly Migratory Species
M	Natural Mortality Rate
MAFMC	Mid-Atlantic Fishery Management Council
MSRA	Magnuson-Stevens Fishery Conservation and Management Act (reauthorized)
MSST	Minimum stock size threshold
MSY	Maximum Sustainable Yield
NEFMC	New England Fishery Management Council
NPFMC	North Pacific Fishery Management Council
NS1	National Standard 1 Guidelines
OY	Optimum Yield
OFL	Overfishing Limit
P*	Probability of Overfishing
PFMC	Pacific Fishery Management Council
PSA	Productivity Susceptibility Analysis
SAFMC	South Atlantic Fishery Management Council
SSC	Scientific and Statistical Committee
TAC	Total Allowable Catch
WPRFMC	Western Pacific Regional Fishery Management Council

INTRODUCTION

The 2006 reauthorization of the Magnuson-Stevens Fishery Conservation and Management Act (MSRA) included new provisions for the establishment of Annual Catch Limits (ACLs) and accountability measures (AMs) to prevent overfishing. The MSRA also elevated the role of the Scientific and Statistical Committees (SSCs) of the eight regional fishery management councils and stipulated that the SSCs are required to account for scientific uncertainty in the calculation of ACLs and the provision of management advice to their councils. Pursuant to the 2009 revised National Standard 1 guidelines, which address the implementation of the MSRA's ACL requirements, ACLs are a function of overfishing limit (OFL) and allowable biological catch (ABC) calculations and represent the upper limit on a stock's total mortality that should not be exceeded. The SSC must establish an OFL for managed species and provide recommendations to its Council regarding ABC levels. The ABC is an annual catch amount that is reduced from the OFL to account for scientific uncertainty. In effect, the greater the degree of scientific uncertainty, the greater the difference between the OFL and the ABC.

The size of the buffer between OFL and ABC is also a function of the Council's risk tolerance preferences and is reflected in the Council's selection of an ABC control rule. While informed by scientific advice and expert judgment, the ABC control rule is, in part, a policy decision made by the Council. Control rules are procedures that help translate biological information concerning stock abundance and productivity into management recommendations based on a particular Council's level of risk tolerance or aversion. The ABC control rule methods being considered and adopted by SSCs in each of the regions are diverse and varied and reflect the different interpretations of the statute and guidelines as well as the unique management contexts associated with the different Councils. Resource needs, data availability, stock assessment frequency, and management capacity and history all play a role in influencing the control rule selections by the different Councils and their SSCs. The control rules being considered include among other things: a tiered approach linked to information quality; a probability of overfishing (P^*) approach; fixed buffers where scientific uncertainty cannot be quantified; and integration of productivity-susceptibility analysis scores.

In addition to accounting for scientific uncertainty, managers must also incorporate estimates of management uncertainty when establishing ACLs and AMs. Management uncertainty is a function of the control that management measures have over total catch and the amount of information that catch data can provide. Lack of sufficient catch information and/or management precision can contribute to management uncertainty. To account for and mitigate the potential impacts of management uncertainty, managers may further reduce catch limits when specifying the ACL or annual catch target (ACT) and/or implement measures that reduce management uncertainty by improving the management control and precision.

The purpose of this report is to provide an overview of the different approaches being contemplated and/or adopted by each of the eight councils to deal with risk and account for uncertainty in their fishery management framework. The regional summaries examine the progress made by each of the Councils to characterize scientific and management uncertainty and incorporate those estimates into scientific determinations and management decisions.

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NORTH PACIFIC FISHERY MANAGEMENT COUNCIL

The North Pacific Fishery Management Council (NPFMC) oversees five fishery management plans including: Bering Sea/Aleutian Islands (BSAI) groundfish, Gulf of Alaska groundfish, Bering Sea crabs, Alaska scallops, and Alaska salmon. To comply with the requirements of the reauthorized Magnuson-Stevens Act (MSRA), the Council is planning to use the existing tier system for both groundfish plans, develop a probabilistic (P*) approach or a fixed buffer below the overfishing limit (OFL) for crabs, and use a fixed buffer for scallops. The operating framework for groundfish, crab, and scallop catch limits is $OFL > \text{Allowable Biological Catch (ABC)} = \text{Annual Catch Limit (ACL)} > \text{Total Allowable Catch (TAC)}$ or $\text{Guideline Harvest Levels (GHLs)} = \text{Annual Catch Target (ACT)}$. Meanwhile, managers are claiming an exemption from the ACL requirements for Alaska salmon stocks and deferring management to the State of Alaska.

The Council's Scientific and Statistical Committee (SSC) calculates the OFL from a set formula established by the tier system. Meanwhile, the ABC, which is regarded as the maximum permissible catch level, is reduced to account for scientific uncertainties with stock assessment models, decreasing trends in recruitment or other population parameters, changes in environmental conditions and other factors.

Currently, the NPFMC relies on a six-tier system when establishing OFL and ABC values for groundfish. This tiered approach is intended to account for scientific uncertainty and establish reference points for all managed stocks. Each tier corresponds to the level of information available for a particular stock. For relatively data rich stocks in tiers 1-3, fishing mortality is reduced when the stock drops below its target biomass level (B_{MSY}). The higher tiers 4-6 correspond to increasingly data poor stocks and ABCs are based on the following formulas:

- Tier 4: $F_{ABC} < F_{40\%}$
- Tier 5: $F_{ABC} < 0.75M$
- Tier 6: $F_{ABC} < 0.75 \times OFL$

For stocks in tier 5, the F_{OFL} = natural mortality rate (M), which is used where there is a reliable estimate of the biomass and some information on the biology of the stock. For stocks in tier 6, biomass estimates are not available so reference points are calculated based on average catch. The maximum ABC derived from the formula in the tier system can be further adjusted downward by the SSC to account for additional unquantifiable uncertainty.

