Report of a National SSC Workshop on Establishing a Scientific Basis for Annual Catch Limits

St. Thomas, USVI – November 10-13, 2009

This document should be cited as:
Witherell, D. (editor). 2010. Second National Meeting of the Regional Fishery Management Councils' Scientific and Statistical Committees. Report of a National SSC Workshop on Establishing a Scientific Basis for Annual Catch Limits. Caribbean Fishery Management Council, St. Thomas, November 10-13, 2009.

Acknowledgements: This report was based on written synopsis of the presentations given by SSC members and staff. Discussions were captured and summarized by rapporteurs Rich Seagraves, John Carmichael, Pat Fiorelli, Chris Kellogg, Dave Witherell, Rick Leard, and Bob Skillman. The report benefitted from review comments made by Pat Fiorelli, Rick Methot, Mark Millikin, Bill Michaels, Deb Lambert, Wes Patrick, David Tomberlin, Pat Livingston, and Doug Gregory.

Cover photo: A queen angelfish (*Holocanthus ciliaris*) swims over a coral reef off the U.S. Virgin Islands. Queen angelfish are one of the most brightly colored marine fish in the world, and are commercially harvested for the aquarium industry. They are distributed throughout the Caribbean, inhabiting coral reefs in shallow waters down to about 200 feet, feeding on a variety of invertebrates, particularly sponges. Similar to the cleaner wrasse, juvenile queen angelfish have been known to set up cleaning stations on the reef, where larger fish gather to have parasites picked off their bodies. Adults are solitary or found in pairs, growing up to 18 inches long with a maximum lifespan of 15 years. The Caribbean Fishery Management Council provides conservation for this species within the Reef Fish FMP. Photo copyright Larry Lipsky; used with permission.

Printed in the United States of America.
Produced by the Caribbean Fishery Management Councils under NOAA Award # FNA05NMF4410002

Second National Meeting of the Regional Fishery Management Councils' Scientific and Statistical Committees

Hosted by the
Caribbean Fishery Management Council
November 10-13, 2009

Report of a National SSC Workshop on Establishing a Scientific Basis for Annual Catch Limits

David Witherell, Editor

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Executive Summary

In 2006, the Magnuson-Stevens Act (MSA) was revised to require that each regional fishery management council's Scientific and Statistical Committee (SSC) provide its Council ongoing scientific advice for fishery management decisions, including recommendations for acceptable biological catch (ABC), and other advice regarding fisheries sustainability. In 2008, the Western Pacific Regional Fishery Management Council (WPFMC) hosted the first national SSC workshop.

In 2009, the Councils decided to fund a second workshop to discuss technical aspects of establishing scientifically-based annual catch limits. The workshop was hosted by the Caribbean Fishery Management Council (CFMC), and held in St. Thomas, USVI. The workshop provided an opportunity for representatives from the eight regional council SSCs to compare notes and best practices. Presentations are available on the regional fishery management councils' website: www.fisherycouncils.org.

The workshop revealed that there are many different approaches to meeting the National Standard 2 guidelines relative to incorporating scientific uncertainty into the setting of annual catch limits. Where feasible, SSCs are considering the P* approach, which uses quantified scientific uncertainty to set ABC at a level to match a pre-specified probability of overfishing. Variations include: the methods used to calculate scientific uncertainty, tiered approaches linked to the quality of information about uncertainty, inclusion of stock productivity scores in the risk calculation, and fixed buffers where uncertainty is not fully quantified.

- The North Pacific Council is planning to use their existing tier system for groundfish, develop a probabilistic (P*) approach to set a buffer below OFL for crabs, and use a fixed buffer for scallops.
- The Pacific Council is developing a P* approach that will incorporate integrated sources of uncertainty to setting buffers below OFL.
- The Western Pacific Council is planning to set ABCs based on lowering exploitation rates for pelagic fishes, catch amounts for bottom fishes and precious corals, and fixed buffers for crustaceans and coral reef species based on trends.
- The New England Council is developing a P* approach for scallop stocks, fixed buffers or rebuilding rates for most groundfish, and reduced catch/exploitation rates for data poor stocks.
- The Mid-Atlantic Council is developing a tiered approach for setting ABCs based on assessment quality, with a P* approach for stocks with reliable assessments and adjustments based on biomass trend for other stocks.
- The South Atlantic SSC has developed tiers and dimensions (assessment information, uncertainty level, stock status, productivity and susceptibility) to establish a control rule framework for ABC determinations.
- The Gulf of Mexico Council is developing an approach that generally mirrors the South Atlantic.
- The Caribbean SSC is evaluating ways to use available data to provide advice on catch limits and management measures to control catch.

The different approaches reflect how each council, SSC, and NMFS regions have interpreted the guidelines and worked towards different approaches based on availability and frequency of stock assessments, as well as differences in data availability across the regions. As with the first workshop, sharing experiences and examples provided participants food for thought on possible ways to address ACL

determinations and other challenges faced by SSCs.

Participants came to a general understanding about the SSC's role in determining "best scientific information available (BSIA)". It is the SSC's job to provide advice on what represents BSIA to the council. The Council then makes recommendations on management actions to the Secretary of Commerce through the NMFS Regional Offices, who rely upon the NMFS Science Centers for BSIA determinations. The Science Centers rely upon the recommendations of the SSC and peer review panels in making a determination.

Participants discussed the role of the SSCs in the stock assessment peer review process. The SSC's role to provide fishing level recommendations (including ABCs) is distinctly different than the technical peer review role of critiquing and evaluating the scientific rigor of an assessment. The technical peer review should occur early enough in the process to inform the SSC when they make fishing level recommendations. There should be a sequential process from the development of an assessment to final recommendation of ACLs by an SSC, moving away from the details and winnowing down to allow the SSC to make a final determination.

Not all SSCs receive SAFE reports, despite the longstanding requirement that SAFEs be prepared. Participants felt that the SAFE reports can be very useful to the public and Council, as well as the SSC. In addition to providing a single document containing scientific stock assessment information for establishing ACLs, the SAFE reports can improve the public understanding and transparency of the ACL decision process. Stronger language is needed in the NS2 guidelines to ensure that the SAFE reports are prepared.

There was general agreement that the development of a risk policy for establishing ACLs is a management (Council) responsibility, informed by science. For example, scientific information that could be useful to the Council in evaluating risk policy options could include projections of future yield, changes in stock abundance, and the costs and benefits of using different levels of P*. The development of ABC control rules should be a joint management and scientific process. In addition, the SSCs may need to exercise professional judgment so some flexibility must be available to the SSCs in the application of ABC control rules.

Participants agreed to form an ad-hoc working group to prepare a white paper exploring possibilities for establishing ABCs in situations when only catch data are available. It was clear that there is no 'one size fits all" solution for addressing data limited situations. Jim Berkson volunteered to lead that group.

Participants felt strongly that it was critical to have another workshop next year. The SSCs now have a very large responsibility to establish ABCs, and many of the methods and control rules are still in the development and testing phases. The diversity of approaches to quantifying scientific uncertainty reflects that this is a new field for fisheries, which requires refinement of approaches over time, and SSC Workshops offer a very efficient way to develop and refine best practices for these technical issues. Topics suggested for the next SSC Workshop included:

- Comparison of technical peer review processes;
- Uncertainty calculation approaches in OFL;
- What is the role of SSC in determination of management uncertainty;
- Ecosystem based management approaches;
- Reviewing NS2 Guidelines;
- Best practices for ACL control rules;
- Best practices of scientific review processes and analytical evaluations.

Participants agreed that in addition to SSC Workshops, further information exchange across councils could be enhanced by sending an SSC member to sit in on other Council SSC meetings on occasion, distributing reports among the SSC chairs, and other coordination where practicable.

Preface

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) requires that each regional fishery management council maintain and utilize its Scientific and Statistical Committee (SSC) to assist in the development, collection, evaluation, and peer review of information relevant to the development and amendment of fishery management plans. The MSA also mandates that 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. Some SSCs have a long history of providing recommendations on catch limits and providing peer review of analytical documents for FMP/regulatory amendments; for other SSCs this is a new requirement.

The Managing Our Nations Fisheries II conference held in 2005, recommended that national SSC meetings be held so that members from different regions could discuss best practices and seek to identify analytical and research needs. In 2008, given the new requirements of MSA and the proposed guidelines for annual catch limits (ACLs), NMFS provided funding to the Western Pacific Regional Fishery Management Council to host a national SSC workshop (Witherell and Dalzell 2009). In 2009, the Councils decided to fund a second workshop to discuss technical aspects of establishing scientifically based ACLs.

This workshop was organized and coordinated by staff from the regional councils, lead by Miguel Rolon and Diana Martino of the CFMC and Dave Witherell of the NPFMC. CFMC staff (Miguel Rolon, Diana Martino, Natalia Perdomo, Maria de los A. Irizarry, Livia Montalvo, and Iris Oliveras) provided logistical and technical support, and Maria Shawback (NPFMC) maintained the website with SSC Workshop materials. CFMC SSC Chair Barbara Kojis served as the meeting chair, and held the discussions to a tight agenda schedule.

An evening reception hosted by USVI Governor John P. deJongh, provided participants an opportunity to mingle and further discuss ideas for SSC input in development of ACL recommendations. In his welcoming remarks, the Governor impressed everyone in attendance with his knowledge of fisheries management, the role of the SSCs, and his grasp of the challenges facing Councils in developing and implementing ACLs.

This report was based on written synopsis of the presentations given by SSC members and staff. Discussions of the group were captured and summarized by regional council staff rapporteurs (Rich Seagraves, MAFMC; John Carmichael, SAFMC; Pat Fiorelli and Chris Kellogg, NEFMC; Dave Witherell, NPFMC; Rick Leard, GMFMC; and Bob Skillman from the WPFMC SSC). Dave Witherell edited and formatted the submissions for consistency and assembled the workshop report. Photos of the meeting and the Governor's reception were provided courtesy of Lee Anderson and Natalia Perdomo.

Welcoming Remarks

On behalf of the CFMC and the CFMC SSC, Chair Barbara Kojis welcomed everyone to the workshop and to St Thomas. She reviewed the agenda which focused on development of ACLs using the best scientific information available. A copy of the agenda is attached as Appendix 1, and a list of participants is attached as Appendix 2.

Ms. Beulah Dalmida-Smith, the Director of the Division of Fish and Wildlife of the USVI, provided welcoming remarks on behalf of the Governor of USVI John deJongh. She was pleased that the meeting was being held in St Thomas, and encouraged everyone to enjoy their stay. Ms. Delmida-Smith stressed the important role of the SSCs, particularly with the new MSA requirements and the responsibility associated with setting scientifically based catch limits. She hoped that the group could provide advice with regards to setting ACLs in the USVI where data are limited.

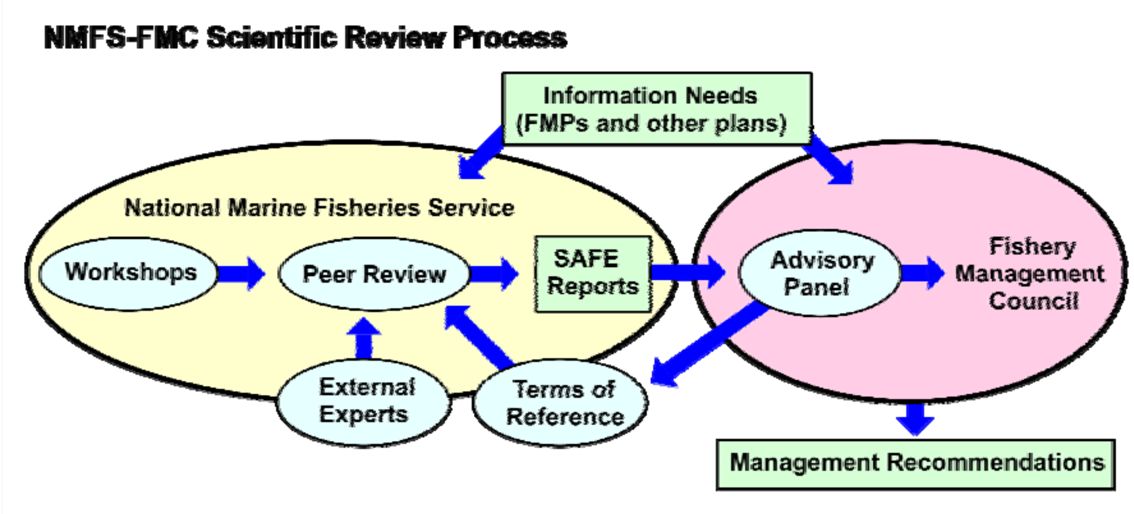
National Standard 2: Best Scientific Information and Role of SSC

NS2 Guidelines

Bill Michaels (NMFS) provided a report on the status of the National Standard 2 guidelines. The Magnuson-Stevens Fishery Conservation and Management Act (MSA) section 301 (a)(2) specifies that conservation and management measures shall be based upon the best scientific information available. Scientific information collected and analyzed by the National Marine Fisheries Service (NMFS) undergoes a review process that includes a series of internal workshops and reviews, a peer review involving external expertise, and evaluation by the advisory body of the Fishery Management Council (Council). The MSA § 302(g)(1)(E) states the Secretary and each Council may establish a peer review process for that Council for scientific information used to advise the Council about the conservation and management of the fishery. The NMFS and Council have developed peer review processes for their regions. In addition to the NMFS-Council partnership in the review of scientific information, the use of external experts (e.g., Center for Independent Experts) in peer review strengthens the reliability and credibility of the scientific information. It is important to understand that each step of the scientific review process is integral to the determination of best scientific information available (BSIA) for fisheries management which involves an iterative process in the improvement of scientific information.

The Council's advisory body is the Scientific and Statistical Committee (SSC) that provides its Council ongoing scientific advice for fishery management decisions as specified in MSA § 302 (g)(1)(B). Each council shall establish, maintain, and appoint the members of a SSC to assist it in the development, collection, evaluation, and peer review of scientific information under MSA § 302 (g)(1)(A). The reauthorization of MSA increases the SSC responsibilities in the review of scientific information, and this is one of the reasons why NMFS proposes to revise the National Standard 2 (NS2) guidelines for scientific information.

The guidelines for NS2 were last revised through a final rule published on May 1, 1998 (63 FR 24233) to bring them into conformance with revisions to the MSA, as amended in 1996 by the Sustainable Fisheries Act. Guidelines for NS2 are codified in 50 CFR § 600.315. To address new requirements for scientific information in the reauthorized MSA, NMFS published an advance notice of proposed rulemaking (ANPR) in the Federal Register (73 FR 54132, September 18, 2008) to propose revisions to the NS2 guidelines. NMFS received ANPR comments from 23 organizations on a variety of topics directly



related to BSIA, peer review, role of the SSCs in peer review, SAFE reports, as well as comments on other fisheries science and management topics. The ANPR comments are available at the public website www.regulations.gov by searching on Docket No. 0808041047-81182-01 or RIN 0648-AW62. During the ANPR comment period, last year's National SSC Workshop on best practices for the SSCs discussed many of the same issues on the need for national consistency in the SSC's role in the review of scientific information, participation in peer reviews, and BSIA determination.

A NS2 work group consisting of 18 members drafted the NS2 proposed rule with careful consideration of the ANPR comments. NS2 work group membership represented each region with various scientific disciplines for fisheries management, and six of the members currently serve as SSC members.

Bill Michaels (HQ), Chair	Peter Fricke (HG F/SF)
Clarence Porch (SEFSC)	ThomasGleason(HQ/GC)
Ron Felthoven (AFSC)	Heidi Lovett (HQ)
James Weinberg (NEFSC)	George Darcy (NERO)
Erik Williams (SEFSC)*	Jim Berkson (SEFSC)*
Ramon Conser (SWFSC)*	Rick Methot (HQ F/ST)
Elizabeth Clarke (NWFSC)	Stacey Miller (NWFSC)
Pat Livingston (AFSC)*	Martin Dorn (AFSC)*
Gerard DiNardo (PIFSC)	Stewart Allen (PIFSC)*

* indicates current SSC membership

The intent of revising NS2 guidelines is to facilitate compliance with requirements of the MSA and to provide quality standards for the collection and provision of biological, ecological, economic, and sociological information to fishery managers, Councils, and the public, while recognizing regional differences in fisheries and their management. This action will provide guidance on the (1) use of BSIA for fisheries management; (2) scientific peer review processes to ensure the reliability, credibility, and integrity of the scientific information used in fishery conservation and management measures; (3) the role of the SSC to the Council with the review of scientific information and participation in the peer review process; and (4) content and purpose of the Stock Assessment and Fishery Evaluation (SAFE) Report and related documents. This morning's presentation will be divided into these four sections with pertinent discussions to identify important questions regarding the

SSC's role in the review of scientific information. The NS2 proposed rule will be published in the Federal Register on December 11, 2009. Since a public comment period for the NS2 proposed rule will be open for three months, this presentation provides only the concept of the NS2 proposed rule. It is recommended that the NS2 proposed rule should be reviewed and comments be formally submitted through the public submission procedures.

Best Scientific Information Available (BSIA)

In 2004, the National Research Council (NRC) of the National Academies published a report entitled "Improving the Use of the 'Best Scientific Information Available' Standard in Fisheries Management" (http://books.nap.edu/openbook.php). The NRC (2004) report provided principles on the application of the BSIA standard in the development of fishery conservation and management measures. The NRC recommended approaches for a more uniform application of the BSIA standard for current and future fishery management actions, and recommended against a static definition of BSIA because of the dynamic nature inherent in the development and improvements in scientific information. As suggested by many of the ANPR comments, the NS2 proposed rule should include the NRC recommendations on the principles of BSIA and should avoid an overly prescriptive definition of BSIA due to the dynamic nature of science.

> *"What is best scientific information available is not a hard line, but it's based upon science principles and it's not just picking numbers. It's assigning a value to a concept that involves your best judgment as to what would work in the situation. That is not being arbitrary by any means."*
>
> **Rick Methot**

A brief outline of the NS2 proposed rule was presented that highlights what constitutes BSIA and its principles. Fishery conservation and management require high quality and timely biological, ecological, economic and sociological scientific information for evaluating the impact that conservation and management measures will have on living marine resources, essential fish habitat (EFH), marine ecosystems, fisheries participants, fishing communities, and the nation. Scientific information should include an evaluation of its uncertainty and identify gaps in the information. The limitations in scientific information may not be used as a justification for delaying fishery management actions, and information from data-poor fisheries may require use of simpler assessment methods and greater use of proxies. Scientific information includes, but is not limited to factual input, data, models, analyses, technical information, or scientific assessments. Although it is desirable to establish procedural standards and principles in the determination of BSIA, a statutory definition should be avoided because the development of science information is an evolutionary process with incremental increases in knowledge. In other words, results valid today may be outdated later, and management should not be overly sensitive to new results that may not withstand the tests of time. BSIA should include a clear statement of objectives; provide a conceptual framework for the interpretation of results; make predictions or test hypotheses; a study design with standardized methods of collecting data, documentation of methods, results, and conclusions; include peer review when appropriate, and communicate of findings. Principles for evaluating BSIA are based on

(1) Relevance. Scientific information should be relevant to the current questions.

(2) Inclusiveness. Scientific information should consider the relevant range of scientific disciplines and diversity of scientific perspectives to include alternative points of view, including relevant local and traditional knowledge.

(3) Objectivity. Scientific information should use standards for objectivity that ensure scientific information is clear, accurate, reliable, and balanced in perspectives to prevent non-scientific or biased considerations from impacting on scientific integrity.

(3) Transparency and openness. Scientific information must be publicly transparent, providing broad public and stakeholder access to the scientific process and products, including data collection and analytical methodology, modeling assumptions, sources of uncertainty or statistical error, and acknowledge gaps in scientific information.

(4) Timeliness. Sufficient time should be allotted for the development of scientific information, including relevant historical data, to ensure its reliability and minimize information gaps. Late submission of scientific information to the Council process should be avoided if the information has circumvented the review process. Management decisions should not be delayed due to data limitations.

(5) Verification and validation. Methods used to produce scientific information should be verified and validated to the extent possible. Verification means that data and procedures are documented to allow reproduction of the analysis by others with an acceptable degree of precision.

Validation refers to testing of methods to ensure the intended performance of analytical methodology, including adequate precision of estimates, unbiased model estimates, robust estimates to model assumptions, and simulation for evaluation of estimates and management strategies.

(6) Peer review. Peer review is an organized method of review and evaluation using appropriate, objective, and relevant expertise to ensure the high quality, credibility, and reliability of the scientific information.

Q & A

It was asked whether the NS2 guidelines will include criteria for judging or evaluating stock assessments. One concern is that different reviewers apply different criteria and not all reviewers understand the consequences of rejected assessments. The response was that the guidelines will address this issue to some extent, but will not be overly prescriptive with criteria. It was suggested that Terms of Reference for assessment reviews address the consequences of rejected assessments and include provisions to require reviewers to provide guidance for dealing with rejected portions. This is particularly important for data poor assessments where there is a high likelihood of rejection of some components.

The question was raised "whose role is it to determine BSIA, the SSC or the Science Centers?" There is no simple answer for all circumstances, as it is actually a process of multiple levels involving both the Councils and the Agency. The SSC provides advice on what represents BSIA to the Council. The Council then makes recommendations on management actions to the Secretary through the Regional Offices, who rely upon the Science Centers for BSIA determinations. The Science Centers, in turn, principally rely upon the recommendations of peer review panels and SSCs in making determinations.

There is concern that NS2 guidelines continue to address BSIA in general terms. While this may be consistent with the NRC report which advises against highly prescriptive definitions, it creates a lack of clarity at the SSC level on critical components such as conflicts of interest, dealing with uncertain analyses, and ensuring consistent application of scientific standards. Applying the general principles to a range of example situations was suggested as a means to provide useful guidance to the SSCs without necessarily resulting in precedent-setting action on particular issues.

It was noted that it would be helpful if the guidelines clarified who is responsible for making determinations of BSIA for the Councils – for assessments, FMPs and amendments, and other analyses, and what criteria should be applied to determine BSIA.

It was suggested that the NS2 guidelines acknowledge the differences in BSIA determinations between models and analyses, the actual data inputs, and the resultant scientific advice. It is possible that the models and analyses represent BSIA, but problems with input datasets hinder use and evaluation of outputs.

Peer Review Standards

The NS2 proposed rule adopts peer review standards from the Office of Management and Budget (OMB) Final Information Quality Bulletin for Peer Review (70 FR 2664, January 14, 2005) as issued pursuant to OMB's authority under the Information Quality Act (Public Law 106-554, Section 515). The OMB peer review standards are required for the review of "influential scientific information" disseminated or relied upon by federal agencies.

In addition to MSA § 302(g)(1)(E) that states the Secretary and each Council may establish a peer review process, the NS2 proposed rule specifies that the Secretary and Council have discretion to determine the appropriate peer review process for a specific information product. The intent of the NS2 proposed rule is to establish national standards while maintaining the necessary flexibility for the existing regional peer review processes established by the NMFS and Councils. Examples of regional peer review processes include the Stock Assessment Review Committee (SARC), Southeast Data Assessment Review (SEDAR), Stock Assessment Review (STAR), NPFMC Plan Teams, and Western Pacific Stock Assessment Review (WPSAR). These existing NMFS/Council

> *"The SSC's role is to advise the council on what is the best scientific information available. If the council decides to act on the basis of its SSC's advice and if the Secretary of Commerce has some disagreement or has some question about scientific information, they, of course, are going to be talking to their regional office and the science centers in their region about that. For the purpose of advising the councils, the SSC is the one that determines BSIA."*
>
> **Pat Livingston**

"I think everybody has a conflict of interest to some extent. If you work for an agency and that agency, be it the state or federal government, has a policy, there is an inherent conflict of interest. I think transparency is something we probably should focus on more than conflict of interest."

Doug Gregory

"A statement I often hear is, we need independence in the peer review process, but we need regional expertise too. When you establish a panel for a peer review, you can balance bias and perspectives to obtain the best scientific information in an objective way."

Bill Michaels

peer review processes may qualify as 302(g)(1)(E) peer review processes, but the Secretary, in conjunction with the relevant Councils, has not yet made that determination. If such a determination is made, peer review processes established under MSA § 302(g)(1)(E) should be announced in the Federal Register with a description of the process. A peer review process is not a substitute for an SSC and should work in conjunction with the SSC (see § 600.310(b)(2)(v)(C)).

Transparency of the peer review process and reports is required, and should be publicly available on the Councils' websites and updated as necessary. The peer review may take many forms, including a written letter or panel review. The selection of the peer review should consider the scope and nature of the scientific information, the timing of the review, and whether the information has previously undergone rigorous peer review. The peer review should be conducted as early in the scientific review process as practicable to ensure the BSIA is available to the Council. The peer review should not duplicate a previously conducted peer review. The scope of the peer review (often called the terms of reference) should be determined in advance of the peer review and the selection of the peer reviewers.

The NS2 proposed rule incorporates the OMB guidelines on the following selection standards for peer reviewers.

(1) Expertise and balance. Selection must be based on the requirements of diverse and relevant expertise with a balance in perspectives.

(2) Independence. Peer reviewers must be independent of the information under review, particularly in regard to the development of the science. A greater degree of independence may be required for some peer reviews, while there is also recognition in the importance of balancing the expertise with regional experience.

(3) Conflicts of interest. The peer reviewers must not have real or perceived conflicts of interest that significantly impair objectivity of the peer review. Potential reviewers must be screened for conflict of interest in accordance with NOAA Policy on conflicts of interest for peer review subject to OMB's peer review guidelines. (http://www.cio.noaa.gov/Policy_Programs/NOAA_PRB_COI_Policy_110606.html).

Q&A

There was considerable discussion and several questions regarding the requirements of a peer review process and the role of the SSC. Concerns were raised regarding the role of existing council committees, the timing of peer reviews, and conflicts of interest. Most Councils have a multi-step review process, involving various combinations of committees and teams and review panels, often culminating with the SSC providing advice to the Council.

A participant asked where in the process should an SSC make a determination of BSIA. It is expected that SSC determination will come near the end, following the completion of peer reviews panels and assessment teams. It is also expected that revised guidelines will not require significant changes in current practices with regard to the relations between plan teams (or other work groups) and SSCs.

The NS2 guidelines recommend that the peer review occur early in the process. This was explained to mean that the SSC should have peer review findings available to review when considering fishing level recommendations and evaluating BSIA. Peer reviews apply to the methods and products that the SSC will use in developing advice, but at some point the peer reviews must conclude and the SSC must offer advice. However, several additional reviews occur as recommendations move through the Council and Agency process before becoming rules and laws.

The use of technical teams to review assessment details varies across the country. For example, the North Pacific uses plan teams, the Pacific uses a STAR committee, and the Western Pacific uses a WEPSAR process. In the South Atlantic, there is no intermediary technical peer review body, so the SSC serves that function as well. There was concern expressed about not having a clear 'wall of science' there.

There was a question about how CIE reviews are done in the North Pacific. It was noted that for the North Pacific, the CIE reviews are done at the AFSC stock assessment level, providing recommendations directly to the assessment authors and the AFSC. These reviews are usually timed so that the advice can be used to improve the next year's assessment and also to provide advice for longer term improvement in the assessment and data sources going into the assessment. The plan teams and SSC also see the CIE report.

A question was raised about how to include new model runs after the technical peer review is completed. Apparently this has occurred with the SEDAR process. Participants from other areas noted that the terms of reference for the technical review teams and SSC could specify how to handle the requirements for peer review. It was noted that there is some risk if the SSC draws a line in the sand and refuses to consider other outputs after the technical peer review, because time needed to conduct a peer review may prevent the use of the most current information.

Although reviewers provided through the Center for Independent Experts are critical to many existing assessment peer review programs, it was noted that the CIE was not created solely to provide independent reviewers. The intent was to ensure that not all scientists participating in assessment teams and contributing analyses were associated with NOAA Fisheries. Over time, however, the CIE has evolved to primarily provide independent peer reviews of stock assessments. Independently, NOAA Fisheries has worked on expanding its own expertise available for conducting the actual modeling and analytical work. It was noted that the existing rigorous CIE standards for selecting reviewers in regard to independence and conflicts of interest have strengthened the reliability and credibility of our scientific information.