ABCs derived from the existing tier system are shown to have a low probability of exceeding the OFL. To ensure that the tier system complied with requirements of the MSRA and the National Standard 1 guidelines, scientists from the Alaska Fisheries Science Center assessed the probability of overfishing (P*) using the buffers incorporated into the existing tier system for groundfish. Values of P* required to match the existing buffers between OFL and ABC (for all tiers) were computed. Given the uncertainty assumptions associated with the OFL calculation, the results revealed that there is a 12% chance that the ABC will exceed the OFL across all groundfish stocks. Though the tier system is not based on a P* approach, the buffer size associated with each tier and the corresponding average P* for this tiered system are considered to be relatively precautionary. NMFS scientists are continuing to

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evaluate ways to better account for uncertainty in OFL and ABC for groundfish.

Like groundfish, the crab OFLs are determined based on tier levels associated with the degree of information available. At present, the BSAI crab fishery management plan (FMP) delegates authority to set GHLS to the State of Alaska and does not include ABC levels; therefore, the Council is working to develop an approach to set ABC to comply with the requirement to establish ACLs. A probabilistic P* approach is the preferred method; however, it has yet to be determined whether that will involve a variable P* with a fixed buffer or a fixed P* with a variable buffer between OFL and ABC. To ensure compliance by the statutory deadline, the crab ACL amendment package is scheduled for review in June 2010 and final action in October 2010.

While there is a federal FMP for salmon in Alaska, it is limited in scope and salmon are largely managed by the state. The FMP prohibits commercial fishing but allows sportfishing for salmon within the exclusive economic zone (EEZ). All salmon management measures in federal waters are extensions of Alaska State management measures. As such, the Council does not set OFL, ABC, or catch limits for any Alaska salmon fishery or species. Whether salmon may be exempt from the ACL requirements of the MSA is debatable and whether the scope of federal management authority over salmon should be expanded is currently the subject litigation.

Most of the fisheries managed by the NPFMC have high levels of management certainty. However, for those fisheries with less management certainty, the Council employs a diverse suite of accountability measures to mitigate potential negative consequences. Comprehensive at-sea observer coverage and an electronic catch reporting system monitor groundfish catch, and the groundfish FMP authorizes in-season accountability measures that enable managers to limit and/or prevent the catch of a particular species as it approaches or exceeds the TAC. Crab stocks are managed by a federal catch shares program, which stipulates that crab catch cannot exceed the total allowable catch (TAC). The scallop fishery, on the other hand, operates as a voluntary catch shares program, and the state manages the scallop fishery in season with 100% observer coverage, catch reporting, and shut down of subareas when the GHL is projected to be reached. These catch share-based management regimes yield very high levels of management certainty. As such, the Council does not anticipate establishing an additional buffer between the ABC and the ACT for any of these stocks.

PACIFIC FISHERY MANAGEMENT COUNCIL

The Pacific Fishery Management Council (PFMC) manages a range of species under four different fishery management plans (FMPs): coastal pelagic species (CPS), highly migratory species (HMS), groundfish, and salmon. The PFMC and its Scientific and Statistical Committee (SSC) are making advancements in identifying, quantifying and incorporating sources of scientific uncertainty into the establishment of annual catch limits (ACLs). Less attention has been paid to incorporating buffers to account for management uncertainty; some anticipate that the recommendations regarding management uncertainty will come from the management teams. Constrained by statutory deadlines, the Council's approach to date has been piecemeal, and they have yet to undertake a more comprehensive comparative assessment across all FMPs or to develop an overarching risk policy.

The PFMC's SSC is charged with determining the best method to quantify scientific uncertainty. The sources of scientific uncertainty are varied and numerous, and the SSC's current approach only quantifies one dimension of uncertainty: stock biomass estimates. Acknowledging that this is an evolving process, the SSC noted that going forward, it will be important to consider other sources of uncertainty, including F_{msy} , future biomass forecasts, ecosystem and climate variability, non-stationary dynamics, etc. While these other sources of uncertainty will not be included in the current harvest specification process, scientists hope to incorporate them into future estimates. The current synthesis model is being adapted to include forecast uncertainty for next cycle of groundfish assessments.

Similar to the tier system of the North Pacific, the PFMC has adopted an approach that categorizes species based on the level of information available for the stock. Category 1 represents data rich stocks, and category 2 and 3 stocks are relatively data poor. The great majority of managed species fall into category 3 and overfishing levels (OFLs) for category 3 stocks have typically been based on average catch levels. The SSC, which is responsible for categorizing species into tiers, will use these classifications to determine the appropriate scientific uncertainty buffers for species in the FMP. Each category is associated with a formula designed to adjust the allowable biological catch (ABC) relative to the OFL and create appropriate buffers to account for scientific uncertainty. For category 1 stocks, ABC is a policy decision that is decided according to a control rule that defines the relationship between scientific uncertainty (σ), the risk of overfishing (P^*), and the appropriate buffer. Until the Council's most recent decision at their April 2010 meeting, the ABC for stocks in categories 2 and 3 was set equal to a 25% and 50% reduction of OFL, respectively. Accordingly, uncertainty and buffers should be greater for category 2 and 3 species, given a specified level of risk. These buffers were established years ago based on recommendations contained in the National Standard 1 Guidelines Technical Guidance which suggested that target catches be equal to 75% of recent catch if the stock is above B_{msy} , 50% of recent catch if the stock is between B_{msy} and the minimum stock size threshold (MSST), and 25% of recent catch if it is below the MSST.

The SSC is tasked with defining the relationship between the variance in stock biomass estimates (the SSC-preferred metric for defining scientific uncertainty) and the probability of overfishing (P^*) the stock based on this scientific uncertainty. The SSC recommended that the choice of P^* is a policy decision that the Council should make based on its preferred level of risk. Following the SSC's recommendation, the Council decided in March 2010 to include the P^* concept as one approach that

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could be taken to decide scientific uncertainty buffers in the biennial specifications process. They also specified a maximum P^* for category 1 stocks of 45% when P^* is used to decide an ABC. While less than the maximum legal threshold of $P^* = 50\%$, the preferred maximum P^* of 45% is less precautionary than decisions the PFMC made concerning rebuilding rockfish stocks where the value of P^* was never greater than 40%.

While a P^* -biomass variance metric cannot be calculated for category 2 and 3 stocks, the SSC endorsed and the Council approved the idea of moving to a P^* approach for those stocks at their April 2010 meeting. Under the P^* approach, the SSC recommended sigmas of 0.72 and 1.44 for category 2 and 3 stocks, which are 2 and 4 times greater than the sigma estimated for category 1 stocks (0.36). The Council decided under their preliminary preferred ABCs for 2011-12 to use the P^* approach for category 1, 2, and 3 stocks. They opted to use a P^* of 0.45 for category 1 (~4% buffer) and 0.4 for category 2 and 3 stocks which equates to buffers of about 17% and 31%, respectively. In addition, the Council decided to treat all component stocks managed in the complexes as category 3 stocks. In effect, this established a 31% scientific uncertainty buffer below the OFL for all complexes.

To assist the Council in choosing the appropriate buffer for category 1 (data rich species), the SSC recommended providing a table that maps potential P^* values to corresponding buffer fractions. The Council could then determine its preferred level of risk and select the appropriate P^* value and calculate the ABC for the stock. Once the SSC determines the OFL and ABC levels, the Council derives a stock-specific ACL /annual catch target (ACT) by applying a harvest control rule that adjusts the ABC downward to account for conservation concerns and management uncertainty.

To comply with the requirements of the 1996 Sustainable Fisheries Act and scale back exploitation when groundfish stocks drop below target levels and prevent them from becoming overfished, the PFMC developed the 40:10 harvest control rule. The default precautionary “40:10” harvest control rule for groundfish applies to stocks which are not overfished but whose population levels remain below the target biomass level (B_{msy}). The rule requires that managers reduce the ACL relative to the ABC once the biomass of a stock drops below 40% of its unfished level ($< B_{msy}$). The PFMC also established a depletion threshold whereby if the biomass drops to 10% of unfished levels (minimum stock size threshold), targeted fishing on the stock ceases. The 40:10 rule, which is also used as a default rebuilding strategy to rebuild the stock to target levels, is typically used when a stock’s biomass is below B_{msy} but above the overfished threshold (25% of the unfished level). This approach regards the ABC as the upper limit on the annual catch level. The Pacific Council employs a comparable procedure for Coastal Pelagic Species (CPS), except that the optimal yield (OY) was termed a harvest guideline (HG).

At its March meeting, the Council’s SSC discussed two options for applying the 40:10 control rule to account for scientific uncertainty. The SSC agreed that choosing between these options is a policy decision for the council to make based on its preferred level of risk aversion. At its March and April 2010 meetings, the Council chose the more precautionary application of its 40:10 rule which would calculate the ACL based on uniform reductions from the ABC level, rather than basing the 40:10 rule on a combination of the OFL level and the ABC level. They also decided to include a 25:5 harvest control rule for assessed flatfish species since flatfish are very productive stocks that can be exploited more heavily. For flatfish, the SSC recommended and the Council adopted a target biomass level of

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$B_{25\%}$, based on a variety of factors. The minimum stock size threshold (MSST) for flatfish was then adjusted to $B_{12.5\%}$ ($0.5 B_{msy}$). Given the reduction in target from $B_{40\%}$ to $B_{25\%}$, and the reduction in the MSST from $B_{25\%}$ to $B_{12.5\%}$, the lower end of the control rule was shifted to $B_{5\%}$ based on symmetry.

To avoid being overly prescriptive in its recent groundfish FMP amendment, the Council deferred some of the more specific decisions regarding buffers to account for scientific and management uncertainty to the biennial specification process. While noting that it was difficult to parse out scientific and management uncertainty in the determining harvest specifications, the Council decided to include the ACT as a useful accountability measure under their preliminary preferred alternative for Amendment 23. They deferred a decision on the specification of ACTs for the 2011-12 management cycle until their June 2010 meeting. Both the short-term ACT decisions for 2011-12 and the long-term decision to include the ACT in the Amendment 23 framework are scheduled for final action in June 2010.