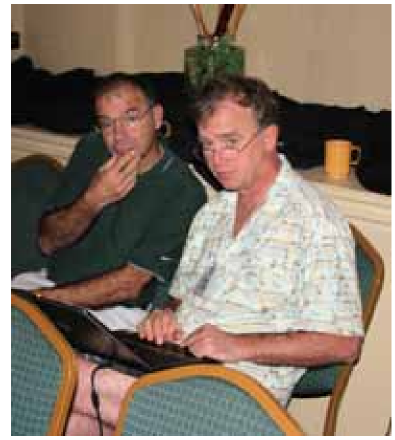
It was suggested that language addressing conflicts of interest and independence of reviewers be clarified and expanded. Inclusion of language such as 'perceived conflict of interest' argues for identification of an arbiter to resolve such perceptions, especially since claims of conflict of interest are increasingly appearing when constituents object to scientific findings. There is also some concern that academic scientists receiving NOAA grants may be perceived as having a conflict.

Role of the SSC in the Review of Scientific Information

MSA section 302 (g)(1)(A) mandates that "Each Council shall establish, maintain, and appoint the members of a scientific and statistical committee to assist it in the development, collection, evaluation, and peer review of such statistical, biological, economic, social, and other scientific information as is relevant to such Council's development and amendment of any fishery management plan." The function of the SSC as stated in MSA section 302(g)(1)(B) is to "provide its Council ongoing scientific advice for fishery management decisions, including recommendations for acceptable biological catch, 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."

The proposed revisions to the NS2 guidelines address ANPR comments recommending that the agency clarify the role of the SSC in the review of scientific information to ensure the credibility and integrity of scientific information for the Council, while maintaining the function of the SSC as the Councils' scientific advisory body as described in MSA section 302(g).

In addition to the SSC advisory role, the proposed rule states that an SSC member may participate in the peer review of scientific information when beneficial due to the expertise and regional knowledge of the SSC member, as long as the SSC member meets the peer review quality standards as described in the proposed rule. The SSCs may conduct peer reviews, participate in peer reviews, or evaluate peer reviews to provide clear scientific advice to the Council. An SSC member may participate in peer review when the expertise and institutional memory of that SSC member is beneficial to the peer review, or beneficial to the Council's advisory body by allowing that SSC member to make a more informed evaluation of the scientific information. Participation of an SSC member in a peer



"The technical peer review needs to occur early enough in the process so that the results of that technical peer review are available with reasonable timeliness for the SSC when the SSC is making its fishing level recommendations to the council."

Rick Methot

"There are distinct roles between the peer review and what it's providing to the SSC and what the SSC does with that information for the ABC recommendation. I think that the SSC should be adding value to the previous peer review and our ultimate responsibility is this ABC recommendation."

J.J. Maguire

review should not impair the ability of that SSC member to accomplish the advisory responsibilities to the Council. As recommended by ANPR comments, an SSC member participating in peer review should meet the peer review selection criteria outlined in the peer review criteria section, including independence from the information under review and without conflicts of interest.

The proposed rule includes another suggestion from ANPR comments in that the SSC's review and evaluation of scientific information should be transparent by providing the public with full and open access to meetings, background documents and reports, subject to MSA confidentiality provisions. It also calls for the recording of minority viewpoints when the SSC cannot reach consensus. The proposed rule also addresses questions about the interplay of MSA section 302(g)(1)(B) (quoted above) and 302(h)(6) which provides that "each Council shall … develop annual catch limits for each of its managed fisheries that may not exceed the fishing level recommendations of its scientific and statistical committee or the peer review process established under subsection (g)." To preserve the SSC's role as the provider of scientific advice to the Council, section 600.315(b)(1)(ii) of the proposed NS2 guidelines states that a peer review under MSA section 302(g)(1)(E) should be conducted early in the scientific evaluation process, in order to provide the SSC with a reasonable opportunity to review the peer review report and make recommendations to the Council. If those recommendations are inconsistent with the findings of the peer review, in whole or in part, the SSC should prepare a report outlining the areas of disagreement and the rationale and information supporting the SSC's determination. The review process of the SSC should be complementary to, and not duplicative of, other existing peer review processes established by the Secretary and each Council.

Q&A

Some participants felt that the draft NS2 guidelines did not provide enough clarification on the SSC's role in the review process, and suggested that the final rule provide more guidance. Additional guidance on conflicts of interest as applied to assessment reviewers was also encouraged.

The group discussed the timing of assessment reviews by review panels and by the SSC. It was suggested that peer reviews should occur early in the process, but what constitutes 'early' is not clear. For clarification, it was stated that the peer review is one in a series of steps required to vet scientific information for the Council and Agency; that these steps can include multiple levels of review by work groups, independent panels, and the Council and Agency; and that the technical peer review should occur early enough that the SSC can be informed by the peer review findings when considering fishing level recommendations. Additional clarification on the meaning of peer review is expected in the final guidelines.

It was suggested that the Terms of Reference for assessment reviews should be carefully and explicitly crafted to require that the review, especially if it occurs late in the progression of activities, provide all the information the SSC will require to provide fishing level recommendations. Terms of Reference may be lengthy, as they must be prescriptive and clear, should include timelines for tasks and deliverables, should evolve over time as methods and requirements evolve, should compel guidance for next steps and recovery actions when a task or objective cannot be completed, and should be crafted to the needs of each circumstance. The SSC's role to provide fishing level recommendations, including ABC, is distinctly different than the review panel's role of critiquing and evaluating the scientific rigor of an analysis. The overall process for developing analyses such as stock assessments must be robust and each step in the process must provide the information and documentation required for subsequent steps in the process. The timing of ABC determination will be delayed if early stages do not get the job done properly.

With regard to scientific assessments, it was concluded that the SSC should be a backstop for what comes out of a technical review process. There should be a sequential process from the development of an assessment to final determination of ABCs by an SSC, moving away from the details and winnowing down to make a recommendation. By the time the assessment package gets to the SSC, there should be no need for the SSC to get into all of the details. However, it was noted that this is a two-way street because the SSC can make recommendations to the assessment author, including detailed suggestions on the model or other information to improve the assessment. It may take several iterations to refine a model, and before a new model is fully adopted for use in ACL determination, the old model can be used as a performance indicator.

SAFE Report

The existing NS2 guidelines specify that a SAFE report is a document or set of documents that provide Councils with a summary of scientific information pertaining to the fishery at issue, as well as specifications on the contents of SAFE reports. The existing NS2 specifies requirements of the SAFE report, and the NS2 proposed rule provides further clarification on the purpose and content of the SAFE. The SAFE should provide the Councils with the necessary scientific information to set catch level specifications and make management decisions for the conservation of the nation's living marine resources. At a minimum, SAFE reports should contain a description of the fishery; stock status determination criteria; overfishing and overfished determinations; management measures necessary to rebuild depleted stocks; information for basing catch specifications; all sources of fishing mortality; bycatch of non-target species; essential fish habitat determinations; and economic, social, community, and ecological information pertinent to the success of the objectives of the fishery management plan (FMP). During this workshop presentation, some of the SAFE requirements were outlined.

The Secretary has the responsibility to assure that SAFE reports are prepared and updated or supplemented as necessary for each fishery management plan (§ 600.310(c)). The Secretary or Councils may utilize any combination of personnel from Council, state, Federal, university or other sources to acquire and analyze data and produce the SAFE report. The SAFE report and any comments or reports from the SSC must be available to the Council for making its management decisions for each FMP to ensure that the best scientific information available is being used. SAFE reports or its component parts must be readily accessible on the Council or NMFS website and routinely updated. The proposed rule provides guidance on the scientific content of the SAFE report necessary for the SSC evaluations and recommendations in support of each Council's mandate to determine catch level specifications which are addressed in the NS1 guidelines.

<u>Q&A</u>

Not all SSCs receive SAFE reports, despite the longstanding requirement that SAFEs be prepared. Participants felt that the SAFE reports can be very useful to the public and Council, as well as the SSC. In addition to providing a single document containing scientific stock assessment information for establishing ACLs, the SAFE reports can improve the public understanding and transparency of the ACL decision process. Stronger language is needed in the NS2 guidelines to ensure SAFE reports are prepared.

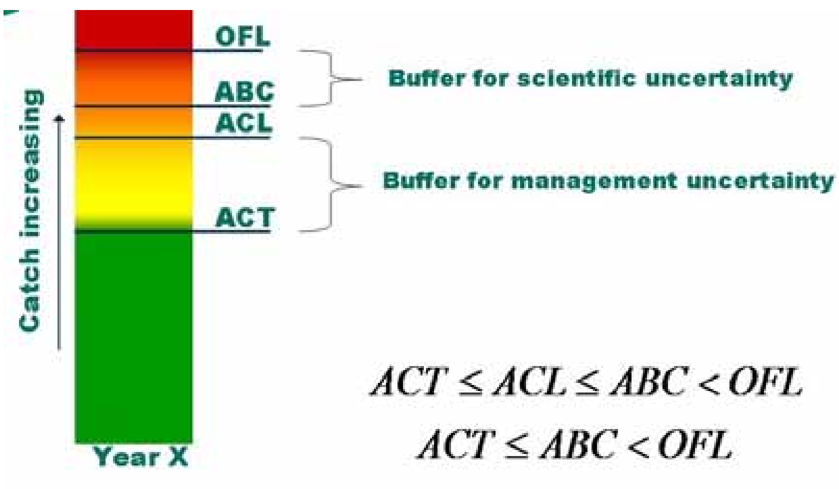
"We lay out very explicitly what we expect to see in an assessment that's brought forward. We don't have the power to command. On the other hand, we do have the power to commend and to complain, publicly in our report, and staff are quite responsive."

Keith Criddle

National Standard 1: ACLs and Scientific Uncertainty

Control Rules and Scientific Uncertainty

Rick Methot (NMFS) and Erik Williams (NMFS) provided a presentation on ABC Control Rules and Scientific Uncertainty. Their report is summarized below.

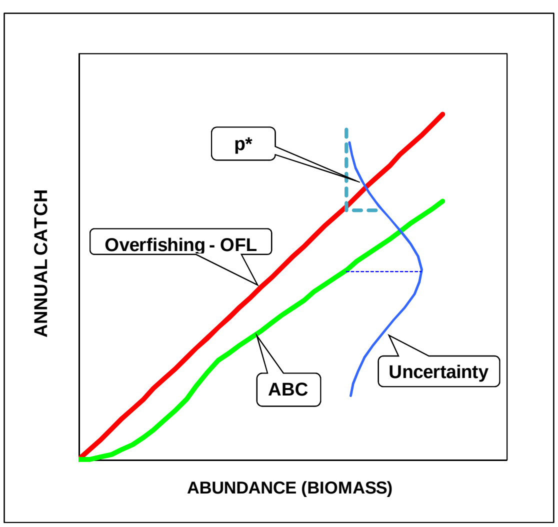


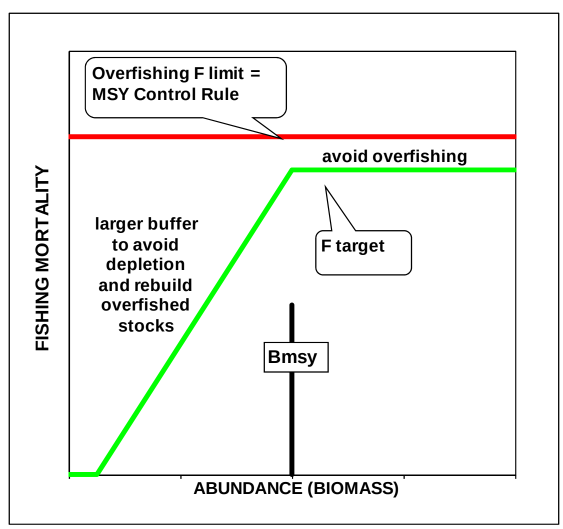
$$ACT \leq ACL \leq ABC < OFL$$

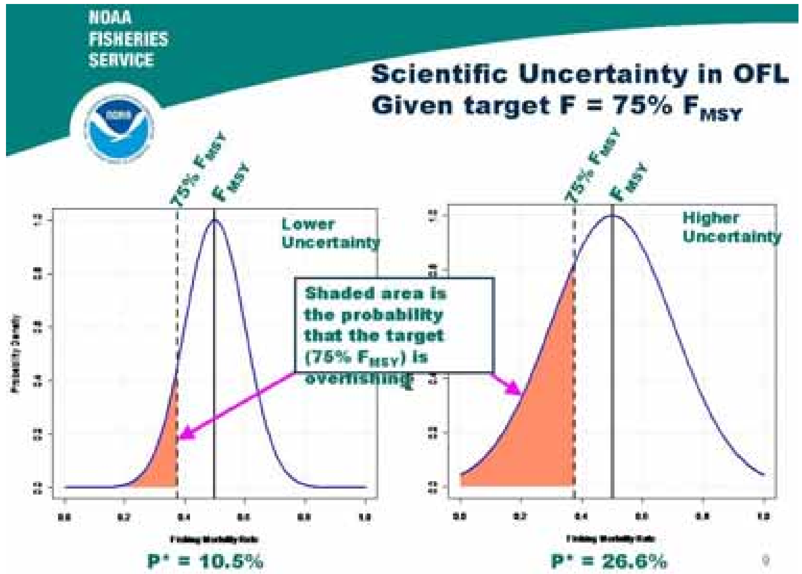
$$ACT \leq ABC < OFL$$

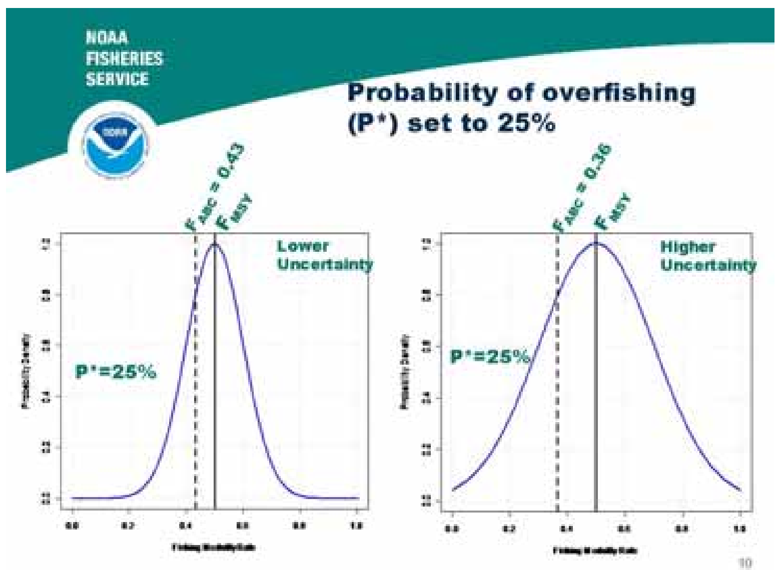
Control rules are procedures for translating information about the abundance and productivity of a fish stock into recommendations regarding future levels of fishing activity. A precautionary approach to implementation of such control rules was recommended in the 1998 version of the National Standard 1 Guidelines, and in a subsequent NMFS Technical Memorandum (Restrepo, et al., 1998). The 2009 update of the National Standard 1 Guidelines provides more explicit guidance regarding the need to account for scientific uncertainty when designing Acceptable Biological Catch (ABC) control rules to prevent overfishing.

An ABC control rule for a quantitatively assessed stock should take into account three basic factors: stock productivity, stock abundance, and uncertainty. Stock productivity is the primary factor in the calculation of the fishing mortality rate, F_{msy} or proxy, that would produce the maximum long-term yield. This fishing mortality rate is the limit for overfishing, F_{limit}. This rate, which determines the fraction of the stock caught per year, is applied to a forecast of the stock abundance for the next one or more fishing seasons to calculate the annual overfishing limit (OFL) in terms of catch. Thus the OFL, as an annual quantity, is expected to fluctuate in synchrony with fluctuations in stock abundance. It follows that long-term fishing at exactly the F_{msy}=F_{limit} would produce a time series of OFL catches, the average of which would be the maximum sustainable yield. However, it is not technically feasible to implement such a policy exactly because the OFL calculation is an estimate that has statistical and structural uncertainty. The ABC control rule is expected to take into account these uncertainties and create a buffer between the OFL and the ABC based on an acceptable probability of overfishing that cannot exceed 50% and should be lower. This probability is termed P*.









The methodology for computing P* is based on simple probability theory, by which scientific advisers can compute ABC from OFL and its statistical distribution, as estimated by a stock assessment. Several authors have demonstrated uses of probability theory to derive fishery reference points (typically denoted "targets" and "limits") that incorporate various kinds of uncertainty. Caddy and McGarvey (1996) described a procedure to set a target fishing mortality rate, given an OFL, so that the rate realized in the next period (F_{next}) would exceed OFL with only some specified probability P*. The procedure assumes that F_{next} will be centered on the target, but may not equal it, because of imperfect implementation of management controls (e.g., quota overruns) or imperfect stock assessment.

Prager et al. (2003) revised and extended the work of Caddy and McGarvey (1996) in several ways. The revised procedure, which they termed REPAST, allows uncertainty both in estimating the limit reference point (a type of scientific uncertainty) and in attaining the target (a type of management uncertainty), uses ratios to reduce possible covariance between quantities, and can be applied to reference points in biomass as well as in fishing mortality rate. Shertzer et al. (2008) described a procedure (PASCL), which extended considerably from that of Prager et al. (2003), and was intended for setting ABCs, ACLs, and annual catch targets (ACTs) over a series of several years, generally the period from one stock assessment until the next. The Shertzer et al. (2008) procedure uses a stochastic projection model, starting from estimates of OFL and terminal-year abundance; it can incorporate major forms of scientific uncertainty and management uncertainty. Most recently, Prager and Shertzer (In Press) applied approximations to the distribution of OFL, for cases when it is not known from the assessment; their conclusions suggest it is preferable to have the assessment model estimate the distribution of OFL directly. A procedure to do this is under development for the Stock Synthesis assessment model.

The general P* framework can easily extend common projection methodology by including uncertainty in the limit reference point and in management implementation, by making explicit the risk of overfishing that managers consider acceptable. Probability based methods, such as P*, provide well-defined approaches to setting ABC based on the degree of scientific uncertainty.

Factors that go into the calculation of the degree of scientific uncertainty should be reasonably inclusive and should recognize that calculation of uncertainty is itself uncertain. Factors to be considered include: statistical uncertainty associated with the fit of the assessment model to the available data, structural uncertainty due to use of particular model structures often with some constant parameters (such as natural

> *"Evaluating the consequences of different P* levels should be part of a technical contribution to the amendments that implement these procedures. Yes, it is a management decision, but it should be informed by science and neither side should work in a vacuum in that regard. The ABC control rule also needs to be a joint science/management process."*
>
> **Rick Methot**

mortality rate), inability to directly account for climate and ecosystem factors, etc. It may be necessary to employ proxies for unmeasured components of uncertainty in data-weak simple models to assure that the addition of more information will be expected to lead to more certainty, rather than to a capability to calculate more components of uncertainty. Until the science for calculation of uncertainty matures, proxies for the overall level of uncertainty may be useful.

In some cases, little may be known other than catch and even this may be associated with uncertainty. In such cases, direct quantification of overfishing limits and other quantities may appear infeasible. Nevertheless, some evaluation of the status of current levels of fishing is a necessary first step. This first step could be a classification of stocks by scientists and locally knowledgeable people into one of four categories of fishery impact. This is essentially a stock assessment tailored to the data that is available and should be conducted with adequate transparency and an appropriate level of review. This classification should be accompanied and guided by a productivity-susceptibility analysis of the species. Possible fishery impact categories are:

- Trivial impact: e.g. potential ecosystem component species;
- Small impact: thus current catch could remain a target but not be allowed to expand unless supported by evidence of the safety of this expansion;
- Moderate impact: thus recent catches could be considered as a limit and future fishing should be more restricted until future transition to a fully assessed stock allows direct calculation of limits and targets;
- High impact: overfishing may already be occurring and immediate reductions appear necessary.

Catch Only Situations

Historical Catch	Expert Judgment	Possible Action
Nil, not targeted	Inconceivable that catch could be affecting stock	Not in fishery; Ecosystem Component; SDC not required
Small	Catch is enough to warrant including stock in the fishery and tracking, but not enough to be of concern	Set ABC and ACL above historical catch; Set ACT at historical catch level. Allow increase in ACT if accompanied by cooperative research and close monitoring.
Moderate	Possible that any increase in catch could be overfishing	ABC/ACL = f(catch, vulnerability) So caps current fishery
Moderately high	Overfishing or overfished may already be occurring, but no assessment to quantify	Set provisional OFL = f(catch, vulnerability); Set ABC/ACL below OFL to begin stock rebuilding

With the ABC defined in terms of an acceptable probability of overfishing, it shares some technical characteristics with the rebuilding analyses conducted after rebuilding requirements were put in place 10 years ago. Rebuilding analyses typically take into account uncertainty in current stock abundance and uncertainty about future fluctuations in productivity (recruitment) in order to calculate a fishing rate that would have at least a 50% chance of getting the stock to a rebuilt condition within a specified period of time. Analyses in support of ABC control rules can be, in addition to calculating an annual probability of overfishing, projected several years into the future to calculate quantities such as the probability that a stock will approach an overfished condition or will remain above B_{msy}. A simple example of such an analysis was presented at the workshop.

Evaluation of the impact associated with potential levels for P* can consider multiple factors because there is a trade-off between the degree of protection from overfishing and the degree to which fisheries can access a large fraction of the biological limit. For example, the vulnerability of a stock to the cumulative effects of overfishing could support a lower p*. High value of catch and fishing opportunities could support accepting a higher P*. The multi-year effect of a particular P* needs also to take into account the management uncertainty associated with controlling the actual catch to the level prescribed by the control rule. Thus, efforts to guide selection of an acceptable annual probability of overfishing, P*, can be guided by a broader cost/benefit/risk analysis oriented towards calculation of optimum yield.

Scientific and Statistical Committee Reports

Each SSC was asked to provide a brief presentation describing how progress being made in their Council region with respect to meeting the National Standard 1 guidelines, paying particular attention to the establishment of ACLs and incorporating scientific uncertainty. These presentations are posted as pdf files on the regional Council website www.fisherycouncils.org and summarized below.

North Pacific

Presenter - Pat Livingston, SSC Chair

Groundfish FMPs

The NPFMC's two Groundfish FMPs include a suite of catch limits for individual groundfish stocks and assemblages. These catch limits include an overfishing limit (OFL), an acceptable biological catch limit (ABC) and a total allowable catch limit (TAC), where TAC≤ABC<OFL. The OFL and ABC are set by the SSC, and the TAC is set by the Council. The OFL and ABC determinations incorporate a tier system for addressing scientific uncertainty. For groundfish, the annual catch limit (ACL) is the ABC, and TAC meets the definition of an allowable catch target (ACT) per the guidelines -- it is a target set not to exceed the ABC.

The groundfish OFL and ABC values are initially based on a set of mathematical formulae as prescribed through a set of six tiers. These tiers are listed in descending order of preference, corresponding to descending order of information availability. The SSC has final authority for determining whether a given item of information is reliable for the purpose of this definition. In Tiers 1-3, the threshold coefficient α is set at a default value of 0.05, with the understanding that the SSC may establish a different value for a specific stock or stock complex as merited by the best available scientific information. For these tiers, fishing mortality is reduced when the stock drops below its biomass target level (B_{MSY} or proxy). In tiers (2-4), a designation of the form "Fx%" refers to the F associated with an equilibrium level of spawning per recruit (SPR) equal to x% of the equilibrium level of spawning per recruit in the absence of any fishing. If reliable information sufficient to characterize the entire maturity schedule of a species is not available, the SSC may choose to view SPR calculations based on a knife-edge maturity assumption as reliable.

For the NPFMC, these six tiers have been sufficient to develop reference points for all managed stocks. In Tier 1, a reliable probability density function (pdf) of B_{MSY} is available, and the preferred point estimate of B_{MSY} is the geometric mean of its pdf. In Tier 2, a point estimate of B_{msy} is the focus for reference points. In Tier 3, the term $B_{40\%}$ refers to the long-term average biomass that would be expected under average recruitment and $F=F_{40\%}$. In Tier 4, a reliable estimate of $B_{40\%}$ is not available. In Tier 5, maturity information is not available, so reference points are based on natural mortality. In Tier 6, biomass estimates are not available, so reference points are based on average catch.

The SSC treats the initial ABC calculation as the maximum permissible. It then considers whether further reductions are warranted due to decreasing trends in recruitment or other population parameters, changes in environmental conditions, uncertainties in the stock assessment models, and other factors. This results in the final ABC. The OFL is always calculated from the set of formulae, and not adjusted by the SSC.

Groundfish catch is monitored through comprehensive at-sea observer coverage, as well as an electronic catch reporting system. In-season accountability measures are designed both to prevent the TAC from being exceeded (e.g. directed fishing closures) and to respond if the TAC is exceeded (e.g. prohibition of retention). There are no recreational fisheries for groundfish in Federal waters, and commercial removals from state water fisheries and bycatch in non-target fisheries accrue towards the TAC, in most cases. Research catches are included as a removal in the stock assessments.

Progress Report: No groundfish stocks are overfished or undergoing overfishing, so no rebuilding plans are required. The Groundfish FMPs will be amended to

1) Information available: *Reliable point estimates of B and B_{MSY} and reliable pdf of F_{MSY}.*

1a) Stock status: $B/B_{MSY} > 1$

$F_{OFL} = \mu_A$, *the arithmetic mean of the pdf*

$F_{ABC} \leq \mu_H$, *the harmonic mean of the pdf*

1b) Stock status: $\alpha < B/B_{MSY} \leq 1$

$F_{OFL} = \mu_A \times (B/B_{MSY} - \alpha)/(1 - \alpha)$

$F_{ABC} \leq \mu_H \times (B/B_{MSY} - \alpha)/(1 - \alpha)$

1c) Stock status: $B/B_{MSY} \leq \alpha$

$F_{OFL} = 0$

$F_{ABC} = 0$

2) Information available: *Reliable point estimates of B, B_{MSY}, F_{MSY}, $F_{35\%}$, and $F_{40\%}$.*

2a) Stock status: $B/B_{MSY} > 1$

$F_{OFL} = F_{MSY}$

$F_{ABC} \leq F_{MSY} \times (F_{40\%}/F_{35\%})$

2b) Stock status: $\alpha < B/B_{MSY} \leq 1$

$F_{OFL} = F_{MSY} \times (B/B_{MSY} - \alpha)/(1 - \alpha)$

$F_{ABC} \leq F_{MSY} \times (F_{40\%}/F_{35\%}) \times (B/B_{MSY} - \alpha)/(1 - \alpha)$

2c) Stock status: $B/B_{MSY} \leq \alpha$

$F_{OFL} = 0$

$F_{ABC} = 0$

3) Information available: *Reliable point estimates of B, $B_{40\%}$, $F_{35\%}$, and $F_{40\%}$.*

3a) *Stock status:* $B/B_{40\%} > 1$

$F_{OFL} = F_{35\%}$

$F_{ABC} \leq F_{40\%}$

3b) *Stock status:* $\alpha < B/B_{40\%} \leq 1$

$F_{OFL} = F_{35\%} \times (B/B_{40\%} - \alpha)/(1 - \alpha)$

$F_{ABC} \leq F_{40\%} \times (B/B_{40\%} - \alpha)/(1 - \alpha)$

3c) *Stock status:* $B/B_{40\%} \leq \alpha$

$F_{OFL} = 0$

$F_{ABC} = 0$

4) Information available: *Reliable point estimates of B, $F_{35\%}$, and $F_{40\%}$.*

$F_{OFL} = F_{35\%}$

$F_{ABC} \leq F_{40\%}$

5) Information available: *Reliable point estimates of B and natural mortality rate M.*

$F_{OFL} = M$

$F_{ABC} \leq 0.75 \times M$

6) Information available: *Reliable catch history from 1978 through 1995.*

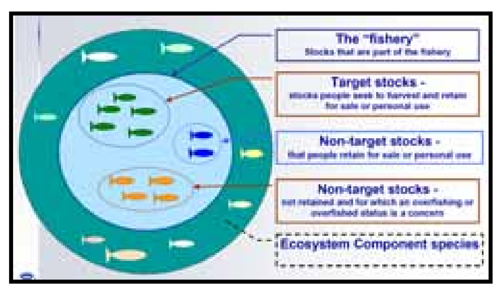
OFL = *the average catch from 1978 through 1995, unless an alternative value SSC on the basis of the best available scientific information*

$ABC \leq 0.75 \times OFL$

describe how the current specification process meets the requirements of the mandatory NS1 Guideline provisions.

The Groundfish FMP will be amended to include a description of the specification of minimum stock size thresholds (MSST) defining when a stock is considered overfished, a description of measures that are taken if and when a stock drops below MSST, a description of accountability measures that are triggered if an ACL (i.e., the ABC) is exceeded, and a description of how catch from all sources -- including bycatch, scientific research (including EFPs), and all fishing activities – is counted against the OY.

The FMP will also be amended to include a description of how the Tier levels for ABC and OFL are based on the scientific knowledge about the stock or stock complex and the scientific uncertainty in the estimate of OFL and any other scientific uncertainty. An analysis done by the AFSC indicated that for the stocks and sources of uncertainty examined, ABCs based on the existing tier levels would have a low probability of exceeding the real, but unknown, OFL (AFSC 2009). This analysis was based on both a P* approach and a decision-theoretic approach. For the P* approach, analysts examined survey uncertainty for BSAI and GOA groundfish from different tiers. The current buffers are based on the ratio of F40% to F35% (Tier 3), 0.75 times M (Tier 5), or 0.75 times average catch (Tier 6). Values of P* required to match the existing buffers between OFL and ABC were computed, given those stocks respective levels of uncertainty (SSB or trawl survey biomass) of those stocks. The average buffer produced a P* value of 0.12. In other words, there is a 12% chance that the ABC is in excess of the true OFL across these stocks, given that the assumptions about uncertainty of OFL are true. The decision-theoretic approach allows ACLs to vary with uncertainty given a specified level of risk aversion. The decision-theoretic approach showed that the average level of absolute risk aversion implied by the current tier system is 0.4. The average buffer size was ~8% for Tier 1 stocks, ~17% for Tier 3 stocks, and 25% (as prescribed by the tier system) for Tiers 5 and 6. Although additional effort is underway to examine more explicit use of uncertainty in the setting of groundfish ABCs, additional action will not be required to comply with NS1 guidelines, and will not be included in the upcoming analysis.



The Groundfish FMPs will also need to be amended to define the stocks in the fishery and to consider whether to add an Ecosystem Component category for certain species. The current target and some non-target species that are currently included in the "other species" categories would be defined as 'in the fishery', and ACLs would be set for them. The current forage fish category and prohibited species category would be included in the Ecosystem Component (EC) species category. The non-specified category is considered outside of the fishery and will be examined to determine if any species in this category should be included in the target category or EC category. To assist with classifying these stocks, a vulnerability analysis was prepared for non-target and selected target species in the GOA and BSAI (Ormseth 2009). Vulnerability is defined as the likelihood of overfishing in the absence of conservation measures. The analysis measured the vulnerability as a function of stock productivity and susceptibility to the fishery. The Groundfish Plan Teams recommended that the Council consider listing all target stocks, sharks, skates, squids, sculpins, octopods, and giant grenadier for inclusion "in the fishery" and be subject to ACLs and status determination criteria. Squid and octopus complexes will be evaluated for possible inclusion under the EC category. Individual species in the non-specified category not considered appropriate for inclusion as EC species category may be removed from the FMPs (e.g., sea anemones, barnacles).

The Council will review a draft analysis to amend the Groundfish FMPs in February 2010, and take final action by June to ensure Secretarial approval prior to the beginning of the catch specification process for the 2011 fishing year, which begins January 1.

BSAI Crab FMP

The State/Federal Bering Sea and Aleutian Islands Crab FMP currently specifies annual OFLs (set by the SSC) and TACs (set by the State of Alaska) for individual stocks, where TAC≤OFL. Similar to the Groundfish FMPs, the OFLs are established by tier levels, based on the level of information available. The Crab FMP does not currently include ABC levels, and thus these levels will need to be established to meet the NS1 requirements for an ACL.

Regarding AMs in the crab fishery, a portion of the fleet carries at-sea observers. A direct allocation of harvest shares prevents the TAC from being exceeded (catch is limited by individual quota shares). Any harvest over the allotted quota results in forfeiture and/or fines. There are no recreational fisheries for BSAI FMP crab species in Federal waters. Crab bycatch in groundfish fisheries is limited by regulation and the numbers of crab caught in all fisheries (crab, groundfish, and scallop fisheries) will be incorporated into the assessment and calculation of crab OFLs. Catch is monitored through comprehensive at-sea observer coverage, as well as an electronic catch reporting system.

To date, there have been four crab stocks that were deemed 'overfished' (Bering Sea Tanner crab, Bering Sea opilio crab, St. Matthew blue king crab, and Pribilof blue king crab) when the stocks fell below the minimum stock size threshold (MSST) following years of poor recruitment. Rebuilding plans were implemented for these crab stocks. Two stocks have achieved fully rebuilt status above B_{msy} (Tanner crab and St. Matthew blue king crab), however one of these stocks (Tanner crab) has since fallen below MSST and requires a new rebuilding plan. One stock is no longer overfished but not yet fully rebuilt to B_{msy} (opilio crab). One stock, Pribilof blue king crab remains well below MSST ('overfished') despite not having a fishery since 1999, establishment of a no-trawl zone to protect the stock since 1995, and closures of other fisheries to limit bycatch.

Progress Report: A workshop to explore alternatives and options for setting ABC tiers was held in May 2009, and the Council reviewed ACL alternatives in October. The preferred approach for establishing ACLs for crab stocks will be to use a probability-only approach as proposed by Hanselman (2009) by modifying and building upon approaches by Caddy and McGarvey (1996) and Prager et al. (2003). This probability only approach, now commonly called the P* approach, is essentially the probability that ACL is in excess of OFL, given that our assumptions about the uncertainty of OFL are true. Two alternative conceptual approaches are being considered in using this approach for crab stocks: ACL levels will be established as either fixed buffers (with a variable P*) by Tier for crab stocks, or alternatively with fixed P*s by Tier levels, leading to a variable buffer (where the buffer is between OFL and ABC). Analysts are currently working to best characterize the uncertainty by Tier level and establish a process by which this can be annually evaluated (see Punt et al. 2009, Turnock 2009).

The Crab Plan Team and SSC have recommended moving forward with a P*

approach for establishing maxABC for BSAI crabs. The analysis will evaluate a range of P* and buffer values (i.e., present one set of alternatives based on constant P* values and another set of alternatives based on constant buffer percentages) as well as a range of uncertainty incorporation. A range of alternative approaches to best characterize uncertainty by Tier level could include:

1) characterize the uncertainty of the assessment model
2) characterize uncertainty of modeled stocks by a retrospective assessment evaluation approach
3) characterize uncertainty by Tier by comparison with calculated variance in candidate groundfish stocks by Tier level

Alternative P* values to be considered include a range from 0.1 - 0.5 (including 0.5 as an upper limit is for display purposes only since this option implies a buffer of zero – i.e., ABC=OFL -- a 50% probability of ABC exceeding the true OFL). Such a range of P*s should assist with evaluating buffers. The choice of a P* value will be a policy decision by the Council, based on analysis of a range of values showing effects of P* on buffer sizes below OFL.

Citing the benefits of working with a constant buffer (less calculation involved and easy to communicate), the Crab Plan Team suggested that the Council consider a range of acceptable P* values and have the analysis find the buffer that consistently satisfies that range (or lower bound); i.e., a buffer setting $ACL = 0.72 \cdot OFL$ (or some other number) may satisfy an acceptable range of P*s for all crab stocks.

The Crab ACL amendment package will be reviewed by the Council in June 2010, with final action scheduled for October 2010 so that ACLs can be implemented prior to the beginning of the crab fishing year, (October 2011).

Crab rebuilding plans will also be developed and revised as needed. The Bering Sea Tanner Crab stock, which had been officially declared rebuilt in 2007, has again fallen below the MSST, requiring development of another rebuilding plan. The analysis to revise the Pribilof Islands blue king crab and opilio crab rebuilding plans, as well as the new Tanner crab rebuilding plan, will be reviewed by the Council in June 2010, with final action scheduled for October 2010.

	BSAI & GOA Groundfish	BSAI Crabs	AK scallops
Stocks in the fishery	Targets and vulnerable non-targets	targets	Target: Weather-vanes only
Ecosystem Components	Forage species, prohibited species	none	None, or other scallop sp.
OFL/ABC control rules	Status quo (tiers)	OFL tiers ABC =P*buffer	OFL=MSY ABC=buffer
Uncertainty	Status quo (tiers), for now. Meets NS1 requirements.	P* buffer; P*<50% by tier or stock	Fixed buffer 75% or 90% of OFL
AMs	Status quo	Status quo	Status quo

Scallop FMP

The State/Federal Alaska Scallop FMP specifies an OFL for weathervane scallops and annual guideline harvest levels (GHL) for stock areas that cumulatively are set well below the OFL. The OFL is currently set equal to MSY = 1.24 million pounds of shucked scallop meats, and is set at a statewide level. The upper end of the GHL in each management area is analogous to a TAC set by substock. The Scallop FMP does not currently include ABC levels, and thus these levels will need to be established to meet the requirements for an ACL.

With regard to AMs in the scallop fishery, the fishery operates as a cooperative and has 100% at-sea observer coverage. The GHL is prevented from being exceeded by directed fishing closures. There is no recreational fishery. The state water commercial fishery is managed under separate GHLs. Catches are reported on fish tickets at the time of landing.

Progress Report: ABCs will need to be established in order to comply with NS guidelines for an ACL. A constant buffer approach is being evaluated at a range of values (10% and 25%) to meet these requirements. It is likely this ABC level will be set on a statewide basis given the lack of regional biomass information. The Scallop FMP will also need to be amended to explicitly remove the mention of pink, spiny and rock scallops from the FMP text. The FMP management measures only apply to the commercial weathervane scallop fishery; there are no fisheries for the other scallop species, which are rare in federal waters. These other scallop species do not overlap in distribution with weathervane scallops, and are not taken as incidental catch in this fishery, so may not end up in the EC species category.

The Council will take final action to amend the Scallop FMP in October 2010, to ensure implementation before the beginning of the fishing year, (June 2011).

Salmon FMP

The State/Federal Salmon FMP is unique in that the catches for the thousands of stocks are limited by in-season management by the Alaska Department of Fish and Game. The Council believes that our Salmon FMP meets the alternative approach described in section (h)(3) on page 3211 of the final rule, which specifically mentions Pacific salmon. There are no recreational fisheries for salmon and only a very small commercial fishery for salmon in Federal waters.

The State manages the commercial and recreational salmon fisheries in-season based on escapement goals and in-season monitoring by area managers. Commercial and recreational fisheries are subject to in-season management changes, including season and area closures and changes in bag limits. The NPFMC believes that salmon management by the State appears to meet the objectives of the NS1 guidelines to prevent overfishing.

Progress Report: The Salmon FMP will be reviewed to ensure that the existing language is consistent with the MSA and the NS1 alternative approach, and the FMP will be amended if necessary. The Council may consider withdrawing the FMP, given that management in the EEZ may no longer be necessary for conservation and management due to changes in international treaties as well as State management policies.

Arctic FMP

The Council developed and NMFS approved an Arctic FMP to establish sustainable management of commercial fishing in the Arctic Management Area before the potential onset of unregulated commercial fishing in the area. The final rule to implement the Arctic FMP was published 11/03/09.

The Arctic FMP establishes two categories of species: target species and ecosystem component species. Target species are those that are most likely to be targeted in a foreseeable commercial fishery based on potential markets and available biomass in the Arctic Management Area. Arctic cod, saffron cod, and snow crab are target species. The remaining fish species occurring in the Arctic Management Area are classified as ecosystem component species, and commercial fishing for these species will be prohibited.

The Arctic FMP provides the maximum sustainable yield (MSY) and optimum yield (OY) for commercial fishing for each target species. MSY is specified for each target species using the MSY control rule described in the proposed Arctic FMP. The OY for each target species is determined by reductions from MSY based on uncertainty, economic considerations, and ecosystem considerations. Uncertainty would reduce the MSY for each target species by an amount ranging from 36 to 61 percent. Additionally, because of the importance of Arctic cod to the Arctic food web, the lack of knowledge of the Arctic cod biomass needed to support commercial fishing and Arctic predators, and the potential high levels of bycatch of Arctic cod in a saffron cod fishery, the MSYs for Arctic cod and saffron cod are reduced 100 percent based on ecosystem concerns. Based on these reductions of the MSYs for the target species, the OY for commercial fishing in the Arctic Management Area for each target species is zero. With an OY of zero for each target species, no quantity of target species is available for commercial harvest. The Arctic FMP specifies the OY for each target species as the lowest amount of catch

sufficient to allow for bycatch of Arctic cod, saffron cod, and snow crab in subsistence fisheries for other species. If a commercial fishery is authorized in the future, the FMP would be amended to include specific accountability measures and mechanisms to prevent overfishing.

Q&A

It appears that the NPFMC approach only examines purely statistical uncertainty. How is model complexity and uncertainty incorporated? Response was that all assessment models are age structured models and difference in the tiers reflects differences in the stock recruitment models.

It was noted that different approaches to defining the ABC buffer are used across the different FMPs. This reflects differences in data available for FMP managed stocks, and is in part driven by the mandatory deadlines for implementation. For groundfish, the tier system has been shown to meet the guidelines, but there is interest in exploring a probability based approach for these stocks in the future. For scallops, age or size structure information is not available by sub-area so a fixed buffer approach is proposed. It was noted that the scallops OFL is defined to equal MSY and recent catches are well below MSY.

It was noted that the NPFMC is not currently considering additional AMs for their fisheries because they are not considered necessary given the tight management control provided under their current FMPs (i.e., due to extensive monitoring, inseason management of catch, and the existence of rationalized fisheries).

Pacific

Presenter – Steve Ralston, SSC Chair

The following is a summary of a paper presented by Steve Ralston "An Approach to Quantifying Scientific Uncertainty in West Coast Stock Assessments" and prepared by the Groundfish & CPS Subcommittees of the PFMC SSC.

The Pacific Fishery Management Council currently manages a wide variety of west coast fish stocks under four different Fishery Management Plans (FMPs), including groundfish, coastal pelagic species (CPS), salmon, and highly migratory species (HMS). In the case of groundfish, the PFMC adopts optimum yields (OYs) for the fishery on a biennial basis following application of a harvest control rule to the results of stock assessments.

Functionally, this procedure involves four separate calculations: (1) estimation of exploitable biomass in the current year, (2) projecting the population forward for several years into the near future, (3) applying a harvest rate to the projected population that would be expected to produce Maximum Sustainable Yield (MSY) in the long term, and (4) adjusting the projected catch downwards to account for a variety of factors of particular concern to management. Application of the MSY harvest rate (FMSY or its proxy) to the projected stock biomass results in an estimated Allowable Biological Catch (ABC), which has been considered an upper bound on annual catches, i.e., catches in excess of the ABC represent "overfishing."

Adjustment of the ABC catch downwards to account for the concerns of management then results in an OY. An example of such an adjustment is the 40:10 groundfish harvest control rule that reduces OY relative to the ABC once the biomass of a stock drops below 40% of its unfished level. Hence, under the Council's traditional approach to setting groundfish catch levels, the ABC is the absolute upper limit on annual catch, whereas the OY incurs some reduction in catch to account for a variety of conservation concerns to management. A comparable procedure is in place for CPS, except that the OY is termed a harvest guideline (HG).

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) was re-authorized in 2006 and included new national provisions for the establishment of Annual Catch Limits (ACLs) to insure that chronic overfishing is prevented. An annual catch limit represents a numerically specified upper limit on the total mortality experienced by a stock that should not be exceeded. In addition, the MSA stipulated that the Scientific and Statistical Committees (SSCs) of each of the eight regional Fishery Management Councils are now required to account for scientific uncertainty in the provision of management advice to their respective Councils. This new requirement effectively adds a new step in setting catch levels. In particular, the application of FMSY (or its proxy) to the projected biomass values from a stock assessment now results in an Overfishing Limit (OFL), which is identical to the old definition of the ABC. As before, annual catches in excess of the OFL constitute overfishing. However, under the new NS1 guidance that addresses ACLs, the ABC is now defined as an annual catch amount that is reduced from the OFL in order to account for scientific uncertainty in the development of management advice by SSCs to their Councils. The expectation under the NS1 guidelines is that scientific advice that is relatively uncertain will result in ABCs that are relatively lower, all other things being equal, i.e., a precautionary reduction would occur due purely to scientific uncertainty.

The guidelines also require that the ACL cannot exceed the newly defined ABC, but it may be less than the ABC in order to account for non-scientific management uncertainties and/or concerns. Moreover, if management is unable to insure that annual catches remain below the ACL, possibly due to inadequate monitoring of shoreside landings during the fishing year, the law provides for the establishment of an Annual Catch Target (ACT) below the ACL to insure that the ACL is not exceeded more than once in four years.

Given the new requirement that each SSC is now responsible for characterizing scientific uncertainty in a manner that allows establishment of a precautionary “buffer” between the OFL and the ABC, this document summarizes the Pacific Fishery Management Council SSC’s preliminary approach to addressing this problem for groundfish and CPS stocks.

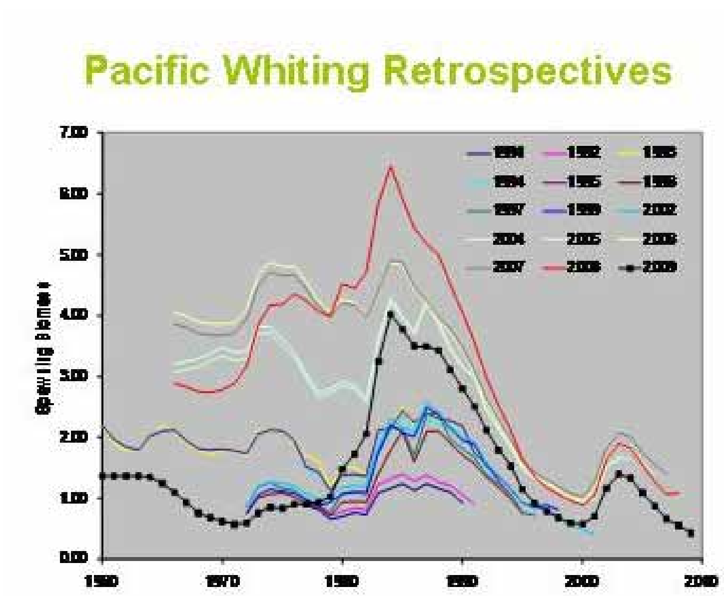
Quantifying scientific uncertainty in estimating an appropriate catch level for a fish stock is challenging. Multiple sources of error can easily be identified, including measurement error that is conditioned on the adopted model, model specification error, forecast error, and uncertainty about overall stock productivity. In addition, there are without doubt other unknown factors that will negatively influence the precision of scientific advice on catch levels. Notwithstanding these difficulties, the NS1 guidelines identify the quantification of scientific uncertainty in the development of advice on catch levels as a key requirement for implementation. Moreover, the Scientific and Statistical Committees (SSCs) of the Regional Fishery Management Councils have been given the responsibility to quantify that uncertainty.

While many sources of uncertainty exist, the focus here is on quantification of statistical measurement error and model specification error, particularly the latter. While not all inclusive, the study of these two factors is feasible with the information that is currently available. They are also likely to include the dominant sources of scientific uncertainty in the development of scientific advice vis-a-vis groundfish and coastal pelagic species catch levels at the Pacific Fishery Management Council.

Although full Bayesian integration through Monte Carlo Markov Chain calculations is a preferred method of estimating measurement error “within” a stock assessment, an inadequate number of studies have successfully achieved that type of analysis. Consequently, we report the first order approximate estimates of the standard error on terminal biomass from stock assessments that are calculated by inversion of the model’s Hessian matrix (i.e., the asymptotic standard error). To summarize variation “among” stock assessments, as a proxy for model specification error, we characterize retrospective variation among multiple assessments of the same stock.

Sources of Uncertainty

Estimation of the OFL (formerly ABC) involves three basic steps: (1) estimation of current exploitable biomass (***Bt***), (2) projecting the current exploitable biomass into the future for several years (***Bt+1***, ***Bt+2***, etc.), and (3) applying an estimate of FMSY to predictions of future biomass. While there are clear uncertainties associated with each step, the PFMC SSC elected to focus its attention first and foremost on variation in the estimation of current biomass in the terminal year of groundfish and CPS stock assessments. Our reason for doing so is aptly illustrated in the adjacent figure, which shows the results of 15 different Pacific whiting stock assessments that have been conducted for the PFMC over the last 18 years. It is instructive to consider this species because it is likely the most data-rich stock managed by the Council, it is of tremendous economic importance, and it has been assessed on an annual basis for many years.



However, in spite of considerable resources having been devoted to evaluating the status of the stock, from an assessment retrospective perspective, estimates of biomass have been highly variable. Note, for example, that estimated spawning biomass in 1985 has ranged from 1.2-5.9 million mt; approximately a five-fold range in abundance.

The figure shows the results of 15 separate stock assessments of Pacific whiting conducted for the PFMC since 1991. The legend refers to the year the stock assessment was conducted. Reasons for these variations in stock size estimation are diverse, including differences in: (1) the modeling software that was used, (2) the composition of the analytical team doing the assessment, (3) the review panel composition, (4) changes in the availability of data, (5) altered parameter priors, especially the scaling of the acoustic survey, and (6) overall model structure. Importantly, these issues contribute to variation in all groundfish and CPS stock assessments, which collectively demonstrate considerable "among" assessment variance. Hence, it is currently the view of the SSC that quantifying and accounting for this source of uncertainty is the first and most important to consider when establishing a buffer between the OFL and the ABC. However, as this process develops into the next biennial management cycle the SSC intends to consider other types of errors, including forecast uncertainty (Shertzer *et al*. 2008) and optimal harvest rate uncertainty (e.g., Dorn 2002; Punt *et al*. 2008). Hence, quantification of variation as revealed in this exercise should be considered a lower bound on total uncertainty at this time. However, even if forecast and harvest rate uncertainty were incorporated explicitly in this analysis, numerous other unaccounted for factors exist that may never be fully evaluated, including for example the effects of climate and/or ecosystem interactions on the estimation of an ABC.

Quantifying Biomass Uncertainty

For our analysis we consider two types of uncertainty in biomass estimation. The first is termed "within" assessment variability and is represented by the coefficient of variation (CV) on the terminal year biomass taken from the most recent stock assessment that has been conducted, whether it was a full or update assessment. In a very limited number of studies (e.g., Pacific Ocean perch) full Bayesian integration of uncertainty via Monte Carlo Markov Chain (MCMC) analysis has been achieved. However, such instances are the exception. Consequently, we use the asymptotic standard error estimate on terminal biomass developed by inversion of the model's Hessian matrix, i.e., the so-called Delta Method (Seber 1973) approximate estimate of variance. This error estimate can be considered a measure of statistical uncertainty "within" a stock assessment model that is "conditioned" or depends on all of the structural assumptions embedded within the model. We converted the asymptotic standard error to a CV by simple division using the terminal biomass statistic as the denominator.

However, as previously noted, "among" assessment variations are attributable to a wide variety of factors, many of which represent a significant form of model or structural uncertainty. Assertion of asymptotic or dome-shaped selectivity patterns is one example, as is incorporation of age-dependent natural mortality. Such structural issues may change from one assessment to the next. Likewise, biologically important fixed parameters often change from one assessment to the next (e.g., natural mortality or spawner-recruit productivity) and whole new data time series can be incorporated into the assessment model (e.g., the NWFSC combined trawl survey). Beyond such changes in model specification, among assessment variation includes other sources of variability due to, for example, differences in the reviewers who evaluated and approved an assessment.

To quantify total, among assessment, variability we assembled time series of biomass from historical assessments of a stock. Because of constraints on how much they could change, we excluded update assessments unless they were the most recent assessment conducted. In situations where a change in biomass metric across assessments occurred (e.g., mid-year biomass in one assessment and beginning year biomass in another) we used ratio estimation (Cochran 1977) over a common time frame to standardize to a common metric across all assessments that were conducted on a stock. Lastly, we limited the number of data points under consideration to the last 20 years from each assessment in order to focus our attention on variation associated with the estimation of current year biomass.

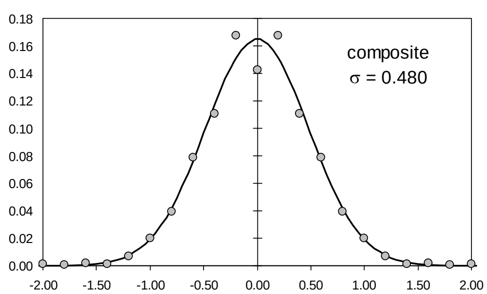
Biomass variation between two stock assessments was quantified by forming ratios of estimated abundances in common years. Specifically, if there existed an estimate of biomass (B) in common year t from assessments i and j, we calculated: $R_{i|j,t} = B_{i,t} / B_{j,t}$, i.e., the proportional deviation of assessment i using assessment j as a standard. Based on a symmetry argument we also calculated $R_{j|i,t}$. Therefore, in any particular year, if there were n assessments with biomass estimates available, the total number of ratios that could be formed was equal to the number of permutations of n objects taken two at a time, which is $n!/(n-2)!$. All of the $R_{i|j,t}$ ratios so obtained were $\log_e$-transformed and the standard deviation of the data calculated. For each stock a frequency histogram of the log-ratios was plotted. Note that because $\ln(R_{i|j,t}) = -\ln(R_{j|i,t})$ all of the distributions were perfectly symmetrical. We used the estimated standard deviation of the $\ln(R_{i|j,t})$ as a quantitative measure of among assessment variability.

To combine "within" and "among" sources of variation we note that for lognormally distributed random variables, the CV on the arithmetic scale is equal to $(\exp[\sigma^2]-1)^{0.5}$ (Johnson and Kotz 1970), where σ^2 is the variance on the logarithmic scale. We used this relationship to convert the within assessment CV to a variance term on the logarithmic scale, added the square of the 'among' assessment log-scale standard deviation, and backtransformed the total variance to a coefficient of variation on the arithmetic scale.

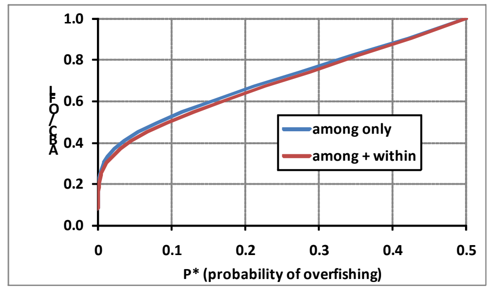
Stock-Specific Accounts

We summarized information for 15 groundfish and two CPS stocks. Specifically, we include the following well-studied, relatively data-rich species: bocaccio, canary rockfish, chilipepper, darkblotched rockfish, Pacific Ocean perch, shortspine thornyhead, widow rockfish, yelloweye rockfish, yellowtail rockfish, cabezon, lingcod, Pacific whiting, sablefish, Dover sole, petrale sole, Pacific mackerel, and Pacific sardine. All have been assessed using some version of the Stock Synthesis modeling program in a fully dynamic context.