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WESTERN PACIFIC REGIONAL FISHERY MANAGEMENT COUNCIL

The Western Pacific Regional Fishery Management Council (WPRFMC) oversees the development and implementation of five fishery ecosystem plans (FEPs) including: pelagics, Hawaii, Commonwealth of the Northern Mariana Islands (CNMI), American Samoa, and the Pacific Remote Island Areas (PRIAs) encompassing precious corals, bottomfish and groundfish, crustaceans and coral reef ecosystems. To comply with the annual catch limit (ACL) and accountability measures (AM) requirements of the reauthorized Magnuson-Stevens Act (MSRA), the Council developed an omnibus amendment to its FEPs. The amendment proposed a risk-based approach to establishing the overfishing limit (OFL), allowable biological catch (ABC), ACL and annual catch target (ACT) values. This approach would establish ACLs *only* for those species not subject to international management with current estimates of maximum sustainable yield (MSY). Establishment of ACLs for the remaining stocks would be prioritized based on their relative risk of overfishing and the Council would defer to the National Marine Fisheries Service (NMFS) to establish suitable maximum sustainable yield (MSY) proxies based on available funding and information. Following a review by NMFS, the draft amendment was sent back to the Council since it failed to include ACLs for all managed stocks. The Council has the remainder of 2010 to update the amendment to comply with the provisions of the MSRA.

Efforts to comply with the statute are confounded by the fact that there is a significant amount of scientific uncertainty associated with council managed stocks. Embedded in estimates of biomass uncertainty are unanswered questions relating to life history characteristics, age structure, spatial distribution, and species' responsiveness to environmental changes. Risk-averse management strategies are not unprecedented in the Western Pacific. In certain instances where there is significant scientific uncertainty, managers have adopted more conservative risk policies. In the case of lobster which have highly variable recruitment regimes, managers established a risk averse probability of overfishing (P*) of 10%. Meanwhile, NMFS imposed a total moratorium on the harvest of gold coral given the uncertainty associated with its age and growth.

Adding to the challenge is the fact that, with the exception of lobster, fish stocks in the western Pacific historically were not managed based on catch limits. Only since 2007 have the bottomfish stocks been managed by setting total allowable catch levels (TACs) based on the risk of overfishing. Bottomfish are managed based on a P* of 50%; however, technical concerns by the Council's SSC and the Western Pacific Stock Assessment Review Panel (WPSAR) prevented the SSC from establishing an OFL or ABC based on the most recent stock assessment. Instead, the SSC selected the 25th percentile of the catch of the bottomfish management unit and the "deep seven complex"¹ and recommended a precautionary ACL. Based on a WPSAR report presented orally to the Scientific and Statistical Committee (SSC) in July 2009 and officially to the Council in October 2009, the SSC recommended an ABC of 254,054 lbs for the "deep seven" species in the complex for the fishing season 2009-2010, which is the 25th percentile point for the years (1982-2006). The Council adopted this recommendation as a TAC in October 2009. There is an estimated 40% risk of overfishing Opakapaka and Onaga with this TAC in the Main Hawaiian Islands (MHI). The SSC also recommended an ACL of 348,334 lbs

¹ *Pristipomoides filamentosus* (Opakapaka), *P. zonatus* (Gindai), *P. seiboldii* (Klaekale), *P. auricilla* (Yellowtail klekale), *Etelis coruscans* (Onaga), *E. carbunculus* (Ehu), *Epinephelus quernus* (Hapuupuu).

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for all the bottomfish species in the complex, which was also adopted by the Council in October 2009 as the TAC. In addition, given that the bottomfish fishery in the Northwestern Hawaiian Islands (NWHI) will be closed in 2011, the SSC recommended that the Main Hawaiian Islands (MHI) bottomfish stock complex no longer be grouped with the bottomfish populations in the NWHI as an archipelagic stock complex.

The AM employed in the MHI bottomfish fishery is a complete closure of the fishery when the catch limit is reached or is projected to be reached. There are no observers in the fishery and catches are self-reported only once a month. Due to this lack of real time catch accounting, for the two seasons since the TAC was in place, the catch limit was exceeded by seven and nine percent respectively. While the closure also impacts the recreational fishery, recreational catch of bottomfish is not included in the TAC, which is managed by the State of Hawaii with area closures, bag limits and other measures. Meanwhile, the bottomfish fisheries in American Samoa, CNMI and Guam are unable to rely on these types of AMs since the current monitoring system does not allow for real-time monitoring of catch relative to the TAC.

In order to maximize yield, minimize impacts to biomass and account for scientific uncertainty, the Council's SSC proposed a default ABC control rule of $0.7 F_{msy}$ for unharvested crustaceans and precious corals with known MSY. Meanwhile, no ACLs or AMs have been calculated for reef fish species. This is due in part to the high number of reef fish species. To make the task of establishing ACLs for each individual species less onerous, the Council plans to identify and group species into stock complexes. There are approximately 20 families that form 99% of the finfish catch.

The Council's SSC recently developed a working group to develop a tier system based on data type and quality in order to derive ABCs and ACLs. The Council will seek SSC advice on risk levels and management uncertainty to be incorporated into ACL calculations. The degree of management uncertainty associated with fisheries is in part a function of the level and effectiveness of monitoring and catch reporting programs. Currently, many fisheries in the Western Pacific, outside Hawaii, are monitored through creel surveys and surveys of fish dealers and fishery cooperatives. Catch estimates are based on raising samples to account for the entire fishery and thus have associated errors around the point estimates. The Council is proposing to institute mandatory catch accounting and reporting requirements for all fisheries in order to minimize this uncertainty.