The summary for each stock includes a brief description of the species, references to what assessments were included in the analysis, whether any ratio estimation was required to standardize biomass metrics, and plots showing: (a) time series of abundance from 1970 to the present, with the most recent assessment in bold, and (b) frequency histograms of the ***ln(Ri|j,t)***.



Results show that for 16 groundfish and coastal pelagic species (thornyhead excluded) the mean of the coefficient of variation on terminal biomass is 0.19 (s.d. = 0.09). This represents the average amount of statistical measurement error within assessments conducted for the PFMC. In contrast, the average coefficient of variation ascribable to model specification error (i.e., among assessment variation) is 0.51 (s.d. = 0.19), which is the far greater of the two sources of uncertainty. Given these results, if only among assessment variation is considered, and the probability of overfishing is fixed at 0.40, an appropriate buffer on the overfishing catch level is to reduce the harvest by ~12%.



Q&A

The question was asked if the current control rule accounts for scientific or management uncertainty. Under the new ABC paradigm, they would apply the 40/10 rule and alter the slope of the ABC line.

Concern was expressed that the assumption that theta = 0.5 across all stocks will result in some sort of masking. It was recognized that the average value of theta is derived by averaging a wide range of theta values observed for all stocks. There was also concern expressed that the analysis presented confused model structure (misspecification) with retrospective patterns. Model specifications have changed over time (e.g., assumptions about natural mortality, assumptions about shape of the stock/recruitment function etc). Any number of issues are contributing to their understanding/estimation of uncertainty including new data sets, new models etc. The SSC is attempting to describe the overall level of scientific uncertainty which integrates uncertainty from all sources.

Western Pacific

Presenter – Rick Deriso, SSC Member

The Western Pacific Regional Fishery Management Council (Council) has five current fishery management plans (FMPs); Pelagics, Bottomfish and Groundfish, Precious Corals, Crustaceans and Coral Reef Ecosystems. The Council is close to completing the transition of its FMPs to place based fishery ecosystem plans (FEPs) for Hawaii, American Samoa, Mariana Islands and the Pacific Remote Island Areas (Wake Island, Johnston Atoll, Howland & Baker Islands, Jarvis Island, Kingman Reef and Palmyra Atoll). The Pelagics FMP will also become an FEP, but will continue to consider management of pelagic stocks on a basin or sub-basin scale as opposed to place-based island archipelagos.

Pelagics Fisheries

For pelagic fisheries, the Council will apply the international exemption under Annual Catch Limits (ACLs) and implement the catch limits set by the Pacific Tuna Regional Fishery Management Organizations (RFMOs). The Western & Central Pacific Fisheries Commission (WCPFC) and the Inter-American Tropical Tuna Commission (IATTC) are principally focused on tunas and highly migratory species listed in Annex 1 of the United Nations Convention of the Law of the Sea (UNCLOS). UNCLOS omits certain species such as moonfish or opah (*Lampris* spp.), oilfish (family *Gempylidae*) and salmon sharks (*Lamna ditropis)*; however, both Pacific tuna RFMOs have taken an ecosystem approach to fishery management and do not limit themselves to managing only those species in UNCLOS Annex 1.

Stock assessments of West-Central Pacific Ocean (WCPO) and Eastern Pacific Ocean (EPO) bigeye and yellowfin tuna are conducted annually or biennially by the WCPFC and IATTC. These are used to inform the conservation and management measures of the two Commissions.

Currently, the Hawaii-based longline fleet is operating under an ACL for bigeye (3,763 mt) and yellowfin tuna (776 mt) from the WCPO in the fishing years 2009-2011. The other longline fleets in American Samoa and

the Commonwealth of the Northern Mariana Islands are provided with a 2000 mt limit or no catch limit if pursuing 'responsible fisheries development'. The objective of the WCPFC conservation and management measure is to reduce fishing mortality on bigeye by 30% and not to increase fishing mortality beyond the 2000 and 2004 average level for yellowfin tuna.

In the EPO the Hawaii-based fleet is limited to 500 mt of bigeye for vessels greater than 24 m in length for the years 2008-2011. The objective of the IATTC conservation and management measure is to reduce fishing mortality on bigeye by about 20%.

All longline vessels in the Western Pacific Region are required to complete a daily logbook of catches, or submit an electronic log, and carry observers if requested by NMFS. There is 20% observer coverage on Hawaii-based deep-set bigeye targeting vessels, 100% coverage on the Hawaii shallow-set swordfish vessels and 7 to 8% coverage on the American Samoa albacore targeting vessels.

The logbook data is used to track the cumulative catch of bigeye from the EPO and WCPO and the fishery is closed by NMFS when the catch limit is projected to be reached. Logbook data on the number of bigeye tuna kept are converted to estimates of catch in metric tons using information on the long-term average weight of the bigeye tuna landed in Honolulu in previous years. The catch forecast is based on the average rates of catch by month during the previous four years. The forecast is uncertain because actual values of future fishing effort, catch rates, and average fish sizes could deviate from the values used in the forecast.

The smaller catch limit for the EPO has proved to be particularly problematic in the past when it was applied to all vessels and was, prior to 2007 much lower (150 mt), since the volume of effort in the EPO may ramp up very rapidly and greatly exceed the catch limit. Conversely, the fishery has also been shut down and subsequently found to have a cumulative catch that is much lower than the annual catch limit.

Hawaiian Islands bottomfish

The bottomfish stock in the Hawaiian Archipelago is managed through the establishment of an annual catch limit for a stock complex of the seven principal species (six snappers and one grouper) in the Main Hawaiian Islands (MHI), termed the “deep seven”. The stock as a whole is not overfished or subject to overfishing, but concerns about declines around the MHI led the Council to implement a commercial ACL for the deep seven complex in 2007-2008 fishing season and has continued to set an ACL for subsequent years (2008-2009, 2009-2010).

Ongoing technical concerns by the SSC and the Western Pacific Stock Assessment Review Panel have meant that the SSC was unwilling to recommend an ABC based on the most recent stock assessment.

Instead the SSC used a simple alternative method to produce recommended allowable catch levels for 2009. Noting the absence of any CPUE trend between 1982 and 2007 (i.e. slope different from zero), the SSC selected the 25th percentile of the entire bottomfish management unit species (BMUS) complex and the catch of the deep seven complex or 348, 334 pounds and 254,050 lbs respectively. The SSC recommended a precautionary ACL of 254,050 pounds for the deep seven complex in the 2008-2009 MHI bottomfish fishing season, and repeated this recommendation for the 2009-2010 season, since a stock assessment incorporating WPSAR recommendations will not be available until 2010.

All commercial vessels must submit a logbook to the State of Hawaii's Division of aquatic Resources on the tenth day of each month. Observers are not deployed on these vessels. These logbooks are used to monitor the cumulative catch and the fishery is closed by NMFS when the catch limit is projected to be reached. The fishery in the Northwestern Hawaiian Islands remains open during the closure period, but is managed through a limited entry program and will close permanently in 2011.

During the two seasons (2007-2008, 2008-2009) that the ACL has been in place, the ACL was exceeded by seven and nine percent, respectively. Fishers catching bottomfish recreationally must report their catches but these are not included in the ACL. However recreational bottomfish catches are subject to the fishery closure.

American Samoa, Guam and CNMI bottomfish

Bottomfish in the three US territories are monitored through creel surveys and trip tickets from commercial fishing. The catch data are then expanded from the surveys to include the commercial and non-commercial landings.

MSYs have been estimated for the deep bottomfish segment of these fisheries, but these have not been used to establish an ACL. Unlike the fisheries in Hawaii, the bottomfish catches from the three US territories contains a substantial fraction of shallow water bottomfish, a mix of mainly reef associated emperors, snappers, jacks and groupers. Current total catches of all bottomfish are between 20 to 30% of the estimated MSY for the deep bottomfish segment.

An SSC Working Group (SSC WG) formed in 2009 recommended that the MSYs of the catch time series for these three archipelagos be broken into catches of deep and shallow bottomfish. The SSC WG also recommended that for these bottomfish fisheries the ABCs be set equal to the MSYs reported by Moffitt et al. 2007, given that catches are well below MSY in American Samoa and CNMI and Guam. Moreover, other indicators contained in the report by Moffitt et al. 2007 indicated that bottomfish in each location all have biomasses >1.5 Bt/B_{MSY} and are subject to fishing mortalities well below F_{MSY}.

No accountability measures have been established for these fisheries. The biggest challenge with establishing AMs will be the monitoring of catches relative to an ACL, since the catch estimates are based on survey expansions. As such, real-time or near real-time monitoring will likely not be possible.

Crustaceans and Precious Corals

These two resources are combined here because little to no fishing activity is currently conducted for crustaceans and precious corals in the Western Pacific Region, although MSYs have been estimated for gold, pink and bamboo corals, and for deepwater pandalid shrimps (*Heterocarpus* spp). Uncertainty about the age and growth of gold coral has led to a moratorium on harvests, while the submersible technology required for harvesting bamboo and pink corals is currently not being employed in the Western Pacific. Currently, the only species being harvested in the Western Pacific Region is shallow water black coral from the Au'au Channel.

With respect to crustaceans, trapping of deep water shrimps are not being harvested in federal waters in Hawaii and CNMI. In the Main Hawaii Islands there is a limited fishery for Kona crab *(Ranina ranina),* which operates within state and federal waters.

MSYs have been estimated for precious coral beds in Hawaii and for the pandalid shrimps iin Hawaii and CNMI.

The SSC WG recommended that, given the zero harvest of pink and bamboo coral, that the ABC for these species should be set as the MSY. As there are no fisheries for these corals, nor have there been for several years, current stocks are logically higher than those at MSY. Moreover, if a fishery commenced and rose to the level of MSY harvest, the fishing mortality would be below F_{MSY} initially, providing sufficient cushion from the effects of overfishing, while developing a revised ABC. With respect to black coral, the SSC WG also recommends setting the ABC for black coral as the MSY, since less than three operators are harvesting black coral and the catches can not be reported or made public, and State of Hawaii has indicated that harvests are below MSY. However, the SSC and Council may wish to recommend to the State that the current harvest of black coral not be exceeded.

The SSC WG recommended that, given the zero harvest of *Heterocarpus* shrimps that the ABC for these species should be set as the MSY. As there are no fisheries for these shrimp, nor have there been for several years, current stocks are logically higher than those at MSY. Moreover, if a fishery commenced and rose to the level of MSY harvest, the fishing mortality would be below F_{MSY} initially, providing sufficient cushion from the effects of overfishing, while developing a revised ABC.

The SSC reviewed the SSC WG report and generated the following control rule for resources where an MSY has been established but there is no current harvest. The Council's SSC proposes to apply a default ABC control rule such that the ABC is set at 0.70 F_{MSY} (= yield 91% OFL = 91% MSY = ABC: see Walters et al 2005) as a precautionary measure, so as to maximize yield while minimizing biomass impact and account for scientific uncertainty.

The AM for precious corals continues to be the State of Hawaii's Commercial Marine License (CML) reporting requirements for black coral and federal permit and reporting requirements for pink, gold and bamboo corals. Bed quotas are already established for the precious corals resource in Hawaii which would prevent overfishing and exceeding the ACL, if harvesting recommenced.

Stock Status	Potential ACL Control Rule
Above B_{MSY}	1.00 x (Recent Catch)
Above Minimum Stock Size Threshold (MSST) but below MSY	0.67 x (Recent Catch)
Below MSST (i.e. overfished)	0.33 x (Recent Catch)

Monitoring of any pandalid shrimp fishery in federal waters through commercial logbooks would be relatively straightforward in order to close the fishery if the ACL was reached.

Kona crab fishing occurs within and beyond state waters in Hawaii and will require determining the volume of catch from federal waters to establish and ACL that covers both zones and monitoring of catches to ensure the ACL is not exceeded.

Coral Reef Species

With the exception of two small pelagics associated with coral reefs akule (*Selar crumenophthalmus*) and opelu (*Decapterus macarellus*) in Hawaii, MSY values have not been established for any other coral reef species in the Western Pacific Region. Some work is being conducted on life histories of jacks, surgeonfish, parrotfish and goatfish in Hawaii Guam, and CNMI but overall there is little information on the demographic parameters such as age, growth, longevity and mortalities of reef fish on fished and unfished reef systems. The NMFS Pacific Islands Fisheries Science Center's Coral Reef Ecosystem Division has generated biomass densities for the Western Pacific Region coral reefs, but absolute biomass estimates are not available, habitat maps are incomplete, and not all depths fished have been surveyed.

The areas of coral reef under Council jurisdiction vary greatly by archipelago. In Hawaii and American Samoa, most coral reef fish are caught within waters under State and territorial jurisdiction. In Guam, substantial volumes of reef fish are caught from offshore banks and seamounts, while in CNMI federal jurisdiction extends up to the high water mark.

In Hawaii, 99% of akule and 85% of opelu are caught within State waters, thus while an MSY is available, the establishment of an ACL by the Council may be little more than a paper exercise. For the remainder of the coral reef species, ABCs and ACLs may have to be set based on the guidance provided by Restrepo et al (1998) for data poor situations where the MSY and the ACL is set based on the evaluation of catch or catch rate trends as shown in the adjacent table.

Some coral reef species might be binned in the ecosystem component but most species of reef fish are exploited or potentially exploitable, not only as food fish but also for the ornamental trade. The most likely strategy by the Council will be to aggregate species into stock complexes, based either in taxonomic groupings (e.g. all surgeonfish, all parrotfish, all butterflyfish), or in trophic assemblages. The latter approach has been tried by the Council (e.g. herbivores, apex predators, secondary predators, omnivores, etc.), but was confounded by the multiple gears that caught a broad overlapping ranges of species. The use of multiple gears is likely to be problematic no matter what aggregation of species is selected.

No accountability measures have been established for any reef fisheries. Commercial reef fish catches are reported on State of Hawaii Commercial Marine License logbooks. Recreational reef fishery catches, which may be substantial, are monitored by the Hawaii Marine Recreational Fisheries Survey, which is a segment of the NMFS Marine Recreational Improvement Program (MRIP). In American Samoa, Guam and CNMI, reef fishery landings are monitored through creel surveys of shoreline and boat-based fishing. The biggest challenge for the establishment of AMs will be the monitoring of catches relative to an ACL, since the catch estimates, apart from the Hawaii commercial catch, will necessarily be based on survey expansions. As such, real-time or near real-time monitoring will likely not be possible.

Progress on developing an amendment to Council FMPs to be consistent with NS1

The Council recently submitted an initial omnibus amendment to NMFS Pacific Islands Region to amend all the FEPs to make them consistent with MSA National Standard 1. The amendment document addressed seven issues and the preferred alternative for these issues selected by the Council were as follows:

Issue 1: Establishment of a mechanism for specifying annual catch limits. The Council would establish and implement ACLs for those stocks having MSYs , except those managed under international RFMOs, and use the likelihood and consequences of overfishing to prioritize the remaining species for ACL development and implementation. This risk ranking would provide the priorities for NMFS' subsequent estimation of MSY values. For situations with limited data availability where MSY values cannot be estimated, appropriate MSY proxy methodologies would be developed via a series of workshops hosted by the Council. These proxies would then be estimated by NMFS. As MSY and/or MSY proxy values are estimated by NMFS (and approved by the Council via its WPSAR process), they would serve as the basis for the implementation of ACLs by the Council using the MSRA process.

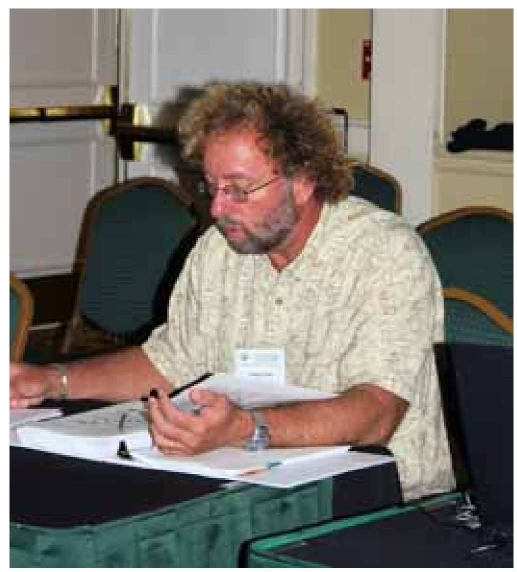
Issue 2: Allocation of ACLs. Under this alternative the Council would not allocate ACLs among gear types, fishery sectors, or other groups at this time and combined ACLs would be established for all managed catches of each species (or species groups).

Issue 3: *Accountability measure.* Federal permitting and reporting requirements would be established for all fisheries subject to ACLs which do not already have mandatory Federal, state or local permitting and reporting requirements.

Issue 4: Implement ACLs in fishing year 2010 for fisheries determined by the Secretary to be subject to overfishing. The Council would continue existing management processes for species subject to overfishing until ACLs are established by the Council using the process recommended here, by no later than 2010.

Issue 5: Determine whether any species should be included in the ecosystem component of managed species. The Council would consider inclusion of FMP listed species in the ecosystem component subsequent to the overfishing risk-ranking recommended in Issue 1.

Issue 6: Determine the process by which OFL, ABC, ACL and ACT values will be established. Two decisions are considered in the alternatives presented here. The first is whether to use a risk-based approach to prioritizing species for ACLs (as previously recommended by the SSC and Council), or to establish and implement ACLs for all managed species simultaneously. The second is whether to task the SSC with estimating MSY values or MSY proxies where necessary (i.e. for species without estimated MSY values or proxies) or to leave this type of work to NMFS and other scientific institutions. The risk-based approach recommended by the Council is be used to establish initial OFL, ABC and ACL values and AMs for all non-RFMO species or species groups which are not included in the ecosystem component. Values for non-RFMO ACL species subject to overfishing (as of December 2008) would be established for implementation by 2010, with values for ACL species with known MSY values and those 5 to 10 ACL species determined to be most at risk of overfishing established for implementation by 2011. Values for the remaining ACL species would be established based on available funding and information.



Q&A

The WPFMC has two FMPs for corals - is there any overlap between the two FMPs? The response was that there is no overlap because Precious Corals are located in deep water (>100m) whereas the Coral FMP covers out to 100m, so there is little if any overlap between resources managed by the FMPs.

New England
Presenter – Steve Cadrin, SSC Chair

New England

Steve Cadrin presented the report "Approaches to Determining Acceptable Biological Catch for New England Fisheries."

National Standard 1 guidelines suggest that "*the determination of ABC should be based, when possible, on the probability that an actual catch equal to the stock's ABC would result in overfishing*" (NOAA 2009). Methods for determining ABCs for New England stocks range from probabilistic approaches for informative stock assessments to data-poor approaches (Table 1).

Probablistic Approach

A statistical approach to deriving *ABC* is to consider *OFL* to be a composite estimate which is a function of projected biomass and F_{MSY}, both of which are estimated with uncertainty:

1)
$$\hat{OFL}_{t+k} = \hat{B}_{\exp t+k}\left[\hat{F}_{MSY}\Big/\left(\hat{F}_{MSY}+M\right)\right]\left[1-e^{-\left(\hat{F}_{MSY}+M\right)}\right]$$

… where $B_{\exp,t+k}$ is the projected biomass k years from the last year of the assessment (t). The most direct approach to deriving *ABC* is as a function of the projected *OFL* estimate and its distribution (Shertzer et al. 2008; either parametrically or nonparametrically):

2)
$$ABC = \hat{OFL} - \sigma_{OFL} z_{p*}$$
or
$$ABC = P_{p*}\left(\hat{OFL}\right)$$

… where σ_{OFL} is the standard error of the *OFL* estimate, z is a function of the desired probability ($p*$; Prager et al. 2003) of exceeding *OFL* (e.g., for p=0.1, z_p=1.96; Figure 1), and P_{p*} is the $p*$ percentile of the distribution of *OFL*. Ideally, $p*$ should be identified in the management plan, but in lieu of guidance on $p*$, stock assessments will have to provide the information needed to derive ABC at a range of reasonable $p*$ values (e.g., $p*$=0.1 to 0.4, z_{p*}= 1.96 to 1.28). Note that fully integrated models that include catch projections as well as MSY reference point estimates are most suited for stochastic projections that account for both components of uncertainty in *OFL* (projected biomass and F_{MSY}) for the derivation of *ABC*.

One complicating factor in projecting uncertainty in *OFL* is that a fixed F=F_{MSY} projection scenario may underestimate uncertainty in *OFL*, because F-based projections are typically less sensitive to uncertainty in $B_{\exp}$. For example, stock size and F_{MSY} from integrated models that estimate both have joint distributions, such that low-$B_{\exp}$;high-F_{MSY} realizations would produce similar *OFL* projections as high-$B_{\exp}$;low-F_{MSY} realizations. Sequential, catch-based projections would incorporate uncertainties more comprehensively. A sequential, catch-based projection would have iterative steps: first, a one-year projection assuming F=F_{MSY} is used to estimate *OFL* in the first year of the projection; next, a two-year projection assumes catch=median *OFL* in the first year and F=F_{MSY} in the second year; and so on…

Accounting for Model Specification Error

The probablistic approach to deriving *ABC* assumes that uncertainty in *OFL* can be accurately measured (i.e., the stock assessment model is correctly specified). If so, stochastic projection of catch associated with F_{MSY} should provide all the information that is needed to derive *ABC*. Unfortunately, many sources of uncertainty are not typically included in stochastic catch projections, and those unaccounted sources should be considered for the objective of avoiding overfishing. Therefore, in addition to stochastic catch projections, unaccounted sources of uncertainty should be identified and measured when possible. Estimates of precision used for stochastic projection assume that the stock assessment and projection model is correct (i.e., the model accurately represents the population and fishery dynamics), but they do not include uncertainty resulting from the model being incorrect.

Two approaches to quantifying model error are retrospective analysis and sensitivity analysis. Retrospective analysis can determine if a pattern of inconsistency exists; and if so, the retrospective inconsistency can be measured. If the magnitude of recent retrospective inconsistency in exploitable biomass is greater than its confidence interval, inconsistency should be considered for the derivation of *ABC*:

3) $$ABC = OFL(1 - \rho_{B\exp})$$

… where $\rho_{B\exp}$ is the retrospective inconsistency in recent estimates of exploitable biomass, expressed as a percentage of the estimate (Mohn 1999).

Another method of quantifying model error is sensitivity analysis, in which differences in biomass estimates among viable model types or specifications can be measured. Similar to the approach described for retrospective error, if the magnitude of model sensitivity for estimating exploitable biomass is greater than its confidence interval, model sensitivity should be considered for the derivation of *ABC*:

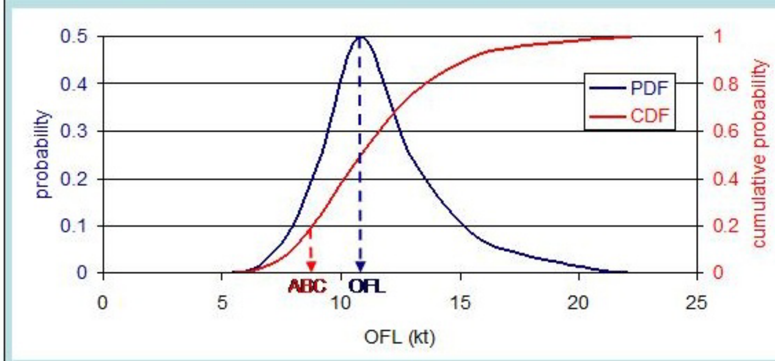
4) $$ABC = OFL\left(1 - \frac{\Delta_{B\exp}}{2}\right)$$

… where Δ_{Bexp} is the relative magnitude of model sensitivity for estimating exploitable biomass, expressed as a percentage of the estimate. Note that unlike retrospective patterns, which are by definition unidirectional, differences among models from sensitivity analysis are bidirectional, so half the relative magnitude would be appropriate for determination of *ABC*. Sensitivity analysis can be used to evaluate different perspectives among alternative stock assessment models, and the approach can be used to evaluate sensitivity to model or projection assumptions for which there is a range of valid assumptions or equally valid decisions. For example:

- What is the sensitivity of the estimate of $B_{\exp}$ to a viable range of natural mortality (*M*)? … alternative selections of survey indices? … time series of data in the assessment? … age-range in the assessment? … selectivity assumptions? …etc.
- What are the sensitivitities of rebuilding expectations to assumed recruitment?

The two examples of deriving ABC from measures of model uncertainty described above assume that all or most uncertainty is represented by retrospective inconsistency (equation 3) or model sensitivity (equation 4). If these measures do not account for the major sources of uncertainty, the buffer between OFL and ABC may need to be derived from both model precision (equation 2) as well as model bias (equations 3 or 4). However, measures of precision and bias are probably not additive.

Figure 1. Distribution of projected catch associated with overfishing (*OFL*) and an example Acceptable Biological Catch (*ABC*) based on a 10% risk of overfishing (p^*=0.1).



<u>Evaluations of Ad hoc *ABC* Methods</u>

All of the above approaches to determining ABC attempt to derive a buffer between OFL and ABC that is based on a measure of uncertainty. Ad hoc approaches to determining ABC can also conform to the guideline to determine ABC based on the probability that it would result in overfishing – if that probability is evaluated. For example, ABC can be based on any percent buffer (x%) between OFL and ABC:

5) $$ABC = x\%OFL$$

… or a similar (but not equalivalent) approach:

6) $$ABC = \hat{B}_{\exp t+k}\left[\frac{x\%\hat{F}_{MSY}}{(x\%\hat{F}_{MSY} + M)}\right]\left[1 - e^{-(x\%\hat{F}_{MSY}+M)}\right]$$

… provided that the probability of overfishing is evaluated. The conventional approach to determining the probability of overfishing is Management Strategy Evaluation (MSE, Butterworth & Punt

Approach	ABC Method	Stock	FMP
Probablistic	P*=0.25	scallop	scallop
Ad Hoc	75%Fmsy	GB haddock	groundfish
	75%Fmsy	GOM haddock	groundfish
	75%Fmsy	redfish	groundfish
	75%Fmsy	GOM cod	groundfish
	75%Fmsy	GB cod	groundfish
	75%Fmsy	CCGOM yellowtail	groundfish
	75%Fmsy	plaice	groundfish
	75%Fmsy	witch	groundfish
	75%Fmsy	GB winter flounder	groundfish
	75%Fmsy	pollock	groundfish
	75%Fmsy	N windowpane	groundfish
	75%Fmsy	S windowpane	groundfish
	75%Fmsy	ocean pout	groundfish
	75%Fmsy	halibut	groundfish
	75%Fmsy	wolffish	groundfish
Rebuilding	Frebuild	GB yellowtail	groundfish
	Frebuild	SNEMA yellowtail	groundfish
	Frebuild	white hake	groundfish
Data-poor	reduced catch	SNEMA winter flounder	groundfish
	reduced catch	GOM winter flounder	groundfish
	recent explitation	N monkfish	monkfish
	recent explitation	S monkfish	monkfish
	median exploitation	skates	skate
	recent catch	herring	herring
	recent catch	red crab	red crab

1999), which involves a series of simulations:

1. A complex operating model is simulated that captures all important dynamics of the population and fishery system; such that the operating model is structurally more complex than the stock assessment model.
2. The operating model is used to generate multiple sets of routine stock assessment information (e.g., fishery catch, fishery samples, surveys) measured with error.
3. The stock assessment method is used to analyze the simulated assessment data and calculate the Ad hoc ABC in equation 5.
4. The ABC is removed from the simulated population in the next year of the simulation.
5. The process is repeated to develop a time series of assessment and management realizations, and replicated many times to generate multiple simulation series.

For the purposes of ABC determination, MSE can evaluate the probability of overfishing as the relative frequency of $F > F_{MSY}$. Other performance criteria (e.g., frequency of depleting the stock to less than ½ B_{MSY}, average long-term yield, variability in yield, economic yield) can also be evaluated to inform the management system on performance with respect to other management objectives.