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CARIBBEAN FISHERY MANAGEMENT COUNCIL

The Caribbean Fishery Management Council (CFMC) is uniquely challenged given the scarcity of data and information regarding stock status. Of the 28 species and species groups managed by the CFMC, less than half have data sufficient to warrant an assessment. Consequently, the region cannot provide overfishing limit (OFL) and allowable biological catch (ABC) estimates and therefore cannot reliably estimate scientific uncertainty or employ a probabilistic approach (P*) for establishing ABCs. Instead, the CFMC's Scientific and Statistical Committee (SSC) recommended a more qualitative approach to dealing with uncertainty and managing risk using recent catch as a proxy and relying on expert judgment to reduce catch levels further based on other estimates of uncertainty. Where OFL and ABC cannot be estimated, the SSC may be able to provide recommendations based on informed judgment regarding potential regulatory modifications that may help end overfishing or facilitate rebuilding.

Using recent catch as a proxy has its own challenges since managers do not have complete estimates of recreational or commercial catch. In the United States Virgin Islands (USVI), there are no estimates of recreational catch. Moreover, commercial catches in the USVI are broken down by family and not by species. Meanwhile, in Puerto Rico, many landings are unclassified. There is also a significant time lag in reporting; the most recent landings data is from 2007. Despite the significant uncertainty, further reductions from recent catch levels are likely to be modest since catches have declined following an earlier amendment that eliminated a gear type and reduced catch levels by an estimated 30%.

In developing an ABC control rule, the CFMC's SSC created eight scenarios that correspond to the availability of data available for a stock or stock complex. Each scenario specifies whether the calculation of an OFL is possible and includes associated management advice. If it is possible to estimate OFL, the SSC may provide ABC recommendations consistent with the control rule approved by the Council. The SSC has only been able to calculate the OFL and ABC for severely depleted stocks/complexes with life history characteristics that make them particularly vulnerable to exploitation. In these cases, the OFL and ABC have been set at zero.

In applying its scenario framework, the SSC focused its attention on the five species classified as experiencing overfishing in the 2005 FMP. Each of the five species was assigned to scenario 7 which meant that the availability and quality of data were not sufficient to calculate OFLs, ABCs and ACLs. As such, the SSC recommended that catch and/or effort for these species be limited to only what is required to collect sufficient data, and participation in the fishery would be dependent on following all data collection protocols. The SSC underscored its recommendation by stating that a precautionary management approach is warranted when a stock is subject to overfishing and there is insufficient information to establish sustainable levels of catch or effort. Rather than a complete closure of the fishery, the SSC recommended the creation of a "scientific fishery" in order to acquire the fishery dependent data necessary to manage the fishery.

Looking ahead, the SSC recommended a precautionary and practical approach to dealing with stocks experiencing overfishing. Specifically, they proposed creating an experimental design for a protocol to collect information needed to conduct stock assessments. Under such a protocol, fishing effort would be limited to the sample size necessary to conduct the assessment and bound by considerations such as

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stock status, the level of uncertainty regarding status and ability to end overfishing and rebuild stock or complex where appropriate. Overall fishing effort would also be constrained according to the level of risk the CFMC deems acceptable.

Absent more reliable data and an improved data collection and monitoring program, some scientists and managers fear that managing Caribbean fisheries via ACLs and accountability measures (AMs) may be ineffective and a deterrent to more accurate reporting. Currently, most landings are self-reported, and there is concern that improved reporting will reveal that the catch limits have been exceeded. Legal requirements notwithstanding, some managers suggest that until there is better assessment information from which to derive ACLs, the more effective and efficient strategy would be to impose input controls such as time/area closures as a means of managing fishing effort.

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GULF OF MEXICO FISHERY MANAGEMENT COUNCIL

The Gulf of Mexico Fishery Management Council (GMFMC) is making incremental progress towards compliance with the annual catch limit (ACL) and accountability measure (AM) requirements. The complexity of this task has resulted in ever-longer timelines for completion of a generic FMP. A draft generic FMP is expected in August 2010, with final adoption in April 2011. The GMFMC formed an ABC Control Rule Working Group, which consisted of Council members, Scientific and Statistical Committee (SSC) members, Council staff, and National Marine Fisheries Service (NMFS) staff to develop a decision making framework to help assess scientific uncertainty and the probability of overfishing (P*).

The working group asked the Council to determine the acceptable levels of risk when establishing ABCs. The Council identified a range of acceptable levels of risk from 45% to 15% that OFL was sustainable. As discussions surrounding the ABC control rule have become more serious, several Council members want to reconsider the bookend approach to acceptable risk, and develop species-specific risk levels instead.

The working group looked at ABC control rule frameworks from other regions and decided to model its approach after that of the South Atlantic, which employs a series of dimensions and tiers to quantify scientific uncertainty and establish appropriate buffers between ABC and OFL. The working group recognized that the framework would need to include different approaches for data rich and data poor species. For data rich species the control rule considers the type of assessment (biomass, proxies, etc.), the within-model uncertainty, past performance of models, and knowledge of environmental covariates. For data poor species, the reliability of catch history and productivity-susceptibility analysis (PSA) analysis will play important roles.

Going forward, the full SSC has requested analyses from the Science Center. The Science Center and the Council staff are negotiating to determine what analyses are possible within the deadlines for the ACL/ACT amendment.

In April, the Council staff presented its first draft of an ACL and annual catch target (ACT) control rule to determine management uncertainty. The draft ACT/ACL control rule, which was presented in the form of a decision table, is only applicable to data-adequate stocks since it requires a stock assessment to produce the inputs. In its current form, the draft control rule specifies that if an ACT is used, then the ACL is set equal to the ABC and the ACT is reduced from the ACL based on the control rule. If the ACT is not used, then the ACL is reduced from the ABC based on the control rule. In advance of its next meeting in June, the Council asked their staff to revise this first draft after consulting with a working group including members from the SSC, SEP, Southeast Regional Office (SERO), and the Law Enforcement Advisory Panel. They also noted that a data poor control rule should be developed.