Rebuilding ABCs

According to national standard guidelines, "*For overfished stocks and stock complexes, a rebuilding ABC must be set to reflect the annual catch that is consistent with the schedule of fishing mortality rates in the rebuilding plan*." Therefore, if the ABCs described above are not expected to meet rebuilding goals (i.e., biomass at or above B_{MSY} by the end of the rebuilding period with the desired probability), ABC should be based on $F_{rebuild}$:

7)

$$ABC = \hat{B}_{\exp,t+k}\left[\hat{F}_{rebuild} \Big/ \left(\hat{F}_{rebuild} + M\right)\right]\left[1 - e^{-\left(\hat{F}_{rebuild} + M\right)}\right]$$

… where $F_{rebuild}$ allows rebuilding to B_{MSY} by the end of the rebuilding period with the desired probability.

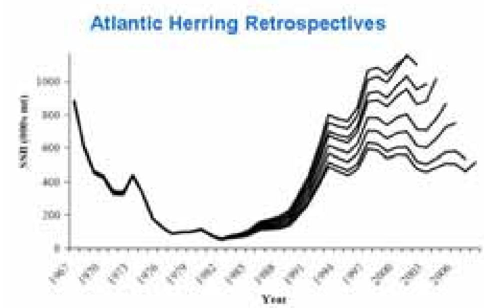
Data-Poor Approaches to interim ABCs

Many stock assessments do not support the estimation of quantities needed to derive ABC as specified in national standard guidelines. However, catch advice is mandated for all fisheries, with few exceptions. Therefore, interim ABC methods are needed until more analytical approaches to ABC can be developed. Accordingly, data-poor stock assessments should provide information on sources and magnitudes of uncertainty in the assessment, particularly with respect to catch advice. In data-poor situations, interim ABC can be based on the magnitude of catch or exploitation index during periods of stability (or periods of stock increase for rebuilding plans).

In the first year of transition to an OFL-ABC-ACL-AM system, the Science and Statistical Committee of the New England Fishery Management Council derived ABC recommendations based on the best scientific information available, which varied depending on the quality of stock assessment information. Despite the variety of approaches to deriving ABC among New England stocks, the underlying standard of preventing overfishing was the objective of each method.

Q&A

During his presentation Steve clarified that the scallop assessment is Y/R based, the SSC recommended a P* of 25% for scallop, that the groundfish example of percentile of projected catch was for illustrative purposes, and commented on the inconsistencies in the model estimates of SSB of herring in the terminal years and on the Council's recommendation of a 17% buffer rather than 40%.



Regarding the selection of an ABC for herring, it was noted that the selection seems to involve both a process issue and a science aspect. While it appears that the Council seems to have "cherry picked" a 17% buffer rather than the 40% as recommended by the SSC, the Council also has issue with the way assessment was revised in response to the retrospective analysis. The SSC intends to address the issue from a scientific perspective.

Rick Robbins from the MAFMC noted that black seabass caused a similar issue and the MAFMC is trying to deal with it at the process level, and specify the process and conditions when a request for reconsideration of ACLs may be warranted. The technical issue with herring and retrospective issues complicates things for New England. Rick noted that the Councils are in a transitional period, but that SSCs and Councils have pretty clear authorities.

One of the problems of using Y/R type of assessment is that it assumes that the fishery is having no impact on the reproductive potential of the stock. It was recommended that the SSC address this issue in its write-up of the control rule.

Regarding the scallop fishery, it was pointed out that the formation of MPAs has complicated the estimation of MSY and resulted in increasingly more restrictive regulations on the open areas even as the population in the closed areas has improved. Yet, science has as yet not developed methodology to handle the situation.

Mid-Atlantic

Presenter – Mike Wilberg, SSC Member

Mike Wilberg presented the paper "Development of ABC Control Rules." The following clarifications were made during the presentation: 1) The third bullet on slide 5 (Preprocessing of data (precision) relates to the standard errors being carried into the assessments, and 2) the 4th bullet on slide 6 (Model uncertainty (precision and bias) would include multiple assessment models but one has as yet been employed.

This draft control rule is still under development by the Mid-Atlantic Fishery Management Council's SSC and its Scientific Uncertainty subcommittee. The framework for characterizing assessments using a tiered system has been supported in principle by the SSC, but the specific methods for determining ABC given the assignment of an assessment to a category have not been decided. Thus, this draft may not reflect the final control rule that will be adopted by the Mid-Atlantic Fishery Management Council.

In the revised MSA, the SSC of each of the eight regional management Councils has been tasked with recommending ABC levels. The goal of an ABC is to avoid overfishing by incorporating scientific uncertainty into catch level recommendations. Importantly, the ABCs will constrain the annual catch limit (ACL) that must be set by the Council, as the Council cannot set an ACL above the ABC recommended by its SSC. For the purposes of this document, we will define uncertainty as follows: Uncertainty, 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.

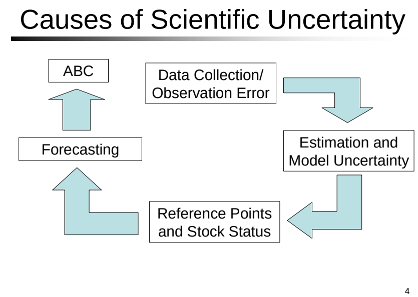
Our goal is to develop a framework for forming ABC recommendations for MAFMC, based on information and results from stock assessments and potentially other outside sources. These recommendations should therefore identify the types of estimates needed from future stock assessments as well as how these data and estimates will be used in the development of ABCs.

Desirable characteristics of methods for developing ABCs include that they are relatively simple, can be developed from multiple assessment models, and that they do not penalize improvement of information by the stock assessment. The methods should be relatively easy to apply and understand, and should not require use of one specific type of assessment model to the exclusion of others.

Scientific uncertainty

Many factors affect our understanding of past population dynamics of a stock, its current status, and how it will respond to fishing in the future. Other authors have developed ways to categorize uncertainty (e.g., Mace and Sissenwine 2002), but we have characterized uncertainty by when it enters the assessment process and how it affects ABC calculations. Because our characterization focuses on the ABC calculation, it does not include other common sources of uncertainty such as implementation uncertainty. These uncertainties enter into the stock assessment process at four points: data collection, parameter and reference point estimation, and forecasting. Data uncertainty includes factors that affect the quality of the data such as the sampling design (Hilborn and Walters 1992). Many sampling designs do not lend themselves well to the estimation of uncertainty. For example, if total catch is estimated through log books of fishers and these log books are not verified or validated, quantifying uncertainty would be challenging. Common methods of estimating uncertainty would not be helpful because the measurements themselves are never verified – the uncertainty cannot be estimated without auxiliary data. Sources of data uncertainty may include:

• Location in space and time of collection relative to stock's range,
• Methods of collection (appropriate for organism, validation),
• Vital rate (natural mortality, growth, maturation, etc.) estimation (data collection and validation),
• Development and standardization of indices of abundance, and
• Survey design (statistical properties, sample size, statistical design, potential catchability changes due to changes in survey).



The second category of uncertainty arises from the use of assessment models themselves. Models, by definition, are simplifications of reality. The simplifications often used in stock assessment and forecasting models contain considerable uncertainty in drivers of recruitment dynamics, effects of mortality sources, etc. Predictions and estimates from these models also contain estimation uncertainty (i.e., uncertainty caused by not having taken a census of the population, not directly measuring the process of interest, or not incorporating all of the causes of variation in the models). Sources of model uncertainty include:
• Assessment methods differ in their quality (accuracy) of estimates in ways that are not well understood. Qualitatively, this uncertainty is indicated by a lack of fit to data sources (i.e., patterns in residuals) and retrospective patterns,
• Estimation uncertainty describes the precision of assessment model estimates,
• Model uncertainty (including assumed parameter values). Fitting different assessment models to the same data set can often produce more variability in estimates than indicated by the precision of estimates from a single model, and
• Method for estimating uncertainty. The methods for estimating uncertainty rely on

suites of assumptions. The degree to which these assumptions are met is often suspect.

Data and models are used to estimate the current status of the stock, which is then compared against reference points that are often calculated external to the assessment model. The reliability of both measures influences the degree of overall scientific uncertainty that must be incorporated into the calculation of ABC levels. For example, reference point values are point estimates or proxies of an underlying random variable. In both cases we can expect there to be a variance associated with these estimates that should be incorporated into ABC estimation.

Examples of such sources of uncertainty include the use of proxies (Williams and Shertzer 2003; Punt et al. 2008). FMSY is not estimated directly for most MAFMC species, and non-stationarity of reference points over time.

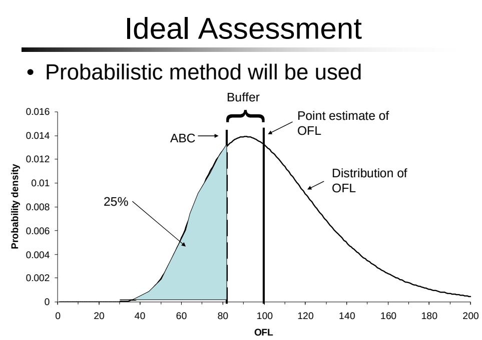
Ultimately managers and stakeholders are interested in how policies influence the sustainability of the fisheries and the stocks on which they rely. Ideally, this requires developing forecasts of the future stock status under alternative management actions. Forecasts have associated uncertainties that include:
• Non-stationarity of processes. This may be unimportant for short-term forecasts,
• How to handle uncertainty not included in the assessment, and
• Process error in population dynamics.

Other considerations, such as productivity of the stock, have also been suggested as important enough to warrant inclusion in ABC recommendations. This may be a concern if productivity has not already considered in reference point estimation. This procedure has been called productivity susceptibility analysis with the idea that management should be more precautionary for species with low productivity or high susceptibility to fishing.

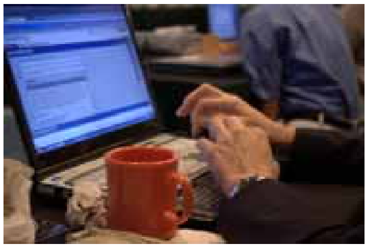
Draft ABC Control Rule

The Mid-Atlantic Fishery Management Council's (MAFMC) SSC has developed a tiered approach to setting an ABC based on the results of a stock assessment. The approach defines four levels of assessment quality defined by five characteristics within each level. The ABC will be calculated using a different method in each tier of the framework. The levels of stock assessments and their characteristics are defined as:

Level 1: Ideal assessment
Attributes of the stock assessment that would lead to inclusion in this category are:
• Assessment model includes appropriate and necessary detail of the biology of the stock, the fisheries that exploit the stock, and the data collection methods
• Estimation of stock status and reference points integrated in the same assessment framework
• Assessment estimates relevant quantities including MSY, reference points, stock status together with their respective uncertainties
• No retrospective patterns
• Assessment model promulgates all uncertainties (stock status and reference points) throughout estimation and forecasting.



When an ideal assessment is achieved, the assessment results are likely unbiased and fully consider uncertainty in the precision of estimates. When this occurs, the ABC will be determined solely on the basis of the acceptable probability of overfishing (P*) determined by the Council's risk policy and the probability distribution of the overfishing limit (OFL; level of catch that would achieve FMSY given predicted biomass). The OFL distribution will be estimated during the stock assessment or directly from the results of the stock



assessment. We term this the probabilistic approach. A probabilistic method of setting reference points while considering uncertainty in stock status as well as in reference point application was proposed by Prager et al. (2003) and later expanded by Shertzer et al. (2008) and Prager and Shertzer (in press). These methods explicitly consider uncertainty and probability of overfishing in determining ABCs.

The probabilistic method uses the distribution of OFL, which characterizes scientific uncertainty, and a level of acceptable probability of overfishing, P*, to determine ABC. Having the full distribution of OFL implies that FMSY and current biomass are estimated with their associated uncertainty. In this approach the ABC is calculated from a fully stochastic projection model that can include any relevant source of uncertainty that has been estimated. The procedure then determines the distribution of stock abundances given some a priori probability of overfishing, P*.

The figure shows the potential distribution of OFL with the point estimate of OFL (solid line) and ABC (dashed line). ABC is determined by the acceptable level of probability of overfishing. In this example the acceptable level of probability of overfishing is 25%, which means that ABC is set equal to the 25th percentile of the distribution of OFL. The difference between OFL and ABC is the buffer that is allowed for uncertainty.

Level 2: Preferred assessment

Attributes of the stock assessment that would lead to inclusion in this category are:

• Assessment approach includes key features of the biology of the stock, the fisheries that exploit it, and the data collection methods
• Estimation of stock status and reference points are integrated in the same assessment framework
• Assessment estimates relevant quantities, including reference point (which may be proxies) and stock status, together with their respective uncertainties
• Retrospective patterns present, but are small in scale (<10%)
• Uncertainty is considered, but is not fully promulgated through the model

Assessments in this category likely have minimal bias, but likely underestimate precision.

In this level, ABC will be determined by using the Council's risk policy, as with an ideal assessment, but with a proxy for the OFL distribution. The method for determining the proxy OFL distribution for this level has not yet been determined.

Level 3: Acceptable assessment

Attributes of the stock assessment that would lead to inclusion in this category are:

• Assessment approach includes essential features of the biology of the stock and the fisheries that exploit it
• Stock status and reference points are estimated, but are not necessarily integrated in the same assessment framework
• Assessment estimates some relevant quantities including reference points (which may be proxies) and stock status; some of these have associated estimates of uncertainty
• Large retrospective patterns present (>10%)
• Uncertainty is not considered beyond bootstrapping of recruitment in projections.

Assessments in this category are likely to provide inaccurate estimates and substantially underestimate the precision of estimates. This level will require an assumed distribution of OFL, like Level 2. In this level, ABC will be determined as with an ideal assessment using the Council's risk policy, but with a proxy for the OFL distribution. The method for determining the proxy OFL distribution for this level has not yet been determined.

Level 4: Unreliable assessment

Stock assessments in this category are deemed to have reliable estimates of trends in abundance, but absolute abundance, fishing mortality rates, and reference points are suspect. These assessments may have passed the best available science criterion because they: 1) are a significant improvement over previous methods, 2) are considered a better integrative approach than relying on any single data source, or 3) are considered reliable for trends, but not overall stock biomass. Specific attributes for inclusion in this category are:

• Assessment approach is missing essential features of the biology of the stock, characteristics of data collection, and the fisheries that exploit it

• Stock status and reference points are estimated, but are not considered reliable
• Assessment estimates some relevant quantities including biomass, fishing mortality or relative abundance, but only trends are deemed reliable.
• Large retrospective patterns usually present
• Uncertainty may or may not be considered, but estimates of uncertainty are probably substantially underestimated.

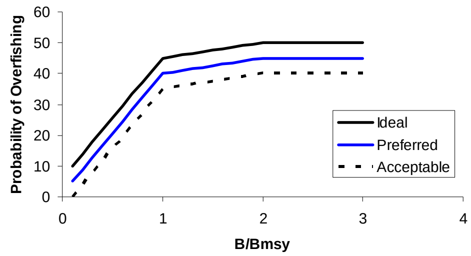
In this level, a simple control rule (e.g., Cox and Kronlund 2008; Dowling et al. 2008) will be used based on trend in biomass and catch history. If biomass is stable, the ABC will be set at that of the most recent year. If biomass is decreasing, ABC will be set by decreasing the recent year's quota by the same proportion as the estimated decrease in stock size. For stocks with increasing biomass, increases in ABC would be done cautiously, and would be at a rate less than the rate of increase in biomass. The SSC will determine, based on studies or expert judgment, the specifics of the control rule that would be expected to attain the Council's risk policy.

Q&A

A participant asked what their plans are regarding the inclusion of all uncertainties through the analyses within their control rule tier structure. Mike indicating they are looking at model priors and recruitment variability among other topics and think that all these uncertainties should be incorporated in one framework, but have not settled on an implementation plan.

Regarding the addition of standard errors in their lower tiers, a participant asked how they will handle the tradeoff between precision and accuracy of the OFL estimates. Because they have noted what they believe to be overly precise estimates of MSY and Bmsy, they are thinking about taking a two-prong approach taking a data-rich species and conducting assessments using alternative models and comparing how they perform relative to variability of estimates of MSY and Bmsy.

In response to a question, Mike indicated that they intend to add more error in the lower tiers as indicated in his talk and adjust



P* as indicated on a slide, but they are still working out the specifics of how to accomplish this.

A concern was raised about penalizing in the lower tiers and providing incentives in the higher tiers since this was close to patting ourselves on the back for doing good science for science sake. Some of the hard choices regarding penalties and incentives might occur in the middle tiers. The reasons for making these adjustments need to have sound scientific justification.

South Atlantic

Presenter – Carolyn Belcher, SSC Chair

Carolyn Belcher's presentation was entitled *"ABC Control Rule for South Atlantic Species -- Final Concept."*

The SAMFC SSC first discussed acceptable biological catch (ABC) control rules in June 2008 in response to publication of a proposed rule addressing National Standards 1 (NS1) guidelines for the Magnuson-Stevens Reauthorization (MSRA). An issue paper outlining various alternative approaches to establishing ABC was provided to the Council in September 2008. The Council supported further developing a control rule approach which specified ABC as a function of yield at maximum sustainable yield (MSY) and assessment uncertainty. The Council further specified that ABC should be set at a level providing a 25% chance of overfishing, with a range of values corresponding to 10 to 50% chance of overfishing. The Council intends to specify ABC control rules in its comprehensive annual catch limit (ACL) amendment.

Although the approach suggested in September 2008 provides guidance for assessed stocks for which the probability of overfishing can be provided in terms of yield, it does not address those stocks that lack assessments. Therefore, the SSC requested a special meeting for March 2009 devoted solely to developing an ABC control rule that could be applied to all managed stocks. During that meeting, the SSC developed the control rule reflected in this document after much deliberation and discussion.

First, the group decided on general characteristics and components of the rule and developed a framework of dimensions and tiers. Dimensions reflect the critical characteristics to evaluate, including data and assessment information availability and life history traits. Tiers are objective levels within dimensions that reflect the range of information available. Each tier is assigned a score which contributes to the overall adjustment factor.

Once the general approach was established, a number of example stocks were put through the framework to ensure that it included adequate tiers to accommodate a variety of circumstances and appropriate dimensions to adequately address uncertainty. This exercise led to considerable further discussion that better defined the concepts and resulted in some tiers being combined to keep the rule as parsimonious as possible. The following sections of this document describe the tiers and summarize critical discussions that occurred during development.

An important caveat must be stated upfront. The approach described here is applicable when the OFL can be stated in weight and some measure of statistical uncertainty about the OFL can be estimated. Future discussions and development will focus on ways to apply this methodology in a consistent manner to stocks for which the OFL or its statistical uncertainty cannot be estimated.

Control Rule Concept

The SSC agreed that the ABC control rule should provide an objective means of determining the buffer, or amount of separation, between the overfishing level (typically MSY) and the ABC. The desired rule should evaluate multiple characteristics, accommodate varying data levels and assessment information, and incorporate productivity and susceptibility measures.

Finally, the control rule should provide objective adjustments to the probability of overfishing according to key risk factors, with actual ABCs expressed as yield in biomass obtained through a probability density distribution or a "P*" analysis.

Discussion of the general concept and approach led to creation of a system of dimensions composed of multiple tiers that are scored to provide a value that can be used to select the appropriate probability of overfishing for each stock. Each stock evaluated receives a single "adjustment factor", which is the sum of tier scores across dimensions and which ultimately determines the amount of buffer or separation between OFL and ABC. Adjustment factors are subtracted from the "base probability of overfishing" to provide the "critical probability". The base probability of overfishing is the value used to determine OFL. The critical probability is a probability of overfishing that is used to determine ABC in the same manner that the base probability is used to determine MSY and OFL. Through this process, tier scores equate to an adjustment in the probability of overfishing occurring, and do not represent, or necessarily correspond to a specific poundage or percentage of the OFL. Recommended ABC values are derived from probability density functions that provide the probability of overfishing occurring for any particular yield.

Control Rule Characteristics

The SSC began deliberations by developing a list of desirable characteristics and principles for ABC control rules. These included:
- Incorporate a tiered system based on data and assessment information availability
- Include objective criteria with numerical scoring that can be applied to all stocks
- Incorporate stock status
- Reflect the degree to which uncertainty is characterized
- Acknowledge the cumulative nature of uncertainty
- Provide a means to incorporate vulnerability and life history traits, ideally through inclusion of productivity-susceptibility analyses (PSA) scores
- Provide flexibility to accommodate a wide range of biological characteristics, assessment methods and information, data availability, and assessment age
- Provide an objective means of incorporating potential changes in data and assessment information availability over time

Control Rule Dimensions

The SSC incorporated these general characteristics and principles into a series of tiers and dimensions that form the foundation of the control rule. Four dimensions are included in the proposed control rule framework: assessment information, characterization of uncertainty, stock status, and productivity/susceptibility of the stock. Each dimension contains multiple levels or tiers that can be evaluated for each stock to determine a numerical score for the dimension. The four dimensions and their tiers are described in detail in the following section and summarized in the adjacent table.

Dimension 1. Assessment Information

The assessment information dimension reflects available data and assessment outputs. The five tiers within this dimension range from a full quantitative assessment which provides biomass, exploitation, and MSY-based reference points to the bottom tier for those stocks which lack reliable catch records.

The age or degree of reliability of an assessment can be incorporated when determining the scoring for an individual stock. For example, a stock having a pre-SEDAR assessment may be ranked at a lower tier despite that assessment having the required outputs for a higher tier, because the reliability of an output value cannot be determined or the method by which an output was obtained is not clearly documented. Estimates from an assessment may be considered unreliable or inapplicable when considered at a later date (e.g. assumed equilibrium conditions may have changed). Similarly, an age-aggregated assessment approach may provide an estimate of MSY, but in some instances such estimates may be considered less reliable than estimates from an age-structured approach. The intent is that tier rankings are based on the data and outputs considered reliable at the time the ranking is made. Scores for these tiers increase as the level of available information declines.

Assessment Information

Tier Description	Penalty
Quantitative assessment provides estimates of exploitation and biomass; includes MSY-derived benchmarks.	0.0
Reliable measures of exploitation or biomass, no MSY benchmarks, proxy reference points	2.5
Relative measures of exploitation or biomass, absolute measures of status unavailable, proxy reference points	5.0
Reliable catch history	7.5
Scarce or unreliable catch records	10.0

Dimension 2. Characterization of Uncertainty

This dimension is considered critical because it specifically addresses language in the MSRA stating that ABC should be reduced from OFL to account for assessment uncertainty. Because accounting for uncertainty tends to be a cumulative process, an incomplete or partial accounting of known uncertainties will tend to underestimate the underlying uncertainty in the results. Tiers for this dimension reflect how well uncertainty is characterized, not the actual magnitude of the uncertainty. The magnitude is incorporated through the assessment and is reflected in the distribution of yield estimates. Adjustment scores for this tier increase as the degree and completeness of uncertainty characterizations decrease.

Uncertainty Characterization

Tier Description	Penalty
Complete. Key determinant – uncertainty in both assessment inputs and environmental conditions are included	0.0
High. Key determinant – reflects more than just uncertainty in future recruitment	2.5
Medium. Uncertainties are addressed via statistical techniques and sensitivities, but full uncertainty is not carried forward in projections	5.0
Low. Distributions of Fmsy and MSY are lacking	7.5
None. Only single point estimates; no sensitivities or uncertainty evaluations	10.0

Uncertainty Tiers, Examples, and Scoring

1. Complete. This tier is for assessments providing a complete statistical (e.g. Bayesian re-sampling approach) treatment of major uncertainties, incorporating both observed data and environmental variability, which are carried forward into reference point calculations and stock projections. A key determinant of this level is that uncertainty in both assessment inputs and environmental conditions are included. No currently assessed stocks meet this level.

2. High. This tier represents those assessments that include re-sampling (e.g. Bootstrap or Monte Carlo techniques) of important or critical inputs such as natural mortality, landings, discard rates, age and growth parameters. Such re-sampling is also carried forward and combined with recruitment uncertainty for projections and reference point calculations, including reference point distributions. The key determinant for this level is that reference point estimates distributions reflect more than just uncertainty in future recruitment. (-2.5). Example: SEDAR 4, South Atlantic snowy grouper and tilefish.

3. Medium: This tier represents assessments in which key uncertainties are addressed via statistical techniques and sensitivities, but the full uncertainties are not carried forward into the projections and reference point calculations. Projections may, however, reflect uncertainty in recruitment and population abundance. Although outputs include distributions of F, F_{MSY} as in the 'High' category above, in this category fewer uncertainties are addressed in developing such distributions. One example for this level is a distribution of F_{MSY} which only reflects uncertainty in recruitment. (-5). Examples: SEDAR 15, South Atlantic red snapper and greater amberjack; SEDAR 17, South Atlantic Spanish mackerel and vermilion snapper.

4. Low. This tier represents those assessments lacking any statistical treatment of uncertainty. Sensitivity runs or explorations of multiple assessment models may be available. The key determinant for this level is that distributions for reference points are lacking (-7.5). Example: SEDAR 2, South Atlantic black sea bass

5. None. This tier represents assessments that only provide single point estimates, with no sensitivities or other evaluation of uncertainties (-10). Example: None.

Dimension 3. Stock Status

Stock status is included among the dimensions so that an additional adjustment to ABC can be added for stocks that are overfished or overfishing. Five tiers are included, ranging from a high biomass and low exploitation level where no additional buffer is applied to the situation where either is unknown and the highest buffering is applied. With the exception of distinguishing between the top two tiers which both reflect stocks that are neither overfished nor experiencing overfishing, application of these tiers is straightforward and based directly on the final status determinations, independent of the sensitivity or uncertainty in that final determination. Scores for these tiers increase for decreasing and unknown stock status.

Stock Status

Tier Description	Penalty
Neither overfished nor overfishing. Stock is at high biomass and low exploitation relative to benchmark values	0.0
Neither overfished nor overfishing. Stock may be in close proximity to benchmark values	2.5
Stock is either overfished or overfishing	5.0
Stock is both overfished and overfishing	7.5
Either status criterion is unknown	10.0

Dimension 4. Productivity and Susceptibility Considerations

The final dimension addresses biological characteristics of the stock. This includes productivity, which reflects a population's reproductive potential, and susceptibility to overfishing, which reflects a stock's propensity to be harvested by various fishing gears. Efforts to quantify these characteristics, generally termed "PSA analyses", typically incorporate a variety of life history characteristics in a framework that distills many metrics into a single risk score. The two primary approaches currently available, one from NMFS and the other from Marine Resources Assessment Group (MRAG), follow similar procedures, but incorporate slight differences in how characteristics are scored and how missing information is addressed. For example, the MRAG formulation incorporates a scoring value for parameters for which values are unknown into the overall score, whereas the NMFS formulation omits from scoring those parameters where the values are unknown.

After presentations on both approaches and considerable discussion on their differences, the SSC decided to incorporate the MRAG formulation of PSA into the SAFMC ABC control rule. The SSC believed this approach to be preferable based on the broad suite of attributes considered in the scoring and the inclusion of unknowns in the scoring. In general, it is believed that including unknowns in the scoring will provide stronger encouragement to address the unknown parameters since doing so will in many cases tend to moderate the buffer contributed by the PSA value. Further, because unknown information contributes to overall uncertainty, accounting for potential unknowns in the scoring is consistent with the underlying control rule framework.

Productivity and Susceptibility - PSA

Tier Description	Penalty
Low Risk. High productivity, low vulnerability, susceptibility low.	0.0
Medium Risk. Moderate productivity, moderate vulnerability, moderate susceptibility	5.0
High Risk. Low productivity, high vulnerability, high susceptibility	10.0

Determining Total Adjustment and Final ABC Recommendations

The uncertainty buffer, or difference between OFL and ABC, is expressed in terms of a reduction in the "probability of overfishing", or "P*". The adjustment score provided by the tiers and dimensions represents the amount by which P* is reduced to obtain the critical value for P*. Therefore, the key product of the control rule is the sum the scores for all the dimensions because that is the ABC adjustment factor that is used to calculate the critical value for P* from the base P*. The scoring of tiers within dimensions is designed to provide a maximum P* adjustment of 40% and a minimum of 0%. When applied to the base MSY specified at the 50% level, this range of possible adjustment results in a range of critical values for P* from 10% to 50%. These critical values are then used to determine the actual ABC using projection tables that provide the level of annual yield that corresponds to a particular P*.