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SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL

Like many Councils, the South Atlantic Fishery Management Council (SAFMC) has been occupied addressing overfishing issues and thus is making slow progress in meeting the requirements of the reauthorized Magnuson-Stevens Act (MSRA) to integrate scientific and management uncertainty into annual catch limit (ACL) and accountability measure (AM) determinations. The Council's Scientific and Statistical Committee (SSC) thus far have done most of the work as it attempts to quantify scientific uncertainty and establish a suitable allowable biological catch (ABC) control rule. Meanwhile, less progress has been made towards integrating management uncertainty into ACL calculations since focus has been diverted to dealing with overfishing and overfishing of red snapper in particular. Moreover, managers feel that they lack guidance on how they should account for and incorporate management uncertainty into their management framework. The Council intends to specify ABC control rules in its comprehensive ACL amendment. It will review a draft of the ACL amendment in June, including options for the ABC control rule and consider other necessary items including annual catch targets (ACTs) and AMs.

The SAFMC's SSC developed an ABC control rule, which will be implemented as part of an omnibus ACL amendment in the summer of 2010. General guidance from the Council specified that the allowable range of probabilities of overfishing (P^*) should be 10-50% and that 50% is the highest legal level of risk. The SSC began discussion in 2008 and devoted a meeting in early 2009 to developing a control rule framework. The subsequent control rule framework developed in 2009 is more broadly applicable but is limited to instances where it is possible to estimate statistical uncertainty around the overfishing limit (OFL). Indeed, the values and scale used in the first control rule were selected with P^* distributions in mind, and are not considered appropriate when that is lacking. As such, the SSC decided at its April 2010 meeting to develop an additional control rule for data poor stocks.

The SAFMC's draft control rule is a comprehensive framework that incorporates a series of dimensions and tiers. The SSC identified four dimensions, which reflect the critical characteristics to evaluate, including data and assessment information availability, characterization of uncertainty, stock status, and productivity-susceptibility of the stock. Each dimensions/risk factor is weighted equally since there is no information to justify weighting them differently; however, this may change with new information. The tiers are designed to reflect the level of available information. Within each dimension, the four tiers correspond to downward adjustments to the "base" (or presumed maximum legal risk) P^* occurring of 50%. The sum of all of these adjustments across the four dimensions, called an adjustment factor, results in a "critical" probability, which is used to determine ABC. Projection tables that provide ACLs that correspond with particular P^* values between 10 and 50% will be developed by scientists at the Southeast Fisheries Science Center (SEFSC) and other technical sources. The SSC will then select the ABC from the table based on the preferred P^* . One of the goals of the control rule is that it should result in objective adjustments to the base probability of overfishing.

The National Standard 1 guidelines also provide that a control rule may include a "depletion threshold," or a point at which targeted fishing would not be allowed. Similar to the "40:10" policy employed by the Pacific Council, the South Atlantic's SSC recommended setting a depletion threshold at 10% of unfished biomass.

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While the SSC has developed a formula to determine appropriate levels of risk, it has not developed risk policy alternatives for Council consideration. The SSC notes that the probability of overfishing can also be looked at as the probability of a stock rebuilding in the case of overfished stocks. The control rule framework of dimensions and tiers makes it possible to look ahead and determine the probability of overfishing that will be considered acceptable if one factor changes, for example if a stock rebuilds from an overfished condition.

The SSC recognizes that parts of this framework may be adjusted in the future with experience and advances in science, as well as insight from the experiences of other SSCs and councils. Still, challenges remain since most stocks are data poor and do not have stock assessments so a control rule based on P^* is not appropriate. Instead, managers are considering multi-species ACLs (i.e., snapper grouper complex) since it is not practicable to establish 72 individual ACLs and AMs for each managed species. Moreover, some claim that many of these species are indistinguishable from one another. The Gulf of Mexico has done some multi-species groupings (i.e., shallow and deep water grouper), but the South Atlantic has done less in part because of hesitation by the SSC which is concerned about the various uncertainties and imperfections associated with multi-species ACLs.

To date, most of the focus in the South Atlantic has been on dealing with scientific uncertainty, and very little has been done to quantify or integrate management uncertainty into the ACL/AM process. There have been some discussions but the topic is politically charged in the South Atlantic, given the high level of management uncertainty in the recreational sector. Potential reductions in recreational catch to account for management uncertainty tread into the data quality realm and the general dissatisfaction with the Marine Recreational Fisheries Statistics Survey (MRFSS) and now Marine Recreational Information Program (MRIP) programs for recreational catch accounting. It also brings up issues of inter-sector allocation and equity, which have yet to be resolved.

MID-ATLANTIC FISHERY MANAGEMENT COUNCIL

The Mid-Atlantic Fishery Management Council (MAFMC) oversees the management of six Fishery Management Plans (FMPs) that regulate 13 managed species. The Council is in the process of developing an omnibus amendment to address the annual catch limits (ACLs) and accountability measures (AM) requirement of the reauthorized Magnuson-Stevens Act (MSRA). In February 2010, the Council reviewed its Scientific and Statistical Committee's (SSC) draft control rule and voted to accept a range of risk alternatives for the Public Hearing Document at its April 2010 Council meeting.

To comply with the requirement to establish ACLs, the SSC is developing an allowable biological catch (ABC) control rule that incorporates scientific uncertainty into catch level recommendations. The Council's SSC defines scientific uncertainty as: "[u]ncertainty, which results from limited knowledge, is the inability to know exactly the current state of the stock, its past and future dynamics, and the effects of management actions on the stock." To identify and account for scientific uncertainty, the SSC focuses almost exclusively on the stock assessment process and pinpoints data collection, parameter and reference point estimation and forecasting as key steps in the process which contribute to an assessment's overall level of scientific uncertainty.

The Council's SSC proposed a draft ABC control rule which employs a tiered approach to characterizing stock assessment quality and associated levels of scientific uncertainty. The approach uses four tiers defined by five characteristics at each level. The specific methods for deriving an ABC based on the tier system have yet to be developed; however the SSC notes that the preferred methods would be easy to apply and understand and could be developed from multiple assessment models. The SSC also recommended that the tier method not penalize improved information by the stock assessments; however, the Council raised concerns about the potential for double penalties if there is a downgrade in the level of information available.

- Level 1: Level 1 of the tier system represents an "ideal assessment" whereby the stock assessment lacks bias and incorporates uncertainty in the precision of estimates. Where an assessment is classified as level 1, the ABC is determined based on the distribution of the overfishing limit (OFL) and the acceptable probability of overfishing (P*) which is a policy decision made by the Council.
- Level 2: Level 2 of the tier system represents a "preferred assessment" which has minimal bias but where precision is likely underestimated. As with the level 1, level 2 uses the P* method based on the Council's preferred risk policy to determine ABC values. Unlike level 1, level 2 uses a proxy for OFL distribution; however, the method for determining the OFL proxy has not yet been decided.
- Level 3: Level 3 of the tier system represents an "acceptable assessment." Level 3 assessments do not thoroughly incorporate uncertainty and may provide inaccurate and imprecise estimates. Similar to level 2, the ABC for level 3 assessments will be determined based on the council's risk policy and an OFL distribution proxy.
- Level 4: Level 4 of the tier system represents an "unreliable assessment" and assessments typically have reliable information regarding trends in abundance but lack information regarding absolute abundance, fishing mortality rates, and reference points. To derive an ABC from assessments classified as level 4, a simple control rule based on catch history and biomass

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trends will be employed.

Contrary to the assumption by many that most of the species managed by the MAFMC would be classified as level 2 or 3, the SSC noted that most species are level 4 and only a few would be classified as level 2 or 3.

The MAFMC regards its risk policy as way to specify the Council's tolerance for overfishing and the determination of P^* is a policy decision to be made by the Council and informed by the SSC. Risk policy is seen as part of the control rule but not the control rule itself. The alternatives for different levels of acceptable risk are described as "risk policy alternatives" and not ABC control rule alternatives. The risk policy alternatives apply to all stocks managed by the MAFMC.

In addition to the risk policy alternatives outlined in the discussion document approved by the Council at its April 2010 meeting, the Council specified that the upper limit for P^* for stocks under rebuilding plans would be 50% unless modified to a lesser value via a rebuilding plan amendment. Furthermore, if no overfishing definition is available for a stock and no overfishing limit is specified, then a cap on allowable increases in catch levels will be established and catch levels may not be increased until an appropriate F_{msy} or F_{msy} proxy has been identified.

The risk policy alternatives fall into categories of increasing complexity that range from a constant P^* to more elaborate matrices that include multiple risk factors. The two options identified as preferred staff alternatives would reflect stock assessment level/tier (ideal, preferable, acceptable and highly uncertain). One option would also include stock status relative to target biomass (B/B_{msy}). The other preferred option would include two additional factors: stock history (whether or not the stock has ever been overfished and life history pattern (typical or atypical). The latter framework is unusual in considering stock history instead of current stock status. It also may present some challenges since historically, the creation of an FMP was prompted by overfishing and/or an overfished status. Until the Magnuson-Stevens Act, there was no need or trigger for an FMP for healthy stocks. The rationale given by staff is that a stock which has previously been overfished, even if it has been rebuilt, may be more vulnerable to overfishing. Life history characteristics are also incorporated into the model in a unique way. Whereas other councils have used the productivity-susceptibility analysis (PSA) to characterize stocks as high, medium or low risk, the MAFMC's approach is to categorize stocks as having typical or atypical life histories. The range of acceptable risk is 14-50% for the first staff preferred alternative and 10-50% for the second. ABC could in theory be set equal to OFL, so neither staff preferred option is more precautionary than what is required by law.

The risk policy options also include an add-on for data poor stocks. In a situation where it is not possible to estimate F , this addition to the risk policy would specify that catch levels should not be increased until F or a proxy can be identified. This tiered approach has been criticized by some as too detailed in light of the limited data that would be available for data poor stocks.

As far as accounting for management uncertainty, the MAFMC is considering two types of AMs: proactive and reactive. Proactive AMs which may include establishment of annual catch targets (ACTs), adjustment of possession limits, closure of directed fisheries, and/or modification of measures to slow landing rates are intended to prevent the ACL from being exceeded. Reactive AMs, on the

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other hand, which may include modification of subsequent year trip or possession, limits, reduction in landing levels in the subsequent year, adjustments to transfer amounts or other automatic reactive adjustments, are in response to an ACL overage and are designed to mitigate the impacts of that overage and/or prevent it from occurring in the subsequent year. ACTs, a type of proactive AM, are proposed for a number of Mid-Atlantic fisheries to account for management uncertainty.