The ABC adjustment factor is obtained by summing the scores across dimensions once the data are evaluated and tier assignments are made within each dimension. The scoring system is designed so that low values are assigned for the 'best' circumstances and the values increase as circumstances worsen. Considering dimension 1 for example, a stock which has an assessment providing estimates of biomass, exploitation, and MSY-based reference points would have a score of 0, while a stock which is unassessed and has unreliable catch records would receive a score of 10. Each stock will be categorized by tiers before the score is tallied so that categorizations are made independent of the final outcome.

The critical P* is expressed as a probability of overfishing and is derived by subtracting the ABC adjustment factor from 50%. For example, if the adjustment factor (sum of the dimension scores) is 20, the critical value for P* will be 30% (50% minus 20%), and the ABC recommendation will be based on a 30% probability of overfishing occurring in the year for which the recommendation is made. Note that, due to varying shapes in the distribution of estimated yield, it is unlikely that the observed difference

between MSY and ABC will equal the difference between the P* that defines MSY and the critical P*, and it is also unlikely the two stocks receiving identical critical P* values will reflect equal differences between ABC and OFL when such differences are compared in weight units.

Setting ABC equal to OFL implies a P* equal to 50%, where 50% represents the chance of overfishing occurring. Reducing P* will reduce ABC and provide a reduction in the probability of overfishing occurring. The relationship between the amount of reduction in P* and the resulting reduction in ABC is determined by the shape of the distribution of yield about the management parameters. For a given reduction in P*, broad distributions (suggesting higher uncertainty) will result in larger reductions in ABC, whereas narrower distributions (suggesting lower uncertainty) will result in smaller reductions in ABC.

Using the ABC control rule described here, the range of P* that is considered acceptable is from 50% to 10%. This range was derived after considering Council guidance directing the SSC to consider ABCs based on probabilities of overfishing between 10% and 40%, general guidance under the MSA that management actions must have at least a 50% chance of success, and the common practice of specifying MSY based on the midpoint of a distribution of possible outcomes. The top tier in each dimension does not reduce P*, so the ABC recommendation for a stock receiving the top score across all dimensions would be the same as the OFL recommendation and there would be no buffer applied between ABC and OFL. While this may be perceived as potentially risk-prone, and inconsistent with some interpretations of the language describing ABC with regard to OFL, the only situation in which this would occur in this framework is for a stock with a complete assessment, including full probability-based uncertainty evaluations, that is at low exploitation and high biomass, and is considered highly productive with low vulnerability and susceptibility. It should be noted that none of the stocks examined so far meet these criteria, and those stocks that have not been examined lack stock assessments and therefore they too will fail to meet these criteria.

The SSC considered whether each dimension should be equally scored and contribute the same relative weight to the final adjustment factor. After discussing various weighting schemes and approaches, the SSC determined that there was insufficient justification at this time to weight any particular dimension greater than another as all are considered important to objectively evaluating overall uncertainty. However, the SSC also recognizes that this could change and the ABC could be modified in the future if evidence develops that suggests one dimension should be more influential than the others.

The SSC is cognizant that ABCs, and the degree of separation between ABC and OFL will be compared across stocks when recommendations are reviewed. The SSC also recognizes the importance of being consistent when evaluating the level of information for a wide range of stocks. In discussing ways of promoting consistency when multiple stocks must be evaluated, the SSC decided that tier assignments should be made within a single dimension for all stocks under consideration, as opposed to evaluating single stocks across all dimensions. This will help ensure that the data level for each stock is evaluated relative to and consistent with other stocks being considered. It is anticipated that approaching the process in this order will help avoid situations where stocks with similar conditions receive different tier ratings.

Overfished Stocks and Rebuilding Plan Selection

The adjustment factor can also be used to derive a probability of rebuilding success for selecting rebuilding schedules. The probability of rebuilding success is determined by subtracting the P* critical value from 100%, such that stocks with high P* values could be managed using a rebuilding schedule that approaches the 50% level commonly used now, and those with the lowest P* values will require rebuilding schedules with higher probability of success, up to a maximum of 90%.

The adjustment factor for stocks achieving the lowest scores across all dimensions would be 0, resulting in a P* of 50% which would lead to the recommendation of a rebuilding schedule with a 50% (100% minus 50%) probability of success by the end of the rebuilding period (Tmax), consistent with most current rebuilding schedules. The adjustment factor for stocks receiving the highest scores across all dimensions would be 40%, resulting in a critical P* of 10% (50% baseline minus 40% for buffer adjustment) and compelling a recommendation for rebuilding projections based on a 90% probability of success by the end of the rebuilding period.

Values for the rebuilding success probability are provided for all stocks in Table 2 for illustration of the concept, although in application only stocks with a status of 'overfished' would require this parameter. Because the decisions required to develop the rebuilding plan are the same ones required to develop ABC, this framework allows estimation of both the rebuilding schedules and the final yield for a rebuilt stock from a single set of decisions. The only change required once a stock reaches the rebuilt status would be to calculate an updated adjustment factor reflecting the change in stock status from 'overfished' to 'not overfished and not overfishing'. Any such changes can be evaluated efficiently and quickly, and the system is essentially self-adjusting to critical events such as a change in stock status because the criteria and scorings are all determined in advance.

Using red porgy as an example, the total buffer adjustment factor of 15 results in a critical P* of 35% (50% baseline minus buffer adjustment of 15%) and a rebuilding probability of success of 65% (100% baseline minus P* of 35%). However, once the stock is rebuilt and the stock is neither overfished nor is overfishing occurring, scoring within the status dimension changes from Tier 3 (adjustment value of 5) to Tier 2 (adjustment value of 2.5) and the overall adjustment factor decreases by 2.5 to 12.5. The expected critical P* for the rebuilt stock becomes 37.5 and the expected ABC for the rebuilt stock can be determined from the probability distribution table of MSY at equilibrium or rebuilt conditions. In management terms, the resultant recommendations for red porgy would be to select a rebuilding plan with at least a 65% chance of achieving SSB>SSBMSY within the allotted rebuilding time period, followed by a recommendation to manage not to exceed a 37.5% chance of overfishing occurring once the stock is rebuilt.

Depletion Threshold

The NS1 guidelines state that an 'ABC control rule…may establish a stock abundance level below which fishing would not be allowed.' Currently the Pacific Fishery Management Council uses a 10% threshold. Specifically, if biomass is estimated below 10% of the virgin condition, then directed fishing is not allowed. The SAFMC SSC supports the concept of a depletion threshold and elimination of directed fishing when SSB falls below the threshold, and recommends that the threshold be established at 10% of unfished conditions. The SSC will recommend that directed fishing not be allowed if there is a reliable indication that current biomass is at or below 10% of the unfished biomass or, in cases where biomass estimates are considered unreliable, if SPR is at or below 10%.

<u>Q&A</u>

In response to the SAFMC comments, the SSC made some revisions to the approach. The Council supported the use of MSY estimates from stock assessments for setting ABCs, and indicated a preference for a buffer of P* = 25%.

In response to a question about how they deal with P* for data poor species, Carolyn indicated that they need better estimates of the variation in OFL and they need further guidance on how best to proceed.

A participant noted that when you go from high to lower uncertainty, the penalty might get smaller, but the pdf will get larger as you do a better job. In response, South Atlantic SSC members indicated that while they have a good first order approximation of uncertainty, they are trying to track down additional sources. There was interest expressed in the PFMC approach across all assessments to get an integrated look at total uncertainty and make appropriate adjustments to ABC.

Others opined that it was more appropriate and logical that we put forward properly adjusted variances rather than P* per se. An SSC member noted that if you increase variance, most of us imagine a nice smooth function, but in reality you have strange, possibly even bimodal distributions. Under these circumstances it is not clear how one should proceed.

To put things in perspective, an SSC member suggested that we view this as a first step in a long process of developing and setting ABCs. While not perfect, the SSC products would be good enough for the Council to understand the issues and concepts, resulting in progress in managing the species. There was interest in not having the buffers shift from one assessment to another.

At the first annual national SSC meeting, two precedents were established regarding the setting buffers, specifically 25% and 50%. So far at this meeting, many different buffer adjustments have been presented. A participant hoped that consensus would be reached regarding this issue.

It was asserted that the MSA called for an integrated buffer encompassing both scientific and management uncertainty (a P*** approach rather than separately a P* and P**approach). In response to the question of why they did not choose the NMFS PSA approach, Carolyn stated that they chose the MRAG approach because it concentrated on scientific criteria and that this relates to setting ABC. A followup question asked what the PSA analysis had to do with scientific uncertainty in the estimates of OFY. Two SSC participants indicated that they were using PSA as a tool to capture and quantify in some sense the poor level of knowledge (uncertainty) of life history and other parameters used explicitly or implicitly in stock assessments.

In response to a query of whether the SSC has role in identifying a range of P* values, Carolyn noted that the SAFMC SSC had this discussion. This is what resulted in their selection 0.50 as a value to start with and then adjusting downward.

Gulf of Mexico

Presenter – Doug Gregory, SSC Chair

The Gulf of Mexico Fishery Management Council formed an ABC Control Rule Working Group to develop a structured decision-making framework to assist in assessing scientific uncertainty, the probability of overfishing, and acceptable levels of risk when setting acceptable biological catch (ABC). The working group, which consists of SSC members, Council members, Council staff, and NMFS staff is expected to have a draft ABC control rule document ready for full SSC review by December 2009.

The working group reviewed ABC methodological approaches being considered by some of the other SSC's and found the framework recently developed by the South Atlantic Fishery Management Council's SSC to be the most complete and applicable to Gulf of Mexico fisheries. Therefore, the working group recommended adoption of a modified version of the SAFMC framework as the basis for developing the Gulf Council's ABC control rule.

The South Atlantic Council's ABC control rule is comprised of a framework of dimensions (critical characteristics to evaluate) and tiers within each dimension that reflect the range of information available. Each tier is assigned a score, and scores are summed across stocks to provide an overall adjustment to the acceptable probability of overfishing, which is then used to calculate the buffer between the ABC and OFL. A summary of the dimensions and tiers currently being considered for the ABC control rule is presented below:

- **Assessment information**
  - Reflects available data and assessment outputs
  - Separate stocks into data 'rich' and data 'poor'
- **Characterization of uncertainty**
  - Reflects how well uncertainty is characterized in assessment
  - Identify stocks suitable for P* analysis
- **Stock Status**
  - Reflects final status determinations
  - Emphasized for data 'poor' stocks
- **Productivity and Susceptibility**
  - Evaluation of "biological risk"
  - Emphasized for data 'poor' stocks
  - Must be balanced between ABC and ACL control rules

It is important to note that this ABC control rule is applicable only when the OFL can be well determined—i.e., estimates of F_{MSY} and stock biomass are available—and some measure of statistical uncertainty about the OFL can be estimated. In the SAFMC procedure, the uncertainty buffer (or difference between OFL and ABC) is expressed in terms of a reduction in the "probability of overfishing" (P*) as defined in Shertzer et al. 2008. Consequently, this approach is applicable only to relatively "data-rich" stocks for which stock assessments are available.

According to the NS1 Guidelines, the size of the buffer between OFL and ABC depends on how scientific uncertainty is accounted for in the ABC control rule, i.e., setting ABC equal to OFL implies little or no scientific uncertainty while larger buffer sizes imply larger uncertainty. However, for a given level of uncertainty, the size of the buffer is also dependent on the risk of overfishing desired—i.e., the smaller the buffer the higher the risk that actual catch may exceed OFL. The Gulf Council, working with the ABC Control Rule Working Group, specified that ABC should be set within a range of values corresponding to a 15 to 45% chance of overfishing. The range adopted by the Council will be used by the working group to set the range of P* values incorporated into the ABC control rule.

Regarding the incorporation of productivity and susceptibility analysis (PSA) into the ABC control rule, the working group heard presentations, reviewed documents, and discussed methodological characteristics of two PSA approaches: (1) the NMFS PSA approach described in Patrick et al. 2009, and (2) the PSA analyses conducted by MRAG Americas for the Ocean Conservancy (Rosenberg et al. 2009). After much discussion the group is recommending that the NMFS PSA methodology be used as part of the Gulf Council's ABC control rule framework.

Next immediate steps for the working group to tackle include:

- Make necessary control rule adjustments (development of meaningful scores, etc.) given the Gulf Council's input on acceptable levels of risk (15% to 45% probability of exceeding OFL).

- Develop a decision tree to translate the Gulf Council's range of risk into meaningful proxies for 'data poor' stocks.

- Hold follow up meeting (or webinar) in late November to review approaches discussed at the National SSC Meeting, especially for 'data poor' species.

- Include Full SSC review and comment/input of the draft control rule at its December 2009 meeting

<u>*Q & A*</u>

The approach is similar to that presented for the South Atlantic. No questions or comments were made.

Caribbean

Presenter - Barbara Kojis, SSC Chair

As reported at the first National SSC meeting in Hawaii, SEDAR (Southeast Data, Assessment and Review) had been unable to successfully complete any stock assessments because of inadequate species specific data. In January 2009, the data available for Puerto Rico and the US Virgin Islands (USVI) was evaluated at the Caribbean Fisheries Data Evaluation SEDAR Procedures Workshop 3 to determine whether it was sufficient to carry out a stock assessment for any species. They concluded that species or species group specific commercial landings data for the USVI were unavailable or unreliable for most species and species groups. While species specific data have been collected in Puerto Rico using trip tickets, they concluded that there were also problems with this data for many species, e.g. lumping of species, misidentification of species, reporting catches from several trips on one trip ticket, etc. MRFSS recreational fishing data are being collected in Puerto Rico, but the data provide limited information because of insufficient port sampling. MRFSS was unsuccessful at obtaining data in the USVI and information on the recreational fishery is very limited.

The workshop produced a table with ratings of the quality of commercial, recreational and fishery independent data available for species listed in the Caribbean Fishery Management Council's fishery management plans. The workshop determined whether the data were sufficient to warrant either a full SEDAR benchmark assessment (BENCH) or OFL advice (OFL). It was assumed a benchmark assessment would also render OFL advice. Of the 38 species/species groups managed by the CFMC and evaluated by the workshop, less than half of species/species groups had data sufficient to warrant either a benchmark assessment or OFL advice in Puerto Rico. The percentage was even less in the USVI (Table 1).

Table 1: Percentage of the 38 species and species groups managed by the CFMC that would warrant a benchmark assessment or OFL advice in the US Caribbean.

Jurisdiction	% BENCH	% OFL	Total
Puerto Rico	10.53%	36.84%	47.37%
St. Thomas/St. John	5.26%	21.05%	26.32%
St. Croix	10.53%	18.42%	28.95%

Subsequent to the workshop, the Annual Catch Limit Plan Development Group (ACLG) (a group with responsibility to review the fisheries data and provide advice to the SSC on OFL and ABC) met and provided ACL recommendations based on average annual catch. While the SSC could not refute the catch level recommendations of the ACLG, given the limited available data and the resulting lack of adequate assessments, the SSC determined that it could not currently estimate values for OFL and ABC for most stocks/groups.

The SSC developed and approved the use of eight scenarios` for Caribbean OFL and ABC as a basis for management advice. The appropriate scenario for any specific stock complex will depend on the data available for that complex. Each scenario specifies whether the calculation of an OFL is possible, and provides management advice. If estimates of OFL are available, the SSC could give ABC recommendations in accordance with a Council-agreed ABC control rule.

Of the 5 species/species groups designated as undergoing overfishing in the 2005 FMP Amendment, all five were assigned to Scenario 7, in which data quality and availability prohibit the determination of OFLs, ABCs, and ACLs. The SSC recommended that species falling under Scenario 7 control the fishery with the purpose of collecting needed data and take into account fishery independent research. Catch and/or effort for species falling under Scenario 7 would be limited to what is required to collect sufficient data and participation in the fishery would be dependent on following all data collection protocols. Subsequently, the SSC clarified this statement because the SSC's intent was not to curtail fishing for these species, and submitted the following statement to the CFMC:

The SSC recognized the need to provide management advice, and as an alternative to estimating ABCs and OFLs, the SSC developed a list of scenarios that provide stock/group specific guidance dependent on the data availability for each stock/group. The SSC's list of scenarios is viewed as an iterative document by the SSC, which can be edited and improved over time, as more information becomes available and more discussion takes place. The current version is specifically meant to apply to stocks/groups that have been declared as undergoing overfishing.

The SSC asserts that a precautionary approach to management should be taken when stocks/groups have been declared to be undergoing overfishing and there is inadequate science to determine the level of catch/effort at which overfishing ends. The status quo is not acceptable once a fishery has been declared to be undergoing overfishing. It could be argued that under precautionary management, there should be no fishery for any stock/group undergoing overfishing without adequate assessment information. However, the SSC recognizes that without a fishery as the source of critical information, there would be little chance of ever reopening a closed fishery or determining the status of a stock/group. Therefore, the SSC has addressed this dilemma by recommending the creation of a scientific fishery to collect the data necessary to conduct an assessment, and thereby scientifically manage the fishery.

The SSC recommends creating an experimental design for a protocol to collect the information needed to do an effective assessment. Collaborative efforts between the Federal government, the territorial governments, MRAG, and the fishers are currently underway to develop an experimental design that will succeed at meeting this goal. When implemented, the magnitude of the resulting fishery should be based on the sample size required to conduct an assessment, taking into account the status of the stock/group, the level of uncertainty regarding its status and ability to end overfishing and rebuild stocks/groups, if needed, and set the level of risk deemed acceptable by the Council.

In the meantime, until an efficient experimental design is implemented, catch/effort levels for stocks/groups identified as undergoing overfishing should

be set below the levels experienced before the SFA amendment. Regulations have already been put in place to reduce catch/effort below those levels. It is not possible to provide a quantitative estimate as to the degree to which overfishing has been reduced or eliminated since implementation of the new regulations, given the available data and the short timeframe, but qualitative information is available, in at least some instances.

The NS1 guidelines require incorporation of scientific uncertainty while setting catch levels. In this case that means: (1) how uncertain are we as to whether the stocks are overfished and/or undergoing overfishing and (2) how uncertain are we as to whether an existing or proposed management regulation would allow a stock to rebuild and/or end overfishing? The more uncertain, the greater the reduction required. For stocks/groups that fall under Scenario 7, the SSC should meet and discuss these questions relating to the stocks/groups subject to overfishing. The SSC can likely provide qualitative guidance, based on informed judgment, to the Council as to the level of uncertainty that exists regarding the two questions above on a stock/group by stock/group basis.

"If I were Spencer Baird in 1876 and wandered into Woods Hole and I knew there were a whole bunch of people fishing, and some were complaining that the fish had gotten smaller and they couldn't find them anywhere, and others were saying everthing is fine, what would I do? I probably wouldn't put in a catch quota, since I didn't know what the catch is and I had no way to actually enforce it anyway. That, in some sense, is where the Caribbean is with respect to what it has to do with some of these stocks."

Mike Sissenwine

There is potential for the SSC to be able to provide guidance on catch limits in the short term, while waiting for the new data collection procedure to be implemented and data and assessments to become available. This would involve recommending adjustments around current regulations based on informed judgment on the status of the stock and how well the regulations are likely working, taking into account our uncertainty around both. For example, if there is sufficient evidence that current regulations have likely ended overfishing, there may be no need to add further regulations. In fact, given sufficient evidence, regulations could be relaxed. Similarly, if uncertainty is so large that little is known about the impact of new regulations on a stock thought to be undergoing severe levels of overfishing, additional regulations may be necessary. The SSC would be providing guidance not based on values of OFL and ABC, which aren't possible to estimate at this point in time. Instead, informed judgment would be used to recommend modifications to current regulations. At the current time, this approach has been discussed in general terms only among a small number of SSC members. Developing this into an objective procedure would not be a trivial task. The full SSC would need to discuss the concept, decide if it is worth pursuing, discuss how to implement it, then formally approve its usage. The SSC is not sure whether this could be done within existing timelines, but believes it would be beneficial to pursue, as it may have potential for providing longer term guidance, as well. Most importantly, this puts the SSC in its proper role, as defined in the Magnuson-Stevens Reauthorization, of specifying the science-based catch limits incorporating scientific uncertainty, rather than turning over this responsibility to the Council.

Note that the SSC is not recommending shutting down fisheries as the default position until the new data collection protocols can be implemented. The SSC is also not calling for further reductions beyond those already put in place, by default. Whether or not further reductions below current catch levels are needed should be determined taking into account the SSC's qualitative answers to the two questions in the preceding paragraph and the level of risk the Council is willing to adopt. The bottom line is that there is no easy answer to setting ACLs in the U.S. Caribbean.

The SSC in essence reiterated that its main concern was that participation in Scenario 7 fisheries requires following all data collection protocols. Catches of a number of these species/species groups had already been curtailed in both Federal and territorial waters by the management measures that had been implemented after the 2005 SFA Amendment.

The SSC also recommended that one of the species groups undergoing overfishing, the parrotfishes, be divided into two groups, the large, rare species, and the smaller, more common species. If this is done, then the catch for the large, rare species should be set to 0 and the other group would fall under Scenario 4. Under Scenario 4 there is sufficient data to determine catch. The SSC advised the CFMC that catch levels for species/species groups falling under Scenario 4 should not exceed average catch in recent years (determined on a case by case basis) and could be decreased if the Council wants to be precautionary. Subsequently, the SSC made recommendations and provided rationale that largely supported the ACLs proposed by the ACLG.

The CFMC requested and the SSC concurred that Puerto Rico, St. Thomas/St. John and St. Croix, each be managed separately. Puerto Rico and St. Thomas/St. John District lie on the Puerto Rican Bank along with the British Virgin Islands. St. Croix is 40 miles south of St. Thomas is separated from the other jurisdictions by a very deepwater channel. The commercial and recreational fisheries and the fishing cultures of the three jurisdictions are quite different. Fisheries and socio-economic data are currently being analyzed separately for each jurisdiction.

Efforts are underway to revise the commercial fisheries data collection system. The fishermen's catch report forms are in the process of being carefully revised to take into account the difficulties small scale fishers, fishing in a highly diverse coral reef ecosystem, have in accurately reporting their catch and effort. The revisions will help ensure that OFL and ABC can be determined from the data that fishers are required to submit on catch report forms, along with other fisheries dependent and independent data being collected during the same period. Other fisheries dependent data are being reviewed to ensure better compliance with data gathering requirements and sufficient sample sizes. It is hoped that the fisheries dependent data collection system will be finalized by the spring of 2010. The possibility of using fisheries independent sampling programs to determine the status of the fisheries is also being pursued.

To conclude, to date the SSC has only been able to determine OFL and ABC for severely overfished species/species groups with life histories that make them particularly vulnerable. For these species OFL and ABC has been set to 0.

Q & A

Barbara added that there is one unknown and potentially large factor that could affect the Caribbean fisheries: the invasive Indian Ocean lionfish (*Pterois volitans*). Lionfish grow to large sizes, are a voracious predator, and are not prey to other species in the Atlantic. Lionfish numbers are rapidly increasing in the Caribbean. Hundreds of lionfish were captured in a recent 'roundup' in the Bahamas. Nine lionfish have been collected in St. Croix and one taken in St. Thomas.

Rick Methot noted that the major island groups in the US. Virgin Islands are a good example of a situation that should have more spatially explicit assessment and management because once the fish larvae settle out of the plankton, movement is restricted. Another participant noted that while stock structuring on a larger scale (U.S. Virgin Islands, British Virgin Islands, and other Caribbean locations) was not known, he opined that this was a minor issue compared to dealing with OFL, ABC, and ACL.

In response to a question of whether there were any large MPAs that might be used to investigate depletion due to fishing, Barbara reminded participants that President Bush recently created some quite large monuments. While these are being monitored, stock levels do not seem to be different inside or outside the monuments. Enforcement may be an issue and could affect interpretation of depletion sutdies. Another participant noted that pioneering work in using MPA in California to address depletion outside the MPAs is promising and should be given serious consideration.

Using PSA to Address Uncertainty

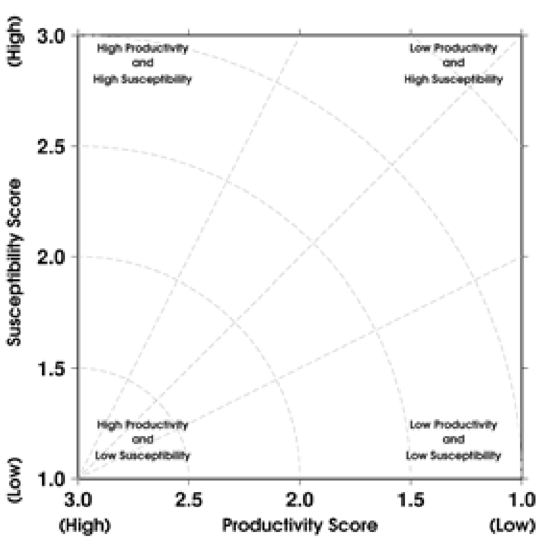
Wes Patrick (NMFS) presented "Using stock vulnerability in setting level of risk aversion". The following is an extended abstract of his presentation, which was coauthored by Paul Spencer (NMFS).

Assessing Vulnerability

In January 2008, NMFS created the Vulnerability Evaluation Work Group (VEWG) to provide a methodology for determining the vulnerability of a stock to overfishing. The vulnerability of a stock to becoming overfished is defined in the National Standard 1 (NS1) guidelines as a function of its productivity ("the capacity of the stock to produce MSY and to recover if the population is depleted") and its susceptibility to the fishery ("the potential for the stock to be impacted by the fishery, which includes direct captures, as well as indirect impacts to the fishery"). The guidelines note that the "vulnerability" of fish stocks should be considered when: 1) differentiating between stocks "in the fishery" and "ecosystem components"; 2) assembling and managing stock complexes; and 3) creating management control rules.

The Approach

Tasked with providing a tool that is flexible in its use and comparable across fisheries and regions, the VEWG reviewed several risk assessment methods to determine which approach was best-suited for the NS1 guidelines' use of the term vulnerability. While quantitative modeling provides the most rigorous method for determining whether a stock is vulnerable to becoming overfished or is currently experiencing overfishing, insufficient data exists to perform such modeling for many of the stocks managed by NMFS. Therefore, the VEWG focused on developing a flexible semi-quantitative methodology that could be used in many fisheries and regions. The Productivity and Susceptibility Assessment (PSA) was selected as the best approach for examining the vulnerability of stocks, because it can be based on qualitative data, has a history of use in other fisheries, and is recommended by several organizations and work groups as a reasonable approach for determining risk.



The PSA was originally developed to classify differences in bycatch sustainability of the Australian prawn fishery by evaluating the productivity of a stock to its susceptibility to the fishery (Stobutzki et al. 2001). The productivity and susceptibility of a stock was determined by providing a score ranging from 1 to 3 for a standardized set of attributes (*N*=13) related to each factor. The scores were then calculated for each factor and graphically displayed on an x-y scatter plot. Stocks that received a low productivity score and a high susceptibility score were considered to be the least sustainable (i.e., high vulnerability), while stocks with a high productivity score and low susceptibility score were considered to be the most sustainable (i.e., low vulnerability).

Modifications to the Original PSA Methodology

While the VEWG agreed that the PSA was an appropriate model in which to base their vulnerability evaluation, the work group began meeting in January 2008 to revise the methodology based on the proposed revisions of Hobday et al. (2004) and Rosenberg et al. (2007), as well as making additional revisions to provide more flexibility for its use in diverse U.S. fisheries.