Given the high level of inter and intra-annual variability in the sources of management uncertainty, practical considerations, and the need for flexibility, the Council proposed delegating authority to the individual species monitoring committees to develop the ACT control rules. In the case of Atlantic surfclam and ocean quahog, which lack monitoring committees, Council staff would develop an ACT control rule. The Council reasoned that the committees and staff have the greatest knowledge of each fishery and the variable circumstances that could give rise to different levels of management uncertainty from year to year. The discussion document further specifies that the staff and species monitoring committees should recommend a percentage by which the ACL should be reduced to account for management uncertainty and that the ACT should have at least a 50% probability of not exceeding the ACL.

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NEW ENGLAND FISHERY MANAGEMENT COUNCIL

The New England Fishery Management Council (NEFMC) and its Scientific and Statistical Committee (SSC) have made headway in complying annual catch limit (ACL) requirements of the reauthorized Magnuson Act and (MSRA) and incremental progress in a developing a risk policy as recommended by the National Standard 1 guidelines.

Most of the efforts to date have been focused on estimating and incorporating scientific uncertainty into the SSC's recommendations for allowable biological catch (ABC). The SSC characterizes scientific uncertainty in terms projected catch. Methods for determining ABCs for New England stocks range from probabilistic approaches for informative stock assessments to data-poor approaches that rely on recent catch history. ABC recommendations by the NEFMC's SSC should be derived from an ABC control rule, which incorporates estimates of scientific uncertainty as well as an appropriate consideration of risk, as determined by the Council. While the NEFMC has adopted the levels of uncertainty included in the SSC's ABC recommendations, they have not provided the SSC with guidance regarding acceptable levels of risk. Over the next six months, the SSC expects to develop a more integrated and comprehensive approach to ABC control rules, and in consultation with the Council, provide options for incorporating the Council's risk preferences into ABC recommendations. In the interim, the Council and its SSC have employed an ad hoc approach to comply with the statutory deadline for establishing ACLs.

The Council and its SSC have not adopted a probabilistic approach across the board due to limited evaluation of uncertainty from many stock assessments. Of the stocks managed by the NEFMC, two may be classified as data rich (groundfish and scallops), three may be classified as data poor (skates, whiting, and red crab) and two are in between (herring and monkfish).

In the case of the groundfish complex, a comparatively data rich but diverse fishery composed of 14 species and 20 stocks, the SSC concluded that the uncertainty in projections is essentially unknown. Absent better information, they recommended that a simple ABC control rule be applied to all species in the complex. The control rule recommended by the SSC requires that the ABC be set at $75\% F_{msy}$ or the mortality rate associated with rebuilding by the target rebuilding date ($F_{rebuild}$), whichever is less. This is consistent with the Council's existing policy that optimum yield (OY) be set at $75\% F_{msy}$ for species in the groundfish complex. An additional justification for $75\%F_{msy}$ as the basis for ABC is that many groundfish stocks are behind schedule for rebuilding objectives, and if a stock is not rebuilt by the target date, the National Standard 1 guidelines require ABC is based on $75\%F_{msy}$. While consistent with current council policy and the guidelines, this constant buffer strategy does not correlate to a constant probability of overfishing (P^*), and there are no upper or lower bounds on P^* .

While the scallop fishery is relatively data rich, the probability of overfishing and projected loss in yield associated with higher F rates led the SSC to endorse a risk-based approach to establishing ABCs. The SSC provided expected catch at alternative risk levels (20%-30%) to initiate a dialog with the Council on their desired risk tolerance. Supporting the proposal by the Scallop Plan Development Team, the SSC ultimately recommended that the ABC be based on a $25\% P^*$.

For Atlantic sea herring and deep sea red crab, interim ABCs are based on limited or unreliable

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information and do not consider acceptable levels of risk. In the case of herring, the SSC had little confidence in the stock assessment, because it did not provide a consistent basis for management advice. As such, they opted to base the interim ABC on average catch in recent years. Likewise, for data poor deep-sea red crab stocks, the interim ABC was based on long-term average landings. While there had been no clear discussions between the SSC and the Council regarding risk preferences and no agreed upon ABC control rules, the Council recently requested that the SSC reconsider its ABC recommendations for both herring and crab due to concerns that they were too conservative.

Meanwhile, the Council and its SSC employed a default method for determining interim ABCs for data poor stocks of skates and monkfish. ABC for skates was based on the most recent survey estimate of stock biomass and the median of historical exploitation rates. ABC for skates and monkfish are not directly associated with OFLs and are not a function of scientific uncertainty. In lieu of reliable estimates of OFL and associated uncertainty, interim ABCs for skates and monkfish are based on inferences of sustainable exploitation rates. Nevertheless, the SSC maintains that the reductions from the OFL are consistent with data poor situations.

Going forward, the NEFMC and its SSC plans to address ABC control rules more comprehensively to ensure greater consistency and articulate a more transparent and clear risk policy for NEFMC-managed species. Specifying the preferred level of risk is the NEFMC's responsibility; however, there is little understanding of the potential implications associated with different levels of risk. As such, the SSC will be taking the initiative and, in consultation with the NEFMC, will analyze and present options and recommendations for ABC control rules for further consideration.

The Council's committees and plan teams plan to consider management uncertainty via the setting of annual catch targets (ACTs) or the establishment of accountability measures.

RESOURCES

Personal Communications

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