Revisions include:

- Selecting an appropriate number of Productivity and Susceptibility attributes;
- Redefining the scoring matrix to provide break points related to US fisheries;
- Developing a universal weighting system;
- Developing a Data Quality Index; and
- Addressing different sectors and gear.

Example Applications

The VEWG selected seven fisheries (Northeast Multispecies Groundfish, Atlantic Shark Complexes, South Atlantic/Gulf of Mexico Snapper-Grouper Longline Fishery, California Coastal Pelagics, California Nearshore Groundfish, Bering Sea/Aleutian Island Skate Complex, and the Hawaiian Pelagic Longline Fishery) to evaluate the effectiveness of its vulnerability evaluation. Overall, 166 stocks were examined, and the results provided some interesting trends in vulnerability scores (see adjacent figure). The work group finished its report in March 2009 (Patrick et al. 2009), and resources for conducting a vulnerability analysis can be found on the NMFS website.

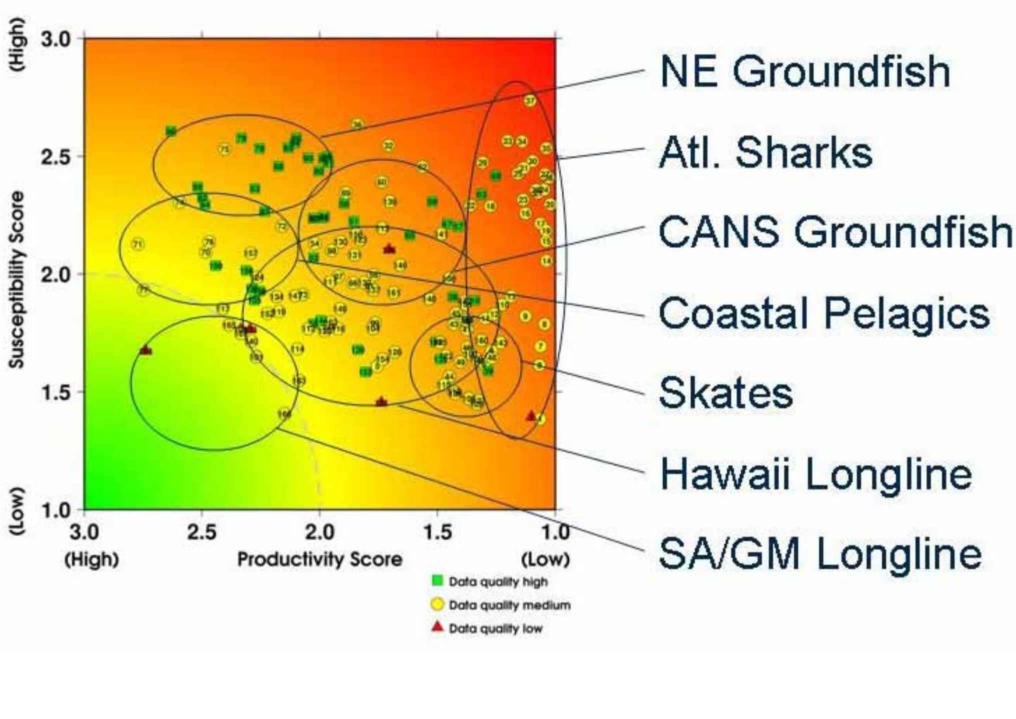
Q & A

In response to several questions on how his conceptual framework might be used, Wes reiterated that NMFS recommended the use of PSA for: 1) differentiating between stocks "in the fishery" and "ecosystem components"; 2) assembling and managing stock complexes; and 3) creating management control rules. Others asked if there was an appropriate cut off for differentiating between stocks of various vulnerabilities. Wes noted that VEWG thought that the appropriate cut off scores would vary among fisheries, so the SSCs should determine these cut-off scores on a case-by-case basis. Wes also recommended the use of cluster analysis to group similar groups of species.

In response to a question about missing some important aspects of vulnerability such as the state of the ecosystem, Wes suggested that these issues could be addressed through the OY determination process. He also explained that some of the attributes used in the spreadsheet analysis of the PSA could be replaced by others if they were more relevant to the stock in question.

Another person asked for the rationale for selecting the ~150 stocks used to calibrate the scoring bins of some of the productivity attributes. In particular, the person noted the lack of some prominent species in Hawaii. Wes noted that the stocks were selected to represent the broad array of species captured in the US, with approximately 25 species from each region being selected. The VEWG thought the snapper, grouper, sharks, tunas, and swordfish species listed represented the Hawaii fisheries very well. While some of the Hawaii groundfish species may have been lacking, the life histories of the species were likely well represented by Pacific and Northeast region groundfish species.

> *"I think PSA can provide a lot of insight into data-poor situations as well as add value to even the highest tier stock assessments. You may wonder why I say that, but there's a lot of biological complexity wrapped up into a very few parameters in a lot of stock assessment models."*
>
> **Don Kobayashi**



"I see the responsibility for deciding how much risk is acceptable as a policy management decision and not a scientific decision. That's my interpretation of why it's important that the council ultimately has to agree on an ABC control rule.

When I go in to buy insurance and I say this is what I want to guard against a certain risk with a $1,000 deductible, and somebody comes back and tells me that I can get a $500 deductible for only a few dollars more, am I cherry picking because I make the decision that I'll take a different deductible? I do think we have to realize that the decisions people are making are risk decisions which include a cost function and they also need to decide on that cost function."

Mike Sissenwine

"To ask the councils to provide a P without letting them look at the tradeoff analysis first is like not doing any consumer research before going to buy your insurance policy. I think they should see the rate sheets before making their decision. Once that decision gets made, it would have been based upon science information and once made, it would be then codified back into the control rule, which is just a statement of policy. It's not necessarily a formula, but it's a statement of policy and that control rule would then be the starting point for the SSC in making their ABC recommendation."*

Rick Methot

Discussion of Scientific Uncertainty

This section includes the discussion that followed Rick Methot's presentations on ACL and Uncertainty, as well as discussion that occurred on this topic later in the meeting.

The NS1 guidelines offer the Councils the option of dealing with scientific and management uncertainty separately or in one step - is there a preferred method? It was noted that the process of evaluating the effectiveness of the buffer between OFL and ABC to account for scientific uncertainty must take into account the degree to which future catches would match the ABC. The Council's have the option of separating the question or dealing with all sources of uncertainty in one step - either is acceptable so long as both sources of uncertainty are accounted.

The NS1 guidelines state that to set ABC=OFL would require conditions where there is virtually no scientific uncertainty about OFL. The question arose about cases where, for social and/or economic reasons, a particular resource is abundant due to low fishing mortality (i.e., low fishing effort). In these cases, could ABC be specified to equal OFL since there would be little chance that overfishing would occur due to the low desirability of the species? Setting ABC=OFL would be contradictory to the overall approach in the NS1 guidelines, and in the situation described, the setting of ABC below OFL would not impose a new constraint on the actual fishery.

It was noted that there are economic costs associated with applying a buffer to OFL to derive a precautionary ABC to account for scientific uncertainty. Achieving ABC is not the only goal because the MSRA requires achievement of OY at the same time. It was noted that, by definition, if you reduce the probability of overfishing by increasing the buffer between ABC and OFL, you are simultaneously increasing the chance of under fishing and foregoing yield. At what step in the ABC/ACL specification process are decisions made relative to these tradeoffs? Rick responded that the issue is a function of the specification of OY and, therefore, the tradeoff between lowering the risk of overfishing and foregoing yield should be evaluated during the OY specification process.

The question was asked if the goal of setting ABC is to achieve a given fishing mortality rate or stock size, (i.e., which is the best target - fishing mortality rate or stock size)? The target of a FMP is to achieve optimum yield, which is in terms of long-term catch and benefits. ABC is an annual biological limit, in terms of catch, that constrains the OY policy. All rebuilding plans are cast in terms of stock abundance (i.e., the stock must be rebuilt to B_{msy} or a suitable biomass proxy). The goal is to set a rebuilding fishing mortality rate, as a limit, that allows the stock to grow to B_{msy} in the time period specified in the stock rebuilding plan. Therefore, both fishing mortality rates and stock biomass must be considered in the overall approach.

The question was raised if in data poor cases where even catch is not reliably estimated, is there a potential to use spatial management under the new ABC/ACL paradigm? That management tool has not been identified as an alternative to ABC/ACLs, but it could be used to help control the amount of catch. Leaving some portion of the stock protected from fishing mortality has some merit in terms of reducing fishing mortality, but those reductions are difficult to quantify. There is also the chance that there is a false sense of security in terms of protecting the stock from fishing mortality through area closures, especially for highly mobile stocks. The use of area closures is not addressed in the guidelines and their use would not explicitly address the requirements to specify ABC/ACL.

The buffer between ABC and OFL is to be set as a function of scientific uncertainty. Does stock size matter? In the context of accounting for scientific uncertainty the answer is no. In the context of achieving OY it may make sense. ABC control rules can be constructed such that the target F declines with declining stock size in order to guard against further declines and hasten the return to B_{msy} stock levels. However, building in a varying buffer conditional on stock size is different from varying the buffer based on scientific uncertainty. Specifying a larger buffer at lower stock sizes is separate from setting buffers based on scientific uncertainty. As with all buffers, their combined effect should be analyzed.

It was noted that reference points are being treated as static quantities when in reality we know that we are dealing with dynamic systems. How do we get at specifying variable reference points? In response, it was pointed out that these are not static reference points. They are annual realizations of outcomes through the application of ABC control rules. They should change in response to dynamics of the stock. Control rules need to be evaluated and updated to reflect changing conditions (of course this is easier said than done). One needs to think in terms of the time frame of response. Careful attention needs to be paid to differentiation between normal random variability versus changes that are systemic in nature.

It was noted that the NS1 guidelines state that Councils may choose to use a control rule that incorporates scientific and management uncertainty in one step. It is important to determine how managers are incorporating scientific uncertainty in the ACL specification, which will depend on the flow of information from the SSC. It was also noted that if council's choose to integrate scientific and management uncertainty in a one step process, it is important to keep in mind that exceeding an ACL triggers AMs. By setting an ACT less than the ACL preserves the ability to exceed the target without immediately triggering AMs.

The general question arose as to who has the responsibility to determine the appropriate level of risk to be taken in developing ABC/ACL specifications. In other words, is the determination of an acceptable level of risk a scientific or management responsibility? There was general agreement that the development of a risk policy is a management (Council) responsibility informed by science. The development of ABC control rules should be a joint management and scientific process. In addition, the SSCs may need to exercise professional judgment so some flexibility must be available to the SSCs in the application of ABC control rules. Overall, the development of a risk policy is a management responsibility under the purview of the Councils as informed by science (i.e., based on advice from the SSC).

Participants had a discussion about who is responsible for actually performing the calculations/running the models to calculate values of OFL, ABC, ACL, etc.? It was noted that the terms of reference (TORs) for a given stock assessment should specify these responsibilities as well as list the information needed for determination of OFL and ABC values. In most situations, it is expected that for quantified assessments, values of OFL and ABC would be generated by the assessment, using methods reviewed by the technical peer review body prior to final determination by the SSC.

There was a discussion about the pros and cons of building buffers by adjusting P*, versus adjusting the probability distribution to account for unmeasured contributions to uncertainty. Measuring uncertainty is a work-in-progress and most Councils are still evaluating buffers from OFL and ABC based on levels of uncertainty. The panel basically agreed that managers need to address appropriate P*, and SSCs may be able to develop distributions from that selection. This selection is in essence a risk acceptance level, and stakeholders may also have input as to risk involved, perhaps on a stock-by-stock basis, particularly in data poor situations. It was pointed out that buffers may be built in other ways than adjusting P*, such as using tiers of data uncertainty that change the size of buffers as stocks are classified in different tiers. Again, participants felt that the Councils

"For those of us in the Southeast, we are asking the council to choose an insurance policy without knowing what it costs or what it covers. We don't have any probability distribution functions to show them. We are asking them to choose a P in a vacuum, and without knowing if the functions are going to be narrow or wide. Once they see what they're going to look like, they may want to change how much they're willing to spend on that insurance policy."*

Doug Gregory

"Whether we adjust P or whether we adjust the uncertainty in the distribution of OFL or whether we do both, comes back to the question of whether we can link a decision back to a risk policy. What does the P* mean in situations where you don't think that the distribution of OFL actually represents the true uncertainty in OFL?"*

Mike Wilberg

"I agree that in these early stages P is the easier component to adjust, rather than changing the distribution, but we need to recognize that in the next stage of ABC implementation we will have to put our unmeasured sources of uncertainty into the distribution. If we start manipulating P* to alias for other sources of uncertainty, I think we're going to paint ourselves into a corner."*

Steve Cadrin

"Quantification of scientific uncertainty for use by the councils is in an embryonic stage of development. Our approach was to take what we thought were dominant sources of uncertainty, but certainly not all of them. I don't think anybody in this room would propose that we will be able to account for all sources of scientific uncertainty in the next ten years."

Steve Ralston

need to see how varying P*s affect the size of buffers and make recommendations to their SSCs.

It was noted that model uncertainty varies based on the model used. In some cases, uncertainty may not be able to quantified. This suggests that proxies for unmeasured components of uncertainty may be needed for stable application of the P* approach.

There was discussion about whether or not there should be a consistent buffer in data poor situations (catch only data). In general, workshop participants did not believe that there was a "one size fits all" solution, and "data poor" was a relative term that could range from no data to some data, albeit not adequate for most modeling exercises. The issue could perhaps be addressed through a workgroup on more of a case-by-case basis.

Workshop participants discussed that PSA was currently being used in developing ABC control rules in South Atlantic and Gulf; however, this was a work-in-progress. It was noted that these results and others will need to be evaluated for applicability to individual stocks and assemblages. It was suggested that PSA may also be useful in defining stock status and providing advice to the councils on a level of acceptable risk when setting ACL relative to ABC. It was noted that PSA could inform the lumping of species into assemblages. Additionally, the PSA can be useful for identifying species needing conservation and management. There was also an expression of caution in using PSA for the assessed stocks because several components of productivity are also used in the calculation of F_{msy}.

Hitting the Target

Background

National Standard 1 (NS1) states that "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." NS1 requires that management measures balance the requirements of preventing overfishing and achieving optimal yield (OY). The Magnuson-Stevens Act defines the term "optimum," with respect to yield from a fishery as the amount of fish which:

"(A) Will provide the **greatest overall benefit to the Nation**, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems;

(B) Is prescribed as such on the basis of the maximum sustainable yield from the fishery, **as reduced by an relevant economic, social, or ecological factor**; and

(C) In the case of an overfished fishery, **provides for rebuilding** to a level consistent with producing MSY in such fishery."

OY is essentially a long-term average amount of the desired yield for a stock, stock complex, or fishery. The specification of OY is important because it gives the Councils a mechanism to consider ecological, economic, and social (EES) factors. The specification of OY also provides a clear and transparent evaluation of the fisheries priorities for producing the greatest benefits to the Nation, including obtaining a desired level of long-term average yield. The inclusion of EES factors provides a logical step to incorporating ecosystem-based approaches into fisheries management.

The Magnuson-Stevens Act requires that FMPs: assess and specify the present and probable future condition of OY from the fishery; include a summary of the information utilized in making OY specifications; and assess and specify the extent to which U.S. fishing vessels will harvest the optimum yield. The Magnuson-Stevens Act also requires that Councils review on a continuing basis, and revise as appropriate, their OY assessments and specifications. The National Standard 1 guidelines provide the Regional Fishery Management Councils and the Secretary guidance on how OY should be specified, examples of benefits to consider when reducing MSY to OY to achieve the greatest benefit to the Nation, and examples of EES factors that could be considered in the OY analysis.

There are a variety of OY definitions in the current Fishery Management Plans. Some OY specifications explicitly mention EES factors, but many do not. However, the decisions on how a fishery is managed, are often based on ecological, economic, and social reasons. The management measures in turn have an impact on the management uncertainty in the fishery. Many OY definitions have not been reassessed in a long time. Because ecological, economic, and social factors are always changing, OY should be revisited periodically. An FMP must contain an assessment and specification of OY and a Council must identify those economic, social and ecological factors relevant to management of a stock and evaluate them to determine the stock's OY. Because achieving OY is the goal, it would be informative to compare catches to OY. If management measures cannot prevent overfishing while achieving OY, the Councils should reevaluate the management measures and specification of OY so that the dual requirements of NS1 are met.

"An annual OY and an ACT are derived at differently, but they conceptually represent the same thing. I think we would expect that the ACT and the annual OY should be fairly close, and if they are significantly different, it may indicate that the OY specifications or the management measures in the fishery need to be reevaluated."

Deb Lambert

How does OY relate to the ACT?

OY is the desired yield from a stock or fishery. OY specifications are supposed to prevent overfishing so should consider scientific and management uncertainty in addition to ecological, economic, and social factors. Because OY is based on MSY, the NS1 guidelines describe it as a long-term average value. However, because OY is the desired yield from a stock/fishery, it may be useful to think about OY in terms of an annual value. Some fishery managers designate an annual OY value, which is consistent with the long term OY, but reflects the short term fluctuations in stock abundance. Over time, the average of these annual OY values should be the specified OY for the fishery.

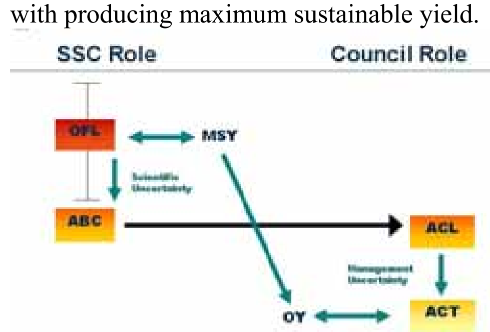
In the ACL framework, the annual catch target (ACT) is a target catch amount specified to account for uncertainty in management of the fishery, in order to prevent the ACL being exceeded. EES factors are not an explicit part of ACT, however the decision to use certain management measures are based on EES factors (for example, a decision not to impose a more effective, but more costly, data collection system in the fishery), and those decisions lead to the degree of management uncertainty in the fishery. Therefore, the management measures (ex: in-season closure authority, quotas, trip limits, days-at-sea, etc) used in a fishery, which, to comply with NS1, are required to prevent overfishing and achieve OY, are connected to the concept of the ACT by virtue of the resulting degree of management uncertainty.

There may be cases where the OY, and its annual expression, are lower than the ACT, if the OY has been reduced for a factor, such as the stock's role in the ecosystem, that is unrelated to management uncertainty. In such a case, the fishery should be managed to achieve the OY, rather than the higher ACT value. An OY that is higher than the ACT may indicate that the OY specification has not adequately considered all the relevant EES factors, as the resulting management measures appear unable to achieve the OY and prevent overfishing. It may also indicate that changes in management measures, to reduce management uncertainty, are needed in order to achieve the desired OY, as reduced management uncertainty would allow the ACT to be increased to the desired OY level.

In conclusion, while OY and ACT values are arrived at in different manners, they conceptually represent the same thing, the target of the fishery. In the presentation, we open for discussion that the target fishing level for a year should be the lower of the ACT and the annual OY. If the two are significantly different, it is an indication that either the OY specification or the management measures in the fishery need to be reevaluated.

Presentation

Debra Lambert (NMFS) gave a presentation on the concept of Optimum Yield (OY) that included an overview of National Standard 1 definitions of maximum sustainable yield, OY, the National Standard 1 guidance on OY, examples of how the Councils applied OY in different ways, a comparison of OY and actual landings from several fisheries and the relationship of OY to the framework for determining ACLs. She also explained how the definition of OY was changed by the Sustainable Fisheries Act to take into the account the protection of marine ecosystems and in the case of overfished fisheries, to provide for rebuilding to a level consistent with producing maximum sustainable yield.



Her examples of how the Council's have defined OY in terms of their fisheries included the following:

- OY is not defined
- OY is the amount of fish harvested legally under provisions of FMP
- OY is zero
- OY is set at MSY or MSY proxy
- OY is set at yield associated with F_{MSY} or $F_{MSY\ proxy}$
- OY is set at a % of MSY or MSY proxy
- OY is yield associated with % of F_{MSY} or $F_{MSY\ proxy}$
- OY is specified annually
- OY is defined as a range and for a fishery/complex
- OY is defined based on a rebuilding plan

Some OY definitions explicitly mention ecological, economic and social factors, but many do not; however, the decisions on how a fishery is managed (ex: in-season closure authority, quotas, trip limits, days-at-sea, etc), are based on ecological, economic, and social reasons.

In her summary Deb provided the following guidance from NMFS to the Councils:

OY is the long-term average desired yield from a stock, stock complex, or fishery. It may be helpful to consider OY in terms of an annual value. There are a variety of OY definitions in the current FMPs. Many OY definitions have not been reassessed in a long time. Because ecological, economic, and social factors are always changing, OY should be revisited periodically. Because achieving OY is the goal, it could be informative to compare catches to OY. If management measures cannot prevent overfishing while achieving OY, the Councils should reevaluate the management measures and specification of OY so that the dual requirements of NS1 are met.

Conceptually, the annual OY value corresponds with the target of the fishery. The full range of conservation and management measures for a fishery, which include the ACL and AM provisions, are required to achieve the OY for the fishery on a continuing basis.

Q&A

It was noted that OY should be applied to catch and not simply landings, due to discards at sea.

There are some extra considerations in determining OY instead of simply factoring OY into the buffer between OFL and ABC. OY, which is an objective, should not be equated with ABC, ACL, or ACT which are essentially biological constraints. OYs for healthy stocks may be constrained by technological interactions with stocks in poor condition.

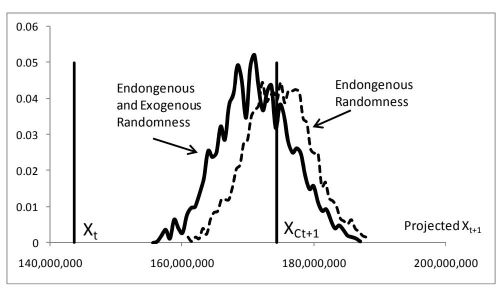
ACLs and Stock Rebuilding

Lee Anderson (University of Deleware) presented an approach for incorporating management and scientific uncertainty as well as economic considerations into management decisions. More specifically, he provided a probabilistic framework for annually adjusting a harvest level specified by the OFL control rule to address uncertainty that he described as possibly simpler than the framework presented by Williams, Shertzer and Prager (2008). The framework also takes into account costs related to the size of the buffer between OFL and ABC. Lee illustrated his concept with calculations from a quasi-hypothetical stock projection model written in EXCEL with a Crystal Ball add-on to perform Monte Carlo analysis. It demonstrated the types of things that can be accomplished with data that is currently available for some fisheries.

He explained that three questions needed to be answered to introduce his probabilistic approach and gave examples of answers: 1) What is the probability distribution that is of policy relevance? 2) How can the probability distribution function be generated? 3) How can the probability distribution function be used to convey useful information about how to set buffers? For a detailed description of the model refer to Lee's written paper.

Lee noted that the concepts of scientific and management uncertainty are closely related. It is difficult to separate their effects even though the National Standard 1 Guidelines tell us we should.

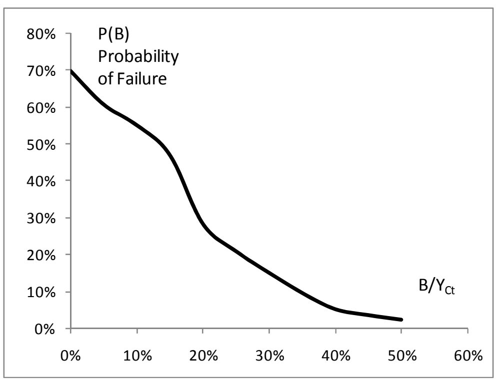
The relationship between probability of failure (or success) and the size of the buffer (between OFL and ABC) is critical and yet has not been used to any great extent. It is possible to introduce some benefit-cost analysis into the procedure.



Q&A

Workshop participants commented that the framework was good in that it deals with more than just the uncertainty in trying to set an ABC and it can consider long-term losses from possible stock depletion. However, it was noted that it may be difficult to quantify long-term values and losses associated with future stock levels, such as the value of a particular stock level in the future. It is unclear how we can move beyond our current approach to incorporate uncertainties that aren't directly modeled?

In responding to these comments, Lee stressed that we want to look at the expected value of the loss of not achieving a management objective. We don't want to be overly conservative and the cost of the buffer between OFL and the catch target should be considered. In response to the comment about uncertainties that are not directly modeled, Lee explained that his model assumes the calculation of catch is right. If there is model uncertainty, some additional steps are needed to extend the model.



Maximum Economic Yield

David Tomberlin (NMFS) gave a presentation on Economics and National Standard 1. David emphasized that the concept of maximum economic yield (MEY) has been overshadowed by all the other targets and goals of the MSRA such as OFL, ABC, ACLs and OY, however it still is a very important concept.

MEY is a useful proxy for OY. It reflects benefits to society more directly than MSY, and is typically is more conservative target than MSY. MEY can be calculated subject to any constraints and can be used as a basis for estimating costs of constraints such as scientific uncertainty. Further, MEY can be useful in multi-species settings.

Those who would benefit from achieving OY are commercial fishermen, processors, consumers, recreational fishermen, subsistence fishermen and those who my value fishery resource in a non-consumptive manner. MSY has several shortcomings as a proxy for OY, three important ones being that it does not include a level of precaution (although ABC does); it does not take into account fishing costs; and the weight of fish is a poor proxy for benefits. The concept of MEY is intended to address at least some of these shortcomings.

MEY is the harvest trajectory that yields greatest benefits to society over time, subject to any constraints desired. Typically, $B_{MEY} > B_{MSY}$, but if not, the constraint that $B_{MEY} >= B_{MSY}$ can be imposed to ensure that B_{MEY} complies with MSRA objectives. David showed some examples comparing B_{MEY} and B_{MSY} for Western and Central Pacific big eye tuna, Western and Central Pacific yellowfin tuna, Australian northern prawn fish and Australian orange roughy. In some Australian fisheries B_{MEY} was estimated to be about 1.2 B_{MSY}.

Some issues that must be addressed in specifying MEY under rebuilding scenarios include risk preferences, lumpiness of fleet and port capital (no significant alternative uses of this capital), structural adjustments (adopting an OY target in a fishery without addressing incentives will likely produce sub-optimal yield (SOY) because of the race for fish and illegal/unreported catch). Rebuilding to B_{MEY} faces same political economy constraints as rebuilding to B_{MSY}.

Lest any participants get the impression that estimating MEY is easy, David also identified data that would be needed to estimate MEY to include landed & discarded catch, revenue by trip/species, effort by trip, ports of departure/landings, variable inputs and costs, fixed costs, employment and crew payments by trip, quota costs, processing output, revenue, employment, labor payments, recreational surveys, subsistence surveys, and ecosystem services foregone due to fishing, although a MEY proxy could be estimated with incomplete information.

Q&A

It was noted that it might be helpful to start with maximum revenues then add other values. This probably will shift the value of

MEY back to MSY. For example adding a recreational fishery to a commercial fishery will increase the desired yield. Similarly adding processor surplus moves the curve back toward MSY.

One benefit of calculating MEY is that it provides a framework for considering the economic value of information in reducing uncertainty and whether it is more valuable to reduce uncertainty in biological modeling or by improving the efficacy of management measures.

Since regulations for one stock might impact regulations for other species, one participant questioned if there any chance for moving toward a longer term approach.

Some regions lack basic socio-economic descriptions of our fisheries. There is no cost information available, let alone benefit information, nor are there data on non-consumptive uses.

David concluded that Lee Anderson had a more complete framework for considering these issues. His main point was that increasing the buffer for uncertainty in setting ABC might simply increase short-term costs without providing longer-term, offsetting benefits unless a more comprehensive framework that considered economic objectives such as MEY is used.

Management Strategy Evaluation

Martin Dorn (NMFS) gave a presentation on behalf of several investigators (Martin Dorn, Teresa A'mar, André Punt and Jim Ianelli) about using management strategy evaluation (MSE) to test alternative management strategies in the North Pacific.

Management strategy evaluation (MSE) is the process of using simulation testing to evaluate stock assessment methods and harvest policies. In contrast to conventional stock assessment models, which are primarily tactical tools for obtaining a single "best" assessment, MSE encourages a more strategic focus that allows a wider range of hypotheses to be considered, and seeks to identify management procedures that are robust to violation of assumptions, and are clearly linked to management objectives. The basic elements of MSE are the following: 1) identify management objectives and performance measures; 2) identify alternative hypotheses and represent them in an "operating model"; 3) identify candidate management strategies; and 4) simulate the application of the management strategies.

Two applications of MSE in the North Pacific were presented. The first application evaluated the impact of climatic regime shifts on the performance of management strategies for the Gulf of Alaska walleye pollock fishery (A'mar et al. in press CJFAS). All management strategies considered had uneven performance when regime shifts were incorporated, suggesting that fluctuations in stock status should be expected regardless of how the stock is managed. The current management strategy kept stock closest to the SB40% target, and had the lowest risk of exceeding the overfishing limit, but differences between the alternative management strategies in overall performance were relatively minor.

The second application evaluated the probability of eastern Bering Sea pollock dropping below the management threshold of B20% (20% of unfished stock size). Measures implemented under the Endangered Species Act to protect Steller sea lion establish a B20% as a limit below which no directed fishing would be allowed. The North Pacific SSC requested that the probability of the spawning stock biomass falling below B20% be estimated for a 3-5 year projection. Projected uncertainty in stock status will depend on stock assessments that will be conducted in future years using data from surveys and the fishery that will be available at that time. Projections that simply propagate current assessment uncertainty forward in time may misrepresent the uncertainty that will be experienced in future years.

MSE allows evaluation of the long-term probability of overfishing and its potential consequences, and thus would seem to be particularly germane to the issues that need to be addressed by SSCs in making ABC recommendations. However, MSEs are potentially complex and labor-intensive compared to conventional stock assessments. MSE is a general approach that allows comprehensive evaluation of

uncertainty (i.e., model mis-specification, fixed parameter values, etc), but there are both pluses and minuses to this generality. For example, issues that are not currently well addressed include how to "bound" the simulated extent of uncertainty, and how to weigh alternative scenarios when selecting among candidate management procedures. MSEs are also valuable in data-limited environments as a tool for evaluating the benefits of surveys and data collection programs, and for evaluating empirical control rules.

Management Uncertainty

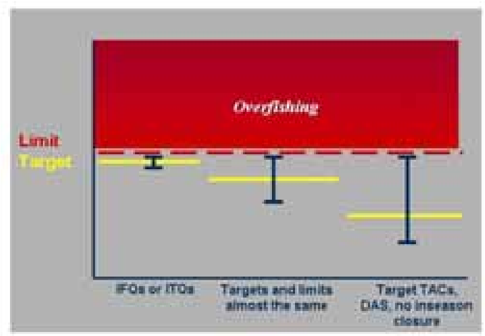
Mark Millikin gave a presentation on "Management Uncertainty in the Context of Annual Catch Limits."

<u>Background</u>

NOAA Fisheries Service provides in the National Standard 1 guidelines that accounting for both scientific and management uncertainty is necessary when setting annual catch limits that prevent /end overfishing. Management uncertainty is the difference between what you plan to catch and what you actually catch for a stock in a fishing year. Catch includes fish that are retained for any purpose, as well as mortality of fish that are discarded. Chief sources of management uncertainty include: (1) inadequate (not timely, or incomplete) catch data; (2) conservation and management measures that don't take advantage of available data; and (3) methods or models and/or quality of stock and fishery data used to estimate future catches that result in poor estimates of actual catch. Consequences of management uncertainty could include: (1) exceeding the annual catch limit (ACL) or even the overfishing limit (OFL) more often, and (2) more difficulty in achieving OY.

NOAA Fisheries recommends the use of an annual catch target (ACT) to address management uncertainty. When following the NS1 guidelines, OFL>ABC, and ABC=ACL. An ACT< ACL would provide separate transparent accounting of management uncertainty with scientific uncertainty accounted for in the difference of OFL>ABC. Use of ACT is appropriate when: (1) past performance shows that a stock's actual catch has often exceeded its catch quota or limit, or (2) fisheries are being managed with annual catch targets and catch limits for the first time when ACLs are first implemented. A Council can ask its SSC for advice on how to calculate management uncertainty based on past fishery performance; still SSCs are not required to recommend ACLs and ACTs.

Assigning ACLs to data poor stocks will be very challenging. Data poor stocks that have catch data have some basis for setting ACLs, even if catch per unit effort data and discard mortality is poorly understood. Data poor stocks without catch data should be considered for assigning to a stock complex/species group if appropriate; otherwise the basis for allowing harvest of the stock needs to be carefully evaluated and an ACL is still needed. Improving data should be a high priority.



Councils are currently considering frameworks for ACLs that include OFL>ABC, ABC=ACL and ACL>ACT, or OFL>ABC, ABC>ACL and no use of ACT. The former framework is less likely to trigger accountability measures (AMs) for a stock in a subsequent fishing year. The latter framework would benefit greatly from precautionary inseason AMs.

<u>Presentation</u>

Mark Millikin discussed the following points: (1) sources of management uncertainty, (2) consequences of management uncertainty, (3) examples of management uncertainty, (4) use of annual catch targets (ACTs) to address management uncertainty, (5) evaluation of overall management uncertainty, and (6) some council's initial considerations for handling management uncertainty. He stated that the NS1 guidelines address both scientific uncertainty and management uncertainty when setting acceptable biological catch (ABC) and annual catch limits (ACLs). He

> *"The importance of setting a target, ACT, below the ACL is that accountability measures are triggered when the ACL is reached. If the ACL is set below ABC to account for management uncertainty and used as a target, then accountability measures will be triggered more often than if ACL is set equal to ABC and a management uncertainty buffer is implemented through ACT."*
>
> **Rick Methot**

noted that management uncertainty was the difference between planned catch and actual catch.

He reported that sources of management uncertainty included: inadequate data, not taking advantage of available data, poor model estimates that lead to poor estimates of catch, changes in management, discards, and latent or variable effort. Consequences of management uncertainty were overages or underages of ACT or ACL that could lead to not achieving optimum yield (OY). Examples where uncertainty was the lowest included ITQs or IFQ fisheries with quotas seldom or never being exceeded. Medium uncertainty occurred in fisheries with good in-season reporting and closures but some late reports, and high uncertainty occurred where there was poor reporting and no in-season closures. With regard to the best practices for using ACT, Mark Millikin advised that when quotas have been used and often exceeded, ACT should be set well below ACL. If a quota has not previously been used, ACT should be the management target.

Management uncertainty can be accounted for in both the difference between ACL and ACT and ACL to ABC; however, in the latter case there is a much higher probability that accountability measures (AMs) would be imposed if the ACL is exceeded. Although the SSC is not required to recommend ACL or ACT, councils may ask for their advice on how to calculate catch (including bycatch) and management uncertainty. In measuring overall management uncertainy, councils should compare past catch to quotas and adjust accordingly. If the SSC does not recommend ABC for data poor stocks, a council could set ACL less than average catch to account for both scientific and management uncertainty or have a separate ACL and ACT. Councils should consider establishing a panel of experts to evaluate uncertainty for data poor stocks to account for uncertainty in setting ACL. For stocks with no catch data, councils may want to use an ACL for a stock complex with an indicator species, and data from fishers might be the only data available during the initial setting of ACL.

In summary, Mark stated that management uncertainty is reduced for stocks that have in-season closure authority and timely, and accurate catch data within a stock's fishing year. Furthermore, the recommended framework would be:

OFL>ABC=ACL>ACT

He believed that this concept was more likely to prevent overages of ACLs than if ACL<ABC with no ACT. He noted that some councils are considering using ACTs, and others are considering using ACL<ABC (but in some cases very close to being equal) for a stock's management uncertainty.

Councils can consult with their SSCs about how to calculate management uncertainty, but SSCs are not required to provide this information. Some fisheries with recent hard quotas (catch limits) or target total allowable catches (TACs) and annual catch data can evaluate overall management uncertainty by comparing past performance (how often and by how much did catch exceed or stay below quotas).

> *"Management uncertainty should be accounted for in the difference between ACL and ACT, in most cases. Without an ACT it's likely that you're going to exceed the ACL more often."*
> **Mark Millikin**

Q&A

It was noted that an IFQ program does not necessarily decrease management uncertainty. Rather an IFQ program can improve the ability to monitor catch and close a fishery (or a component thereof) when an established target is reached. The commercial sector has better monitoring and controls than the recreational sector, thus scientific and management uncertainty are greater for the recreational sector. Past performance by the recreational sector is difficult to measure because effort is not controlled, and in-season closures are not viable measures in most cases due to the inability to real-time monitor the catch.

It was noted that the ACL establishes the basis for triggering AMs. The major benefit of a ACT is that the ACT can be exceeded without triggering the need for onerous AMs. It was noted that some councils don't use ACT, but past management measures were set to achieve OY and controls are in place to limit catch to that OY.

With greater uncertainty regarding ABC and ACL, the panel discussed the possible need for ACTs, which is not a requirement but an option in the NSI Guidelines to deal with high degrees of management uncertainty. It was noted that ACTs may be particularly useful with the recreational sector due to the inability to in-season monitor the catch and possible history of overages in this sector.

The panel reviewed a portion of Rick Methot's presentation regarding setting ACL/ACT in data poor situations. It was pointed out that biology of stocks is key to setting ABC for data poor stocks. It was noted that if only catch is known, councils should use a panel of science and local experts to evaluate whether the level of catch is: too low, too high, or about right for a given stock or stock complex, and then determine the appropriate ABC, ACL, and/or ACT. If historical catch was not targeted and was confidently below a level that could approach overfishing, a stock could be classified as an ecosystem component stock without the need for a status determination criterion. If catches were small, ABC and ACL could be set above historical catches with an ACT set at a historical average catch. For moderate to high catch levels, ABC and ACL would likely need to be set below historical catches to avoid AMs. It was noted that caution is warranted when using catch data only because catch could be stable with increasing effort, confounding scientific advice. A suggestion was made to form an Ad Hoc Working Group to produce a white paper to address ABC in situations where only catch data are available. Meeting participants supported this proposal.

Workshop participants discussed the potential that under-reporting may disguise the possibility that historical catch is too high, e.g., some Caribbean stocks. For data poor situations, it was noted that catch controls may not be useful and area closures may be more appropriate to prevent/end overfishing. Consequently, management may get little advice from the scientific process. One possible approach would be to allow only experimental fisheries until adequate information is known about stock status.

In further reviewing the relationships between OFL, ABC, ACL, and ACT, participants discussed the premise that a management regime may be set up using tiers with small buffers for more data rich stocks and larger buffers for data poor stocks. It was also pointed out that SSCs must deal with changes in data that may move a stock's status from one tier to another and how robust such changes are viewed when providing ABC advice.

Other Contemporary Issues

Catch Shares

Mark Millikin (NMFS) gave a presentation on behalf of Galen Tromble and Alan Risenhoover regarding catch shares and NOAA's Catch Share Policy under Development. A summary of the presentation is provided below.

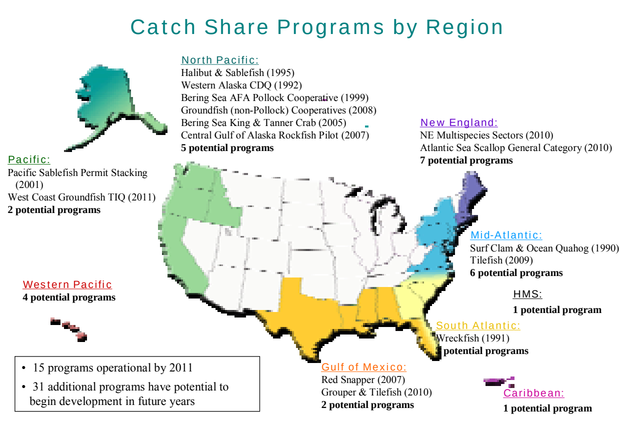
U.S. domestic fisheries operated as open access domestic fleets under the theme of common property alongside foreign fishing near U.S. shores before the Magnuson Fishery Conservation and Management Act (M-Act) of 1976. Expansion of U.S waters to 200 miles from shore ended most foreign fishing, and domestic fleet expansion resulted along with more command and control management (quotas, effort, seasons, areas). A few limited access programs began, notably the individual transferable quota (ITQ) fisheries for surf clams and ocean quahogs and individual fishing quotas (IFQ) fisheries for North Pacific halibut and sablefish. The Sustainable Fisheries Act amended the M-Act in 1996 to be the Magnuson-Stevens Act (MSA) and placed more emphasis on the need to end overfishing and rebuild overfished stocks resulting in more control of fleet expansion and consideration of limited access. Some overfishing of New England groundfish stocks persisted and overfished stocks have been problematic for some New England and Pacific coast groundfish stocks. As a result, these fisheries and some others are not producing their full economic value and employment.

Competition among fishermen under an overall quota without catch shares often results in a race to catch as much fish as fast as possible. This often results in quota overages, seasonal gluts of fish in the markets, fishing safety problems, and high amounts of bycatch.

The MSA was amended by the Magnuson-Stevens Reauthorization Act of 2006 to establish more stringent requirements for ending overfishing and statutory language for "Limited Access Privilege Programs." NOAA Fisheries is developing a "Catch Shares Policy" to encourage regional fishery management councils to consider catch shares as an option for management in their various fisheries. Catch shares programs would set an annual quota for each fish stock and allocate an exclusive portion of that quota to entities such as fishers, cooperatives or communities. The recipient of a share is responsible to stop fishing when it is reached. Benefits of catch share programs could include control of catch to prevent overfishing, reducing overcapacity, improving overall economic performance in the fishery, improving safety at seas, and increasing participants' responsibility for monitoring and management. This has already occurred in the Atlantic surf clam and ocean quahog ITQ fisheries and the North Pacific halibut and sablefish IFQ fisheries. We expect that 15 catch share programs will be in place by 2011, and up to 31 more programs may be developed in the coming years.

Some of the concerns that stakeholders have raised about catch shares include: increased wealth by large stakeholders, inherent economic inequalities in the distribution of shares, exclusion of entry level fishers, financial speculation of shares, high grading, increase in false reporting, implementation and monitoring costs, privatization is hard to reverse, and crews may sometimes be disadvantaged.

NOAA Administrator Lubchenco announced the formation of a Catch Shares Task Force in June 2009 to develop NOAA policy on catch shares. The NOAA policy on catch shares would be designed to ensure that catch shares are fully considered when Councils take up Fishery Management Plan (FMP) amendments. The policy will include guidance, not rulemaking, and will not mandate catch shares, but rather encourage their broad consideration.



Desired attributes of the policy are expected to include:

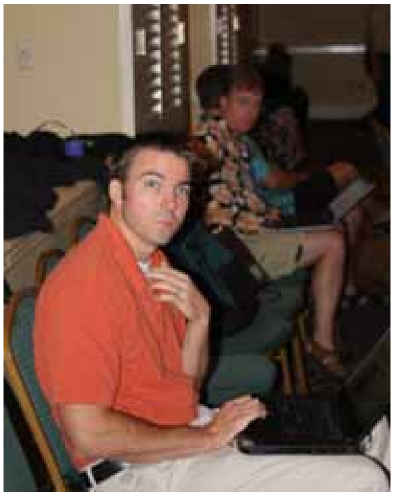
removing impediments to consideration and use of catch shares; promotion of fair and equitable treatment through descriptive analyses; ensuring when possible, sustainable fishing communities; possible collection of royalties for initial or subsequent distribution of allocations; and seeking additional funds to supplement cost recovery and implementation of catch share programs. Some working assumptions about catch shares include: (1) there is no one size fits all catch share program, (2) not all fisheries can/should be managed by catch shares, (3) catch shares generally keep costs low and produce high valued product for the overall fishery, and catch shares should be designed so as to comply with the MSA and other applicable law just like other FMP actions.

NOAA Fisheries released a draft/interim policy on the web on December 10, 2009. The public comment period will end April 10, 2010. There will be a second round of stakeholder briefings and presentations by NOAA Task Force members for each Council.

Q&A

Although catch share programs may not increase the number of fishing jobs available, they have potential for increasing abundance of resources and provide corresponding improvements to employment.

There was a discussion about the role of the SSCs in development of catch share programs, given that this is primarily an allocation issue. There was general consensus that there indeed was an important role for the SSCs relative to reviewing analyses of catch share programs, given potentially large social and economic implications. Both the Pacific and North Pacific SSCs review all environmental and economic analyses to ensure that these analyses are robust (i.e., scientifically sound and complete). The SSCs do not weigh in on policy matters such as accumulation limits of quota, or limitation on movement of quota. Rather, the SSC provides an evaluation of the documents, and may provide additional comments to the Council, such as the need for baseline data to evaluate before and after consequences of implementing a catch share program.



Marine Recreational Information Program

Rob Andrews (NMFS) gave presentation on the Marine Recreational Information Program. The goal of the Marine Recreational Information Program (MRIP) is to develop a nationwide system of surveys operating with consistent standards and sufficient flexibility to meet national, regional and state needs, and to provide reliable information about recreational fishing in a timely manner to support effective and fair management. MRIP is a national program that will provide an umbrella of recreational fishing data collection design and operational guidance that will be applicable in all regions. Specifically, MRIP will provide enhanced survey design, implementation and management approaches that include: 1) utilization of angler registries as sample frames, 2) optimized sampling and estimation designs, 3) development of improved methods for estimated discarded catch, 4) development of methods for covering "rare-event" species, and 5) enhanced quality assurance and quality control procedures. Within this national framework, regional data collection partners will make their own decisions regarding basic survey design choices, survey coverage beyond the standard minimum, and temporal and geographic resolution beyond the standard minimum.

Improvements to survey design and management will be implemented in a sequential, phased approach. In the initial, or Evaluation phase, current survey methods are being fully documented and evaluated. Second is the Innovation phase, in which new survey methods are being developed and tested via pilot projects, and the results compared to current methods. In the final Activation phase, survey improvements will be implemented. MRIP will establish survey standards and best practices based on the results of the projects in the first two phases. NOAA Fisheries and its partners will implement improvements in survey design and management and will expand sampling as necessary and possible to achieve improved spatial and temporal resolution of catch estimates in consultation with our regional data collection partners.

MRIP work groups are currently developing or implementing projects in each of these phases. Descriptions of MRIP projects, including status updates, are provided in the MRIP Implementation Plan, which can be downloaded from the MRIP website (http://www.st.nmfs.noaa.gov/mrip/aboutus/organization/downloads/MRIP_Implementation_Plan.pdf).

Q&A

It was noted that this is a very big project with over 100 individuals involved. The Executive Steering Committee includes members from the Councils and State Commissions, and this helps to keep the focus on what data are needed for stock assessment and management. MRIP is working hard to remove bias and uncertainty in the MRFSS survey, improving the surveys and data to provide more robust estimates of recreational catch.

It was noted that MRIP is regionalized, and not a one-size-fits-all data collection. Each region can decide what information is needed for the fisheries in its region, while still adhering to the overall standards for an MRIP data collection program.

There was a question of how to identify the pool for a mail out survey, particularly for those states that don't get an MRIP permit (not registered). In these cases, the pool is licensed anglers, and there should be some matching of addresses from the licenses and logbooks. A comparison could be made with a telephone survey as well. It was noted that logbooks may have limited use for in-season management, even with monthly or bi-monthly reporting.

Marine Protected Areas

Participants had a short discussion on the development of MPAs in their region, and possible inclusion in the national MPA system. In the mid-Atlantic, the Council has recently proposed several new MPAs for scup and the canyon areas. The Gulf of Mexico has used closure areas to protect shrimp nurseries and habitat, and some of these areas have had monitoring, but funding for monitoring has not been maintained. Other Councils have been hesitant to nominate sites for the MPA system, given concerns about authorities and prior experience.

Barbara Kojis noted that the USVI marine conservation district, a 17 km^2 year-round no-fishing reserve area designed to protect a red hind spawning aggregation, has been extremely successful. Monitoring has shown increase in the size of fish, a 1:1 sex ratio (a good indicator for this sequential hermaphrodite), and increasing numbers of spawners. Nassau groupers are also developing a new spawning aggregation in the reserve. Fishermen have reported increasing catches of red hind in areas outside of the protected areas. Based on this success, other closures to protect spawning aggregations of other species have been implemented (seasonal closure of snapper/grouper spawning areas).

"The goal of MRIP is not explicitly to support in-season management. It's to address a lot of the potential biases that were pointed out in the NRC review. There's always going to be practicalities associated with sampling. The idea of real-time data collection from the recreational sector is maybe somewhat of a myth."

Rob Andrews

Ecosystem Considerations

There were no presentations on this topic. However, it was noted that the PSA can be a useful tool for ecosystem considerations by identifying those species most vulnerable to fisheries. A mapping tool that examined disturbance patterns by fishing gear was developed in the northeast and was useful in the EFH evaluation process.

It was noted that ecosystem-based management could be a major focus topic for a future SSC Workshop. There are a variety of approaches being taken across the country, and together with the fact that the National Ocean Task Force has adopted ecosystem-based management as a national objective, it would be valuable to compare scientific approaches and seek best practices through the SSCs.

"It seems like the system is far over engineered for any realistic level of knowledge and capability to apply the whole thing. It sorts of reminds me of buying a new VCR or DVD player -- I guess I'm dating myself -- a DVD player or a Blu-ray player, and you get a handbook that's ninety pages; then you get the nice one-page pullout cardboard piece that contains everything you need to know to use the damned thing. I guess some of us are still looking for that one page that probably covers 99 percent of the applications and we are not there yet."

John Boreman

"A very strong argument can be made to meet at least one more time just based on one topic: the quantification of scientific uncertainty and the unique role of the SSCs in the process for quantifying and setting an ABC. I find these meetings to be very helpful and useful. It's been gratifying to me."

Steve Ralston

"This annual meeting is an essential activity that we need to continue. Methods are still being developed and tested and we would benefit by reconnecting next year to discuss the progress we have made."

Luiz Barbieri

Final Recommendations

Participants felt strongly that it was critical to have another workshop next year. The SSCs now have a very large responsibility to establish ABCs, and many of the methods and control rules are still in the development and testing phases. The diversity of approaches to quantifying scientific uncertainty reflects that this is a new field for fisheries, which requires refinement of approaches over time, and SSC Workshops offer a very efficient way to develop and refine best practices for these technical issues. Topics suggested for the next SSC Worskhop included:

- Comparison of technical peer review processes;
- Uncertainty calculation approaches in OFL;
- What is the role of SSC in determination of management uncertainty;
- Ecosystem based management approaches;
- Reviewing NS2 Guidelines;
- Best practices for ACL control rules;
- Best practices of scientific review processes and analytical evaluations.

Participants agreed that in addition to SSC Workshops, further information exchange across councils could be enhanced by sending an SSC member to sit in on other Council SSC meetings on occasion, distributing reports among the SSC chairs, and other coordination where practicable. In addition, at the next CCC meeting the Council Chairs should discuss relationships between individual Councils and their SSCs and agree on a set of best practices for governing that relationship.

Lastly, the group supported the establishment of a subcommittee to examine issues for data poor situations and develop approproate catch level recommendations. As one goes through the guidelines, it was suggested that a default F = 75% of Fmsy may emerge as a simple robust approach that is useful in some circumstances and avoids consideration of exactly where the fishery is in terms of biomass. Jim Berkson agreed to lead the data poor subcommittee in development of a white paper exploring these issues.

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Appendix 1: Meeting agenda

November 10-13, 2009. Wyndam Sugar Bay, St. Thomas USVI

TUESDAY

9am Welcoming Remarks, Introductions and Announcements
Rapporteur assignments; other tasking

Peer review
National Standard 2: Update and Discussion [Michaels]
NS2 notice here http://www.nmfs.noaa.gov/msa2007/docs/NS2_ANPR.pdf
• Meeting NMFS and Council objectives for BSIA and peer reviews
• Clarifying the role of SSCs in the review of scientific information

1pm **National Standard 1 and Scientific Uncertainty**
- Report on National Standard 1 Guidelines [Methot and Williams] NS 1 Guidelines here http://www.nmfs.noaa.gov/msa2007/docs/acl_final_rule.pdf
- Quantifying scientific uncertainty in OFL

Council Approaches to Complying with NS1 Guidelines
- Status report from each SSC on approaches being taken to implement NS1 Requirements

North Pacific – Pat Livingston
Pacific – Steve Ralston
Western Pacific – Rick Deriso
New England – Steve Cadrin
Mid-Atlantic – Mike Wilberg
South Atlantic – Carolyn Belcher
Gulf of Mexico – Doug Gregory
Caribbean – Barbara Kojiis

WEDNESDAY

8am Council Reports (continued)
Discussion of Scientific Uncertainty
- Can we get to full probabilistic methods for setting buffer between OFL and ABC?
- Proxies for unmeasured uncertainty and tiered approaches to setting buffers
- Using stock vulnerability in setting level of risk aversion [Patrick] See WG3 Report http://www.nmfs.noaa.gov/msa2007/docs/vewg_report.pdf Extended Abstract; Presentation

1pm **Hitting the Target**
- OY Overview including requirements and relationship with ACL/ACT [Lambert]
- Setting ACLs within a stock rebuilding plan [Lee Anderson paper]
- Defining Maximum Economic Yield and MEY Control Rules [Tomberlin]
- Management Strategy Evaluations [Dorn - T]
- Accounting for management uncertainty including the use of ACTs [Millikin]

THURSDAY

8am **Other NS1 issues**
- Dealing with data poor situations: Best proxies for Fmsy; Science advice when only catch is known; How to group stocks into complexes
- Rebuilding plans and policies

1pm **Other Contemporary Issues**
- Catch shares [Millikin]
- The Marine Recreational Information Program and National Angler Registry: Status of Implementation
- MPAs
- Ecosystem considerations

FRIDAY

8am **Discussion and Meeting Conclusions/Recommendations**
12 noon – Closing remarks

Appendix 2: National SSC Workshop Participants and Observers

North Pacific Fishery Management Council (NPFMC)
Patricia Livingston
Franz Mueter
Keith Criddle
Dave Witherell

Pacific Fishery Management Council (PFMC)
Steve Ralston
Tom Jagielo
Martin Dorn
Vidar Wespestad

Gulf of Mexico Fishery Management Council (GMFMC)
Doug Gregory
Richard Fulford
Will Patterson
Rick Leard

Caribbean Fishery Management Council (CFMC)
Barbara Kojis
Jim Berkson
Mike Sissenwine
Miguel Rolon

South Atlantic Fishery Management Council (SAFMC)
Carolyn Belcher
Andy Cooper
Luiz R. Barbieri
John Carmichael

Mid-Atlantic Fishery Management Council (MAFMC)
John Boreman
Michael Wilberg
Thomas Miller
Rich Seagraves

New England Fishery Management Council (NEFMC)
Steve Cadrin
Pat Fiorelli
Jean-Jacques Maguire
Chris Kellogg

Western Pacific Fishery Management Council (WPRFMC)
Rick Deriso
Bob Skillman
Mike Trianni

National Marine Fisheries Service Participants
Rick Methot
Mark Millikin
David Tomberlin
Paul Crone
Owen Hamel
Don Kobayashi
Shannon Calay
James Weinberg
Bill Michaels
Deb Lambert
Wes Patrick
Rob Andrews
Stewart Allen
Erick Williams
Paul Rago
Stephen Brown

CFMC Support Staff
Diana Martino
Maria de los A. Irizarry
Natalia Perdomo

OTHER ATTENDEES
Lee Anderson
Rick Robins
Tony Kerns
Ken Stump
Sara Jones
Chad Hanson
Dennis Heinemann
Dana Wolfe
Claudia Friess
Beulah Dalmida-Smith

